UNIVERSITY OF EDUCATION, WINNEBA

USING COOPERATIVE TEACHING AND LEARNING APPROACHES TO IMPROVE FORM 3 SCIENCE (A) SHS STUDENTS' PERFORMANCE IN TITRIMETRY

VITALIS AADIREYIR

190013345

A DISSERTATION IN THE DEPARTMENT OF SCIENCE EDUCATION, FACULTY OF SCIENCE EDUCATION, SUBMITTED TO THE SCHOOL OF RESEARCH AND GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF A DEGREE OF MASTER OF EDUCATION IN SCIENCE EDUCATION OF THE UNIVERSITY OF EDUCATION, WINNEBA

JULY, 2021

DECLARATION

Student's Declaration

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

………………………… ……………………………

VITALIS AADIREYIR. DATE

Supervisor's Declaration

I hereby declare that the preparation and presentation of this dissertation was supervised in accordance with the guidelines set for dissertation laid down by the University of Education, Winneba.

………………………..…… ……………………………

DR. ARKOFUL SAM DATE

(SUPERVISOR)

ACKNOWLEDGEMENTS

First of all, my sincere thanks go to the Almighty God whose love, protection, mercies and guidance have brought me this far.

My heartfelt thanks go to my supervisor, Dr. Arkoful Sam of the Department of Science Education, University of Education, Winneba, for his guidance, encouragement, constructive criticism and his suggestions and also for spending time and energy in reading through the scripts during the period of the work. Also, I wish to thank all those wonderful people who helped me in diverse ways during this study.

My special thanks also go to the Headmistress of St. Francis Girls SHS for granting me permission to carry out the study in her school.

Finally, I am especially grateful to the science teachers and the students of St. Francis Girls SHS for accepting to be part of my study. God richly bless you all.

DEDICATION

To the Almighty God for faithfulness in fulfilling His promise to me. I also dedicate this work to my wife madam Mary Assumpta Aadireyir, and children Aadireyir Sabina, Aadireyir Sarah, Aadireyir Sandra and Aadireyir Salorm for their love, support and prayers throughout the study.

TABLE OF CONTENT

CONTENTS **PAGES**

LIST OF TABLES

LIST OF FIGURES

DEFINTION OF ABBREVIATIONS

WASSCE	West African Senior Secondary Certificate Examination
GAST	Ghana Association of Science Teachers
JICA	Japanese International Cooperation Agency
STME	Science, Mathematics and Technology Education
COE	College of Education
PLTL	Peer-Led Team Learning
DTM	Direct Titration Method
BTM	Back Titration Method
KNUST	Kwame Nkrumah University of Science and Technology
WAEC	West African Examinations Council
MESS	Ministry of Education, Science and Sports
ICT	Information and Communication Technology
SHS	Senior High School

ABSTRACT

This study on titrimtry which is practical oriented sought to find out the effectiveness of using cooperative learning to improve upon the performance of students in titrimetry in senior high schools in St. Francis Girls' SHS. The research also assessed the attitude of students towards the use of cooperative learning.The main instruments used for data collection was achievement test with observation as supplementary instrument. One hundred and twenty students participated in the study. The participants were selected from third year students science classes in the school, thus, 3 Science (A) and 3 Science (B). These two classes were randomly assigned as a control group, instructed through the traditional (lecture method) and the other as experimental group instructed through cooperative strategies. A pre test on student's knowledge and skill in titrimetry was conducted before instruction to determine their baseline achievement. At the end of the instruction, a post test was administered. The scores obtained from the pre tests and post tests were analysed using statistical package for social sciences (SPSS) version 16 for windows 2007. The results obtained from the statistical analysis showed a significant improvement of the students, largely attributed to the use of cooperative learning. It was concluded that cooperative instructional approaches had a positive effect on the students' performance in titrimetry. It was recommended that teachers should endeavor to incorporate cooperative learning strategy into any method of teaching to enable the student reap the benefits.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter provides the introduction to the study which includes the background to the study, the problem statement and the purpose of the study. It also covers the research questions that were formulated to guide the study, the significance of the study, the justification of the study, the limitations and delimitations that were identified during the study as well as definitions of some terms used in the study. Finally, it presents the organisation of the chapters in this study.

1.1 Background to the study

Many studies have been conducted on effective ways of teaching and learning in the various academic disciplines, especially science. In Ghana education system, science is so important that its teaching and learning have been greatly emphasised. Chemistry is one of the most important branches of science which enables learners to understand what happens around them. Chemistry is a core subject for medical sciences, Textile science, Agricultural science, synthetic industry, printing technology, pharmacy, chemical technology,(Jegebe 2007). Chemistry is one of the science subjects in science curriculum that is important for any given progress in technology. It occupies a central position among all the sciences (Ahiakwo, 2012). The current West African Senior School Certificate Examination (WASSCE) and West African Examinations Council (WAEC) syllabus in chemistry contains topics in physical, inorganic, analytical and organic chemistry which is the basic focus of the study.

Organic chemistry is an essential part of everyday life and it has enormous economic importance in breweries, cosmetic industry, plastic, etc. The number of candidates who fail or get low grades in elective science subjects in SHS in Ghana has become a great concern in recent times. A minimum of credit is required to enable a student read chemistry or chemistry related programme in the universities and other higher institutions. The same goes for physics and biology (KNUST, 2011).

Chemistry tends to be one of the subjects that disqualifies a large number of students from entering the universities. It is also one of the causes of some science students' engagement in remedial classes and resitting of West African Senior Secondary School Certificate Examination (WASSCE) after completing second cycle schools to better their grades to enter tertiary institutions.

It can be said that chemistry occupies a central position in the field of science and science related professions. It is linked with biology through biochemistry, which is the study of the chemistry of living organisms, especially the structure and function of protein. Discoveries in biochemistry have found very important uses in medicine, agriculture and industry. Chemistry is also linked with Physics through physical chemistry (Ameyibor&Wiredu, 1991). Even though chemistry seems to be one of the subjects which influences the lives of people in many ways, it is one of the academic subjects students tend to dislike most (NUL, 1999). Looking at the unique position of chemistry in the sciences, it is very important that due attention is given to the areas students find difficult handling in chemistry. A study of the Chief Examiners report on West African Senior School Certificate Examination (WASSCE) in 2008 chemistry practical results revealed that some of the candidates could not use the mole concept to solve problems posed in quantitative analysis. According to the report, a number of them also could not quote the correct units for the titre values, molar masses and concentrations for the solutions used. Full WASSCE Examination results in the recent times show that even though some students in the SHS's within Jirapa Municipality have been scoring passes in chemistry, very little could be said about the quality of passes that was required to make them pursue the study of science and science related fields at the universities. A study by Brown (1999) showed that one of the contributory factors to poor performances in chemistry was inadequate acquisition of skills for practical work.

Literature shows that inappropriate methods of teaching and learning such as lecture method, rote learning and lack of practical learning contribute immensely to the lack of interests and poor performance of Ghana students in science. Government of Ghana, the Ministry of Education, Ghana Education Service as well as many other stake holders have made a lot of effort to address science education issues in the educational system. However it appears that, the continuous use of inappropriate teaching and learning methods continue to erode the diverse efforts put in by the bodies mentioned above. Some educational bodies and associations in the Ghana Education Service having realised the problems confronting science education in Ghana have initiated some projects to help solve these problems to improve science education at the various levels of the educational system and support research work on science. For example the Ghana Association of Science Teachers (GAST) focuses on promoting effective teaching and learning of science at the pre-tertiary level by organising workshops, updating the science content of the curriculum of basic and second cycle school, developing teaching and learning resources and writing of text books. Most of these are achieved through the organisation of annual science conferences (GAST, 2000).

Another body, the Japanese International Cooperation Agency (JICA) project, a nongovernmental organisation has established science resource centers, in three of the Colleges of Education (COE).These are Akrokeri, Bagabaga and Akropong Presbyterian COE. The resource centers are to enhance development and production of science teaching and learning materials. JICA also supports the organisation of Science, Mathematics and Technology Education (STME) clinics and workshops for first and second cycle students. Again, JICA sponsors selected teachers at the COE to pursue certificate, degree and some masters courses in science, mathematics and technology education outside the country, specifically in Japan (JICA, 2007).

In addition, the Ghana Education Service had over the years and in recent times, made several attempts to reform teacher education and the training system to enhance the quality of teaching and learning of science and mathematics at the basic education level. This guided the 2004 New Educational Reforms Implementation Committee to the upgrading of the 38 Teacher Training Colleges to Diploma awarding institutions, and later setting aside 15 colleges out of the 38 to pursue quasi- specialist programmes in science and mathematics.

According to Hussain (1990), knowledge is increasing in an exponential rate. This new knowledge added to technological equipment are influencing our daily lives and making deep impact on our ways of living, beliefs and thoughts. The Government of Ghana (2004), realising this, identified science and technology clearly as the bases of launching Ghana into a state of middle income country and a competitor with other developing nations in the 21st century. The Ministry of Education, Science and Sports (MESS) were therefore tasked by the government to orient individuals to all levels of the educational system to enhance the teaching and learning of science and technology. The Educational Reforms buttressed the Vision 2020 by drastically reviewing the state of science education at all the pre-university levels of the educational system. Natural sciences were introduced at Basic 1 to 3. Basic electronics, Information and Communication Technology (I C T) became part of the curriculum of pre-tertiary Education. The science syllabus was thematically organised to make science education more related, integrated and more relevant to everyday life experience.

Included in the topics in the syllabus for SHS chemistry is titration. Titrations are very common practical exercises in secondary education to assess a chemistry students' attitude in chemistry. The unit comes under several labels such as quantitative analysis, mass-volume relationships, volumetric relationship and volumetric practical work. It is an integral and compulsory unit for all Senior High School chemistry students and for under-graduates studying chemistry, biology, physics and other applied science like biochemistry, microbiology, agricultural science, nursing and pharmacy. These groups of students must possess the fundamental experiences from the Secondary level. Several factors account for students' performance in chemistry. These factors according to Okebukola, (2006) accounted for 64% of the variance of students' score in practical chemistry. When stepwise multiple resection analysis was applied on the data collected, students' participation in laboratory activities made the greater independent contribution to variance in performance, followed by students' attitude to chemistry as a subject. Other related factors are teachers' attitude to chemistry laboratory work and the availability of chemistry laboratory materials.

Titration in Senior High School syllabus covers simple acid-base titration, back titration, redox titration and double indicator titration. There is the theoretical aspect of titration that has to be well understood for the student to appreciate the practical work. Students are expected to know the meaning of acids and bases, their properties and how to identify them by their reaction to indicators and other chemicals. Students often get confused with choosing the right indicator for a particular titration which indicator is needed and when it is to be added to the solution being titrated against. The students need to know what happens to the reacting species as the reaction proceeds till the end point is reached. Studies carried out by numerous philosophers showed that students face the challenges of proper handling and usage of the major equipments which are the pipette, burette and conical flasks. Students find difficulty in pipetting solution and transferring it to the conical flask. Some students read levels of solutions in burettes wrongly as they determine initial and final volumes in the course of titration. Other students are not able to determine the correct end point during titration.

Another area students face problem with, is work presentation. This involves drawing a table of values and selection of consistent titre values for the calculation of an average titre. Others are balancing of reaction equations, calculating amount of species involved in the reaction and concentrations of solutions. Looking at the problems faced by students in titrimetry, cooperative learning appears to be the learning method that would help students acquire adequate knowledge and equip them with the requisite skills to carry out titration effectively.

1.2 Statement of the Problem

In a series of theoretical and practical pre-tests conducted by the researcher to find out strengths and weaknesses of students in order to devise remedial interventions, it came to light that a large number of them did not understand the theoretical aspect of titrimetry. This made it difficult for them to know and understand the concept underlying the practical work they were doing. It was also found that some students lacked manipulative skills. They had difficulty in the proper handling and usage of the titration equipment. For example they found it difficult reading the level of solutions in pipettes and burettes correctly, as a result of their non-familiarity with the graduation on them or as a result of wrong placement of eye when observing the meniscus. It was also found that during titration, the students usually exceeded the end point or did not arrive at the end point before taking the reading that may be due to wrong judgment of colour change on their part. It also came to light that some of the student's work presentation was very poor in the areas of presentation of tables of results, balancing of reaction equations and the calculation of entities and concentrations.

1.3 The Purpose of the Study

The purpose of the study was to use cooperative teaching and learning approaches to improve form 3 Science (A) SHS students' performance in Titrimetry.

1.4 Research Objectives

The Study objectives were to:

1. Assess the causes of students' poor performance in titrimetry and also evaluate the effects of cooperative teaching and learning approaches on students' theoretical knowledge in titrimetry
2. Evaluate the effect of cooperative teaching and learning approaches on students' manipulative skills in titrimetry
3. Assess students' attitudes towards the use of cooperative teaching and learning approaches in titrimetry.

1.5 Research Questions

1. What are the causes of students' poor performance in titrimetry and also the effects of cooperative teaching and learning approaches on students' theoretical knowledge in titrimetry?
2. What are the effects of cooperative teaching and learning approaches on students manipulative skills in titrimetry?
3. What are the attitudes of students towards the use of cooperative teaching and learning approaches in titrimetry?

1.6 Significance of the Study

The study is to help students acquire the necessary knowledge and skill which will make them competent in titrimetry. It is also to raise the confidence of students and make them develop interest in practical work. It is to help chemistry teachers identify problem areas of students in titrimetry and also by the application of the remedial activities carried out in this study, design workable instructional approaches for this aspect of chemistry.

The findings in this study could likely position other stake holders and policy makers in education in Ghana to make informed judgments about teaching methodologies that are more likely to improve on the achievement level of students and their interest in titrimetry. Stakeholders can also identify the contextual variables that may be modified to bring about improvement in curricula and writing of science textbooks in relation to the practical aspect of chemistry.

1.7 Limitations

The study was limited to the following phenomena such as absenteeism, illness and lack of logistics on the part of the school management. Again, the study was limited to only the views of form 3 SHS science students since such students have had adequate exposure to the concept Titrimetry.

1.8 Delimitation

The study involved S.H.S 3 chemistry students because students' performance had been noted to be poor in Titrimetry. In addition, the study was delimited to using cooperative teaching and learning approaches to improve form 3 SHS science students performance in Titrimetry.

1.9 Organisation of the study

The study is organised into five Chapters. Chapter one is the introduction. The issues that are discussed in this chapter include background to the study, the statement of the problem, the purpose of the study, research questions, significance of the study, limitation, delimitation, definition of terms as well as organization of the study.

Chapter two focuses on the literature that relates to the study.

Chapter three deals with the methods used in the study. It is devoted to description of research design, population and sample, sampling procedure, research instruments, testing of validity and reliability of instrument and Data collection procedure.

Chapter four presents results of the research and analysis followed by discussion.

Chapter five summarizes results and findings. It also treats the conclusion and ends with recommendations and suggestions made by the researcher.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This section reviews literature on the study. The followings were systematically dealt into:

Theoretical Framework of the study

Cooperative Learning

History on the use of Laboratory Practical in Scientific Investigation

Titrimetry and its importance in chemistry

Empirical Framework of the Study

The role of the teacher in Cooperative Learning

Definition of Titrimetry Skill and

Titrimetry Skill and Factors Affecting its Acquisition.

2.1 Theoretical Framework of the study

This research is within the broad tradition of constructivism traced to the work of Parsons and Brown, 2002. This tradition currently dominates research in science education. Although constructivism is not in a literal sense a framework, the theoretical stance may be said to constructivist. Constructivism may be defined as an epistemological view which sees the learner as an active participant in the teaching/learning process. The learner comes into the learning situation with prior (experience) knowledge on subject matter. It is based on prior knowledge that the learner interprets the new situation presented. This means that the construction of new knowledge in science is strongly influenced by prior knowledge. It is also a process where motivation and interest in subject matter may enhance or hinder such construction from taking place. The new knowledge gained may be a replacement, addition, or modification of their existing knowledge. The construction of new knowledge takes place at an existing cultural context, such as geographical location, religious, social and economic class, ethnicity and language. It is within the constructivist framework to say that one should pay attention to attitudes, experience and interests in a teaching situation. The study framework, therefore, could be seen to be organised on the principle that individuals build or construct their own meaning of new information on the basis of their existing knowledge and that what a person brings to the learning environment matters. Each learner brings experience that affects his or her view of the world and his or her ability to accept other views grounded in science. In this way, science education can be contextualized and linked to the life world experience of learners. The new experiences are used by the learner to construct new meaning. This knowledge construction is shaped through social interactions with members of the community (Piaget, 1986). Thus, making learning meaningful for the learner, one has to take cognizance of the social and cultural environments of the child. With recognition of the need for the child's environment in the classroom, school learning will largely be informed by the interaction between the conceptual domains of the home or community and school. Social constructivist theories state that, learners construct meaning through interactions with others, with materials, and by observation and exploration of events (Drivers, Asoko, Leach, Mortimer & Scott, 1994).

Constructivist–based research suggests that informal science experience laid the critical foundation for deep conceptual understanding (Jones, 2000). As such, constructivists hold the view that learners understanding of school science, to a large extent, is conditioned by their presents common sense experiences. This understanding, in turn is shaped by their prior encounters with various natural phenomena, even though their interpretations of such encounters may or may not be scientifically valid (Ebenezer & Connor, 1998). In the construction process, what a learner already knows or believes interacts with a new conception to which the learner has been exposed. Without both cognitive and social interaction, a new understanding will be different to achieve (Tobin &Tippins, 1993; Tobin, Tippins&Gallard, 1994). A constructivist teacher plays a key role at the interface between curriculum and student to bring the two together in a way that is meaningful for the learner. Thus, teachers with a constructivist viewpoint can influence the understanding, which is not scientifically based to a more scientifically accepted understanding (Brooks & Brooks, 1999). Teaching strategies using social constructivism as a frame of reference relate to teaching in contexts that might be personally meaningful to students. These also involve negotiating understanding with students through class discussion in small as well as large groups of students (Creswell, 2008). The study is underpinned by cognitive, psychomotor and effective factors of learning. This is because the whole being of the learner is involved in construction of knowledge from the perspective of social constructivism discussed above. In other words, learning involves all the three: cognitive, psychomotor and affective domains and that all the three are equally important in knowledge construction. The learner can only be motivated to engage in meaning making in science only if it is interest and value to the learner and this can be achieved through effective cooperative learning.

2.2 Cooperative Learning

Several definitions of cooperative learning have been formulated. This one widely used in higher education is probably that of Johnson and Johnson (1994). This states that cooperative learning is instruction that involves students working in teams to accomplish a common goal under conditions that include; positive interdependence, individual accessibility, face-to-face promotive interaction, appropriative use of collaborative skills and group processing.

However, it has been observed that the definition of cooperative learning should be flexible since different terms for group learning are often used interchangeably but that basic principles in all are the group learning approaches (Mills, 2000). Cohen and Manion (1994) showed that both cooperative and collaborative learning have common features which involve students developing materials, gathering information, collecting data, sharing experiences and discussing or evaluating results. Mills and Cottel (1998) are also of the view that collaborative and cooperative learning are positioned as a continuum from most structured (cooperative) to at least structured (collaborative). At its core, cooperative learning is based on the premise that cooperation is more effective than competition among students for producing positive learning outcomes.

Prior to World War II, social theorists such as Allport, Watson, Shaw and Mead began establishing cooperative learning theory after finding that group work as more effective and efficient in quantity, quality and overall productivity when compared to working alone (Gilles &Adrain, 2003). However, it was not until 1937 when researchers May and Dood (1973) found that people who cooperate and work together to achieve shared goals, were more successful in attaining outcomes, than those who strive independently to complete the same goals. Furthermore, they found that independent achievers had a greater likelihood of displaying competitive behaviour.

Philosophers and psychologists in the 1930s and 40s such as John Dewey, Piaget and Johnson, (1995) also influenced the cooperative learning practiced today (Sharon, 2010). Dewy believed that it was important that students develop knowledge and social skills that could be used outside of the classroom and in the democratic society. This theory portrayed students as active recipients of knowledge by discussing information and answers in groups, engaging in the learning process together rather than being passive receivers of information (eg. Teacher talking, students listening). Lewin's contributions to cooperative learning were based on the ideas of establishing relationships between group members in order to successfully carry out and achieve the learning goal. Creswell's contribution to cooperative learning was positive social independence, the idea that the student is responsible for contributing to group knowledge (Sharon, 2010).

Johnson and Johnson (1975) identified that cooperative learning promoted mutual liking, better communication, high acceptance and support, demonstrated an increase in a variety of thinking strategies among individuals in the group. Students who showed to be more competitive lacked in their interaction and trust with others, as well as in their emotional involvement with other students. According to Johnson and Johnson (1994) five elements of cooperative learning are (positive interdependence, individual accountability, face-to-face interaction, social skills and processing) essential for effective group learning, achievement and higher-order social, personal and cognitive skill (For example, Problem solving, reasoning, decision-making, planning, organizing and reflecting).

2.3 History on the use of Laboratory Practical in Scientific Investigation

The use of laboratory method in science teaching originated from the ideas of early scientists. The 17th century is very significant in this respect. Mendelson (1982) has characterised the century as the century of "the scientific Revolution". This characterisation is so, because, according to Westfall (1971), it was in the 17th century that the experimental method became a widely employed tool of scientific investigation. The general feeling of disillusionment among scientists with earlier methods precipitated this trend (Butterfield, 1957). The feeling of disillusionment had to do with the result of scientific investigations that did not match the efforts put into them. The scientists of all times blamed the method of conducting science, for the low output. The emphasis on scientific method of investigation during this period paid off with the several discoveries and inventions in the 17th century and beyond, thereby giving the impressions, albeit unintentionally, that science is synonymous with its method.

2.4 Titrimetry and its importance in chemistry

Titrimetry was first introduced by Jean Baptiste Andre Dumas, a French chemist. He used it to determine the composition of nitrogen combined with other elements in organic compounds.

He initially named it volumetric analysis. It is a method of quantitative analysis using measurement of volumes. For gases, the main technique is in reacting or absorbing gases in graduated containers over mercury and measuring the volume changes. For liquids, it involves titration. It can also be said to be a method of determining chemical differences and principles of redox (reduction-oxidation) reactions between molecules. Chemicals under this topic are classified based on the results obtained from titration. The process of creating a balance chemical equation ‘in vitro’ is called titration. It typically uses a volumetric flask, hence, called volumetric titration. There are three types of volumetric titration, which are classified based on the rate of their reaction. They are direct Titration Method (DTM), the Indirect Titration Method (ITM) and Back Titration Method (BTM). The DMT involves a one-step titration process. The ITM involves a two-step titration process and the BTM uses a three-step titration process.

The quantitative relationship between the two reacting solutions is important to the chemist. Up to some point in chemical analysis involving solutions, solid precipitations of chemical reactions between such solutions were dried, separated and massed. The technique is called gravimetric analysis. It is used in quantitative experiments to determine mass relationships. The technique is useful but it is always practically efficient. It is difficult and in many cases a waste of effort and materials to separate and measure mass of products of a reaction while they are in solution. Titrimetry looks a better and faster technique, especially if the substances involved are acids and bases. They can be titrated against one another for better quantitative results. Titrimetry is used in high school and college chemistry laboratories to determine unknown concentrations of substances. In titrimetry, a titrant (solution with known concentration) is added to a known quantity of analyte (solution with unknown concentration) and a reaction takes place. Knowing the volume of the titrant allows the student to determine the concentration of the unknown substance (Nelson & Kemp, 1997).

Medical laboratories and hospitals use automated titration equipment for basically the same purpose. Besides these, the process has found ample use in analytical laboratories and industries that manufacture drugs, fine chemicals, petrochemicals, beverages and food processing benefit immensely by the application of these processes. For example, it is used to determine the presence of volatile component in the ejecta flow of crater cavity volume in ecological study to determine biodiesel industry. It is also used to determine the acidity of a sample vegetable oil (Ackerman, 2005). By knowing the precise amount of base that is needed to neutralise a sample of vegetable oil, scientists know how much base to add to neutralise the entire amount. Volumetric analysis has also been used in space science to study the relationship between brain structure and sensory ecology of aquatic animals (Lisney, Bennett & Collins, 2007), in metal application (Mendelson, 1982) and in several other areas of science as long as one wants to live a healthy and good life.

2.5 Empirical Framework of the Study

Johnson and Johnson (2002) conducted peer-led team learning (PLTL) in titrimetry over a three-year period and compared the performance of the students with that of students who had taken traditional version intitrimetry in the preceding three years. The course instructor, text, examination, structure and grading system were the same for both the treatment and comparison groups.

On average, the workshop students significantly outscored their traditionally taught counterparts on individual examination, final grades, retention , and percentage, earning the minimum acceptable grade of C. Similar results were obtained specifically for female students and underrepresented minority students. Similar findings have been reported for PLTL programs in titrimetry at another institution (Oliver, J. S. 1985) and in a biology (Pederson, 1994), as well as for a collaborative learning implementation in titrimetry (Simon, S. 2000).

A classic implementation of cooperative learning in chemistry is that of Hanson and Creswell (2008) who used a “person workshop” format in the general chemistry class at SUNY-Stony Brook. Students worked in teams of three or four on activities that involved guided discovery, critical thinking questions that help provide the guidance, solving context-rich and sometimes open-ended and incompletely defined problems. Most activities focused on a single concept or issue and could be completed in a 55-minute session. Following each workshop, students completed an individual quiz on the workshop content, thus promoting individual accountability. The use of this approach led to substantially improved examination grades relative to the previous year, in which titrimetry was conventionally taught. It also increased attendance in tutorials session and improvement in student self-confidence, interest in chemistry and attitudes towards instruction.

According to Johnson, Johnson and Stanne (2000) hundreds of research studies of team-based learning in higher education have been conducted, with most of them yielding positive results for a variety of cognitive and affective outcomes. Analyses of the research support the following conclusions: individual student performance was superior when cooperative methods were used as compared with competitive or individualistic methods (Mills, 2000). The performance outcomes measured include knowledge acquisition, retention, accuracy, creativity in problem solving, higher-level reasoning.

Study by Johnson and Johnson (2000) showed that cooperative learning is superior for promoting meta cognitive thought, persistence in working toward a goal, transfer of learning from one setting to another, time on task, and intrinsic motivation. For example, students who score in the 50th percentile when learning competitively would score in the 69thpercentile when taught cooperatively (Johnson & Johnson, 2000). Similarly positive effects of group interactions have been found specifically for chemistry related areas. In a meta-analysis of research on cooperative learning in high school and college chemistry related areas, Brown (2000) found that student in the 50th percentile with traditional instruction would be in the 61st percentile in a cooperative learning environment.

Several studies on cooperative instruction report positive effects on a variety of cognitive and affective outcomes. In a compilation of pre-posttest gains in force concept inventory scores obtained by students in introductory physics courses, the use of instruction involving "interactive engagement" led to an average gain two standard deviation greater than was observed for traditionally-taught courses (Simon, S. 2003); Students in engineering capstone design courses taught with active and cooperative approaches outperformed traditionally-taught students in acquisition of design skills, communication skills, and teamwork skills (Osborne, Simon, & Collins, 2003). The use of cooperative method had significant positive effects on understanding science and technology, analytical skills and appreciation for diversity, among other outcomes (Johnson, Johnson, & Smith, 1998).

Affective outcomes were also improved by the use of cooperative learning. Relative to students involved in individual or competitive learning environments, cooperatively taught students exhibited better social skills and higher self-esteem. They also showed more positive attitudes about their educational experience and the subject area (Johnson, Johnson & Smith, 1998). Towns (2000) used field notes and survey data to analyse students' attitude towards group activities in a physical chemistry class. The students viewed the group work as a positive force in their learning and they also valued the interactions for promoting a sense of community in the classroom.

Johnson, Johnson and Smith (1998) in a review of 90 years of research found that cooperation improved learning outcomes relative to individual work across board. Similar results were found in an updated study by the same authors who looked at 168 studies between 1924 and 1997. Sabina and Sabina (2006), looking at 37 studies of solutions in science, mathematics, engineering and technology found similar results. Another issue of interest of engineering faculty is that cooperative learning provides a natural environment in which to promote effective team work and interpersonal skills, which employers frequently identify as a critical gap in the preparation of engineering students.

Johnson, Johnson and Smith (1998) recommended explicit training students in the skills needed to be effective team members when using cooperative learning groups. Johnson and Johnson report that social skills tend to increase more within cooperative learning rather than competitive or individual situation (Johnson & Johnson, 1998). Mathews, R. (1986) showed that students' report increased team skills as a result of cooperative learning. In addition, Mills, (2003) cited a number of benefits of cooperative learning for developing the interpersonal skills required for effective team work. Cooperative learning therefore is effective than competitive for promoting a range of positive learning outcomes including enhanced academic achievement.

In cooperative learning environment, the learners are challenged both socially and emotionally as they listen to different perspectives and are required to articulate and defend their ideas (Smith & Johnson, 1992). Ebenezer, & Zoller (1993) also contrived that when learners articulate and defend their ideas, the learners begin to create their own unique conceptual framework and not rely on the expert's or text's framework. In cooperative learning, learners have the opportunity to converse with peers, present and defend ideas, exchange diverse beliefs, question other conceptual framework and are actively engaged Fredua-Kwarteng, & Ahia, (2005).

According to Smith and Johnson (1998), Educationists strongly argue that all students gain from cooperative learning Brown (1999) contend again that the use of cooperative learning groups has been shown to increase students' ownership of learning and improve outcomes for students in general and underserved groups of students in particular. In fact, educationists still have different views about the group of students who gain most from cooperative learning. For example, Derek, (2007) reported that, under prepared students may benefit more from students led discussions than better students.

However, those who disagreed with cooperative learning such as Freedman, (2002) contend that in peer tutoring students doing the teaching learn more, especially at a conceptual level, than students receiving the tutoring. Other authors have also pointed out some draw backs in cooperative learning. For example, Amedahe, (2002) cautioned against abuse and overuse of group work and identified two weaknesses. The weaknesses are that too much hard burden is placed on stronger students and also it is detrimental to students who benefit more from learning alone.

Cohen & Manion (1994) are more concerned about the level of commitment of some members of their groups during cooperative learning. Another issue that Sabina and Sabina (2006) looked at is the principle to be used for the grading of group members. For example, all students get the same grade project or are assigned separate tasks within a group project, which are assessed separately.

2.6 The role of the teacher in Cooperative Learning

Teachers can guide learning of students having different backgrounds by creating an environment in which they are actively involved in co-operative learning which is based on construct vision on the proper methods satisfying their goal. Kennedy (1998) argued that, students should not be dependent on the teacher as the authority on either subject matter content or group process. Kennedy, stressed that, it is not up to the teacher to monitor group learning, but rather the teacher's responsibility is to become a member, along with students in search of knowledge. Jones, (2000) emphasised that teachers are the most influential factor in educational reforms.

However, the crucial role of teachers in efforts to reform the curriculum has been assessed from different perspectives. For example, Tobin and Dawson (1992) are of the view that teachers should not be blamed for the relative lack of success of curriculum reform efforts. In discussions on reform failures, some theorists and practitioners have found out that, formal systems of education have been remarkably insensitive to indigenous conditions, culture, languages and knowledge in many parts of the world (Johnson & Johnson (1994).

To understand the role of teachers with respect to educational reform, it has been suggested that, their belief and views (Jenkins (1994) or their practical knowledge (Hanson (2007) be analysed. Kim and Bonk (2002), however were of the opinion that, curriculum development have often failed to take into account the teachers, the students and their out-of-school origins, aspirations, culture and traditions (Mathews (1986). On the other hand, Muller and Osborne (1998) are concerned about how science is presented as a subject.

In the same study, Muller and Osbrone (1998) indicated that science is usually presented as a rigid body of facts, theories and rules to be memorised and practiced rather than a way of knowing about natural phenomena. This approach seems to have become the subject of criticism among policy makers, teachers, educators and researchers. This approach appears to have contributed to the decreasing popularity of science among students.

Secondly, research on students' conceptions of scientific topics has convincingly demonstrated that students exposed to this approach often end up with a poor understanding of scientific concepts (Miller & Osborne, 1998). Others such as Parsons & Brown, (2002) contended that science is an active process, hence both 'hands-on' as well as 'minds-on' activities should constitute the core of the education process. They were of the view that inquiry should be the central element of the curriculum and that it will develop students' understanding of scientific concepts, along with reasoning and thinking skills.

However, Kennedy (1998) is of the view that no matter the learning situation prevailing in the classroom, teachers need to be in a position to even respond to classroom situation they never anticipated. Therefore, teachers will have to pay more attention to aspects of science they usually ignore, or do not feel very comfortable with, for example, the relation between science and social (real life) issue.

2.7 Definition of Titrimetry Skill

Skill is defined as an ability and capacity acquired through deliberate, systematic and sustained effort to smoothly and adaptively carryout complex activities or job functions involving ideas, (cognitive skills), things (technical skills) and or people (interpersonal skills) (Business Dictionary, 2000). It is also defined as the proficiency, facility or dexterity that is acquired or developed through training or experience (the Free Dictionary, 2002).

From the above definitions, titrimetry skill refers to all the learning experiences that a student goes through to make him or her proficient in carrying out titration. This involves the sharpening of the mind to do critical thinking especially in balancing chemical equations, analysing and interpreting data, as well as calculating amounts of species involved in chemical reactions. There is also need for the ability to handle and manipulate the equipment that are used for titration like the burrette, pipette and conical flask.

2.8 Titrimetry Skill and Factors Affecting its Acquisition.

2.8.0 Teacher's attitude and pedagogy

A lot of factors could be responsible for students' performance in skill acquisition in titrimetry, high or poor. Earlier studies on students' attitudes to learning and what pupils learn were found to be greatly influenced by how they are taught. Pupils will be unable to receive enough science learning experience when school teachers themselves are not pleased with science teaching (Simpson & Oliver, 1990). The significant role that teachers play in pupils' attitude formation towards subjects has been confirmed by a number of studies; notable among them are that of Ebenezer and Zoller (1993) on attitude towards science with American grade 10 pupils of ages between 15 and 16, and the work of Cohen and Manion (1994) who studied the attitudes towards science of 2965 United States college pupils. Hendley, Parkinson, Stables and Tanner (1995) conducted a small-scale qualitative study in the United Kingdom on key stage 3 pupils' preferred subjects and found that teacher-related comments surfaced as of most reasons for liking or disliking a subject. Similar outcomes have been reported by Atwater and her colleagues in a study in the United States. They found that pupils' attitudes towards science are significantly influenced by how they perceived their science teacher and to a lesser extent by the science curriculum. Though, teacher-attitude has been cited by several studies as an important determinant in attitudes formation, the classroom environment also plays a significant role in attitudes formation (Simpson & Oliver, 1990). A sample of 699 pupils from 27 high schools in America, through a study conducted by Simpson and Oliver (1992) established that the most positive attitudes were associated with high level of involvement, very high level of personal support, strong relationships with classmates, and the use of a variety of teaching strategies and unusual learning activity. A strong support for this finding comes from the work of Piburn and Baker (1993) who, interviewing pupils comprising 83 elementary school pupils, 35 junior high school pupils and 31 high school pupils in the United Kingdom, identifies the classroom environment as one of the major factors in interest generation in science education. Similar conclusions that classroom environment has influence on attitudes towards science were drawn from 57 major longitudinal study conducted in North Carolina (Simpson & Oliver, 1990). Teaching method has also been cited as one of the strongest influence on students' attitudes towards science. Evidence has been provided by Woolnough (1991), that the quality of teaching of science is a significant determinant of attitude towards science. A review of Woolnough's work according to Osborne and Simon (2003), revealed six factors that were responsible for the pupil choice or non-choice of the science of extra-curricular activities and the quality of the science teaching. It has also been identified that, all teachers in that particular work know that the teaching method or the pedagogy does indeed make a difference (Osborne& Collins, 2001). Attitude of peers and friends is found to be another significant factor which determines attitudes towards science (Breakwell&Beardsell, 1992). An earlier study by Simpson and Oliver (1985) indicates a peer group influence which exists in relationships among peers increases from age 11 onwards, peaking at age 14. This is a period where often subject choices are about to be made and also where an individual attempts to assert self-identity.

2.8.1 Students' attitudes and beliefs towards titrimetry

Another factor important for students' acquisition of skills in science is students' attitudes and beliefs. Students always develop some sort of idea about what science is all about, how scientists are as persons, what they actually do and how this relates to society, the environment, their lives and other people. Students' idea about the nature of science, the personalities of scientists and the purpose and meaning of their activities may have different sources (Anamuah Mensah & Apalo, 1986). They may emerge from out-of-school influence, or encounter with school science and the science teachers (Millar & Osborne, 1998). Some ideas may arise from their own culture. These may influence, or encounter with school science and science teachers (Millar &Osborne, 1998). Some ideas may arise from their own culture. These may influence the students' eagerness, motivation or interest to learn science. According to Fredua-Kwateng & Ahia, 2005, learning involves moving from the familiar to the unfamiliar, traversing the emotional quagmire of success, self-doubt and challenge as well as classroom identity. There is widespread belief that emotions are a central part of learning and teaching. According to Acar, (2008), Baslli and Sanford, (1991), firstly, it may be the reflection of both the academic background in the natural sciences of many science education researchers. Secondly, it may assume difficulty of accommodating the students' voice in the curriculum that continues to put emphasis on science as body of established knowledge to be learnt.

In a number of cases, attitudinal studies in science education research have often been driven by the disturbing trend in the decline in pupils pursuing post compulsory science education, especially, in the developed economies (Johnson & Johnson, 1989). Recently there has been a proliferation of studies on attitudes towards science, as well as reviews on such studies (Mathews, 2004; Osborne & Simon, 2003; Jones, 2000; Simons, 2000). These give support to the importance of attitudinal studies in science education and research. Earlier than these, however, the conclusions drawn from some of the studies appeared to be consistent in findings, but the results have not been conclusive (Johnson, Johnson, & Smith, 1998) also supported this observation and commented that most cases, variables such as personality, classroom and structural variables have been separated and discussed in isolation from conclusions, as one of the reasons for which attitudinal studies lack conclusiveness in results.

Whatever the explanation may be, pupils living with attitudes of any kind are likely to influence the use of knowledge, competencies or skills acquired from science class for purposes of career choice, democratic participation in debate on scientific issues.

2.9 Students' interests in science education

Teaching, learning and curriculum development, in which personal and contextual relevance are considered are key educational concerns (Morgan, 2003). This implies that personal and societal interests are to be seen as key to science. Smith, (1998) refers to it as 'personal-curiosity science'. This is in contrast to the 'readymade' science school textbooks and classrooms with which most adults across cultures have had some contact. This textbook of science is often criticised for its lack of relevance and deeper meaning for the learners and their life, and that the content is frequently presented without being related to social and human needs (Arends, 2010). According to Narrow, (1998), the personal-curiosity science concern pupils themselves deciding school science topics from their peculiar interests and desire. Nelson, (1997) alludes to the fact that economical significance for a country to have a high number of skilled scientists and engineers is well accepted but young people do not choose their studies or carriers because it is good for the economy of their country, especially for a country where young people have such choice. They do so based on their own interests, values and priorities. It is therefore important that school science reflects this if it is to adequately prepare school leavers for the society they are entering.

Johnson and Johnson (1989) also revealed that the content and practice of science education have not been connected with students' interests and experiences, leading to a sense of its irrelevance to their lives. A consequence of this is that school leavers may be ill-prepared by their school science education for personal decision making on the many controversial societal issues that continue to raise public debate and concern. However, a more interesting school science can lead to more motivation, engagement and participation (Mills, 2004). The pupils will need to be strongly motivated so that they gain the awareness that they are learning something worthwhile, interesting and valuable for themselves.

2.10 Frequency and challenging laboratory work

Osborne, & Collins, (1982, 2002) just as collaborated by Derek (2007) suggested that laboratory activities have potential to enhance cognitive growth, positive attitudes as well as social relationships among peers. Studies revealed that students' progressive skill acquisition towards practical work including volumetric analysis increased through constant and challenging laboratory activities (Regan & Childs 2003; Derek, 2007). However as the frequency slowed down to no laboratory activities for weeks the interest also slows down adversely affecting acquisition of skills.

Osborne, Simon, and Collins, (2003) submit that activities in many laboratories are centered on verification of what is already known rather than helping students to develop process skills that motivates them to stay longer at task. According to Derek (2009), drill and practice is applied to train students to pass practical examination. It may also be that teachers and students place great emphasis on obtaining the correctness of the answers and the mastery of process skills is normally left to chance. This may suggest why some students just work to already given answers without concentrating much on the titrations just as some teachers themselves teach to test (World Bank, 2007). Such students will have nothing much to fall back on as home assignment since they are not challenged or motivated to find out things for themselves. The results are poor study habit which leads to low process skill acquisition.

2.11 Summary of Literature Review

Cooperative learning is the instructional use of small groups so that students work together to maximise their own and each other's learning (Johnson, Johnson & Holabec ,1993). Cooperative learning technique has two major theoretical perspectives thus, motivational and cognitive.

The motivational theories of cooperative learning emphasise the students' incentive to do academic work, while the cognitive theories emphasise the effects of working together. Cooperative learning experiences, promote more positive attitudes towards the instructional experience than competitive or individualistic methodologies. The approach has numerous benefits such as instilling in learners important behaviours that prepare them to reason and perform in an adult world (Adams & Hamm, 1996; Marzano & Pickering, 2001).

Research efforts on cooperative teaching and learning indicate that it enhances student achievement (Johnson & Johnson, 1989; Slavin 1990; Webb 1989). Kennedy, (1998) stated that peer interaction is central to the success of cooperative learning as it relates to cognitive understanding.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter describes the methodology of the study. It covers the research design, the intervention, population, sample and sampling procedure used as well as research instructions used for data collection. Other issues considered in this chapter were reliability and validation of the research instruments, data collection and data analysis.

3.1 Research Design

The study is a quasi – experimental design. Non – equivalent groups, pretest – intervention – posttest, is the design (experimental group), receiving cooperative learning instructional method and the other group (control group) receiving more traditional lecture discussion teaching method. Both groups were then assessed again with the same test items administered at the start of the meeting (post test items) to ascertain the impact of the treatment. Amedahe (2000) explained that the design is potentially useful in that it controls all threats to validity and all sources of bias such as history and maturation. A self-designed base-line pre - test items which was based on the students' form two third term practical work on titrations in Senior High School to establish these students' initial level of achievement before treatment was conducted with both experimental and control groups. With help from the Science Department two classes, thus, 3 Science (A) and 3 Science (B) were selected for the study. In these two classes selected for the study, 3 Science (A) formed the experimental group while 3 science (B) formed the control group.

All the students from the two classes for the study were examined based on their first term chemistry practical on titration in SHS three (3) chemistry syllabus before the intervention which was termed as the Base line pre test. The topics that were examined were simple acid-

base titration and redox titration, which form part of the practical topics documented in the chemistry syllabus. The intervention took a form of cooperative learning approach. The study specifically sought to improve the theoretical knowledge, manipulative skills and work presentations skills of students in relation to titration in chemistry through cooperative learning. Under the theoretical aspect of titrimetry the skills tested for were concepts of acid, bases and salt, nature of indicator and their selective usage as well as titration procedure. Under the manipulative aspect of titrimery, the skills tested for were pipetting and transferring solutions into conical flask and then taking readings from burettes and pipettes. Under the work presentation aspect of titrimery, the skills tested for were presentation of table of results, balancing of reaction equations, calculation of amount of species and concentration of solutions.

One science teacher each from the 3 Science (A) and 3 Science (B) classes was trained on the use of cooperative learning approach for the experimental group. With the 3 Science (A) experimental class of thirty students, six groups were formed having five members in each group, while the 3 Science (B) formed the control group. Tasks on areas to be treated under a topic were assigned to the various groups. This was done in such a way that two groups would be researching on the same task at the same time. The groups were given the tasks two days ahead of the time for presentation. This was to allow them to have ample time to search for relevant information, discuss among their group members and arrive at a consensus before presentation.

Each group was encouraged to be independent as possible. On the day of presentation, each group did it in turn. The groups were assigned the same tasks followed by each other successively in presentation. This gave the students the opportunity to see different ways of solving the same problem or approaching the task. The teacher summarised the major correct points agreed on by all members in each of the groups on the black board.

On the manipulative skills which dealt with the correct handling and usage of the titration equipment, groups were assigned tasks to find out and discuss among their group members how to use the various equipment. Each group was given the relevant equipment to practice as part of their research. On the day of presentation each group was given the opportunity to demonstrate whilst members of other groups made constructive criticisms. The correct way of using the instrument was them accepted for use by the entire class.

On result presentation, groups were again assigned tasks to find out most appropriate way of presenting the table of results from the titration, writing balanced reaction equations and calculation of concentration and amount of entities involved in chemical reaction during titration. Their findings were presented and the best among them was adopted.

The control groups however were taught with the traditional method of teaching, consisting lecture and teacher-directed discussion. After the end of the eleventh week, all the students in both classes were examined to ascertain the impact of the cooperative learning approach. The self-designed post test covered simple acid-base titration and redox titration which were taught to both experimental and control group during eleven week-period of teaching. During the implementation of the experimental group, Treatment Verification Checklist, developed by Reid Forrestal and Cook, (1989) adapted by the researcher was applied to observe the teaching and learning process (Appendix B). This was done to decide if cooperative learning method was implemented as intended.

3.2 The Treatment Verification Checklist touched the following areas:

1. How teachers impact scientific concepts using cooperative approach in teaching assessing student.
2. Attitude towards cooperative learning shown by students in the experimental group during intervention stage (Appendix C).

Quasi experimental design was used, because this was appropriate as the study is to investigate whether the classes are intact and, therefore random selection and assignment are not possible.

The study was a combination of qualitative, and quantitative approaches and was conducted at different terms because the topic is treated only at third year as it is in the designed syllabus and S. F. SHS has only one third year class studying Elective chemistry. According to Ary, and Razavieh (1990), qualitative inquiry seeks to understand human and social behaviours from the "inside" perspective.

The quantitative inquiry on the other hand is principally concerned with discovery of "social facts" devoid of subjective perceptions or infrusions and divorced from particular social and historical context.

Narkevissei, Pathnana, and Browniee (1992), advanced two purpose of combining methods in a single study as follows: that a skilful use of a combination of different techniques can maximize the chance of bias and that they complement each other.

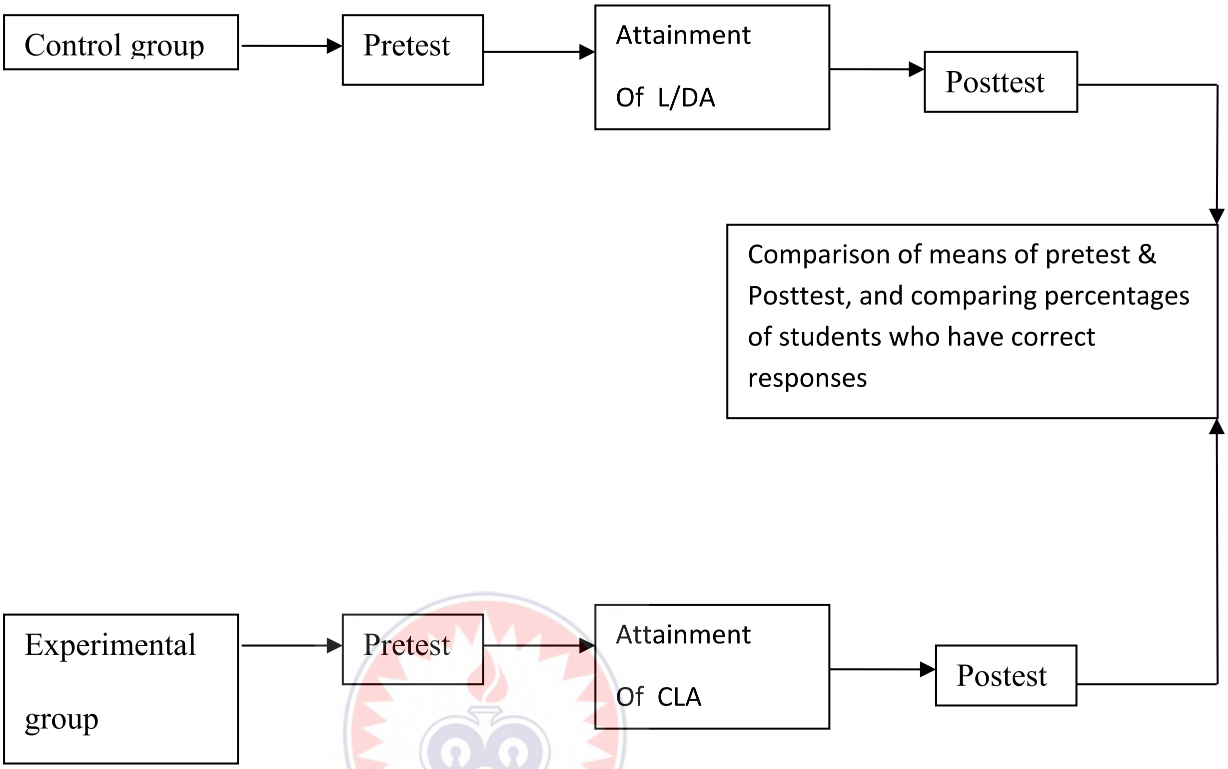

Figure 1: Diagrammatic representation of the design for the study

L/DA means lecture discussion approach

CLA means cooperative learning approach

3.3 Population and sample

In this study, the targeted population for the study comprised all students and chemistry teachers in the St. Francis Girls SHS in Jirapa Municipality of the Upper West Region of Ghana. Jirapa Municipality was chosen for the study because the researcher is more familiar with the area in respect to science education delivery in the Senior High School. For lack of time, logistics and funds, St. Francis Girls SHS was randomly sample for the study, which include 3 Science (A) and 3 Science (B).

The two classes were far part within each of the classes and so none of the classes knew what was happening in other classes. Three (3) Science (A) and 3 science (B) respectively were made experimental group and the other made control groups. Again, the Researcher had to observe the science teachers as they teach using the cooperative learning approach and so could not have had enough time to consider all the classes in the school.

The sample represents the subjects (participants) the researcher used due to the fact that they bear similar characteristics as the target population. The reason for opting for sampling is also in line with Sarantakos (1998) findings that sample is noted to produce comparable and equally valid results. Sarantakos further explained that samples offer more detailed information and a high degree of accuracy because; they deal with relatively small numbers of units. The selected students were in SHS 3. A total sample of one hundred and twenty students were used for this study.

Students from SHS 3 classes were preferred because they had passed through the 2nd year level of education and might have learnt some basic science concepts and had opportunities to try their hands on titration. The cooperative learning approach might be seen by SHS 3 to be a new method and are thus likely to appreciate it.

3.4 Sampling Procedure

The procedure adopted for the selection of the classes was that of a purposive and stratified random sampling technique. The sampled classes were grouped into 3 Science (A) and 3 Science (B). This sampling technique gave all members of the target group equal chances to be picked (Bell, 1999)

The names of all the classes in the school were written down on pieces of paper, grouped into science and non-science with the help of the staff of the school. The papers were later folded and placed in a basket. The folded papers in a basket containing names of the classes were thoroughly shaken and by hand picking approach, the science classes were selected.

3.5 Research instruments.

The instruments used for data collection in this study were observation, achievement tests and

questionnaire implementation. The tests were base line pre test and post tests. The observation and test were meant to provide consistent and uniform measure, without variation (Amedahe, 2002).

There were test items for baseline pre test and post tests. The test items considered the theoretical knowledge of the students, the manipulative skills and work presentation ability in titration as stipulated in the syllabus meant for SHS level. Marking schemes for the test- items were also drawn by the researcher (Appendix A)

Observation is a collection of data mainly by vision as contended by Easterby Smith, Thorp and Lowe (1991). They mentioned that observation provides information when other methods are not effective. It also offers first hand information without relying on reports of others. It is relatively inexpensive to run. Observation was again useful to reveal whether people do what they claim to behave.

3.5.0 Achievement Tests

Two tests were administered, thus, pre test and post test. The questions were used to test both experimental group and control group understanding and application on the concept titrimetry and were in line with the cognitive and effective domains of Bloom'staxanomy outlined in SHS Chemistry syllabus.

3.5.1 Pilot Test / Instructional Stage

Pilot test, according to Polit and Hungler (1995) , is a small-scale version or trial done by the investigator in preparation for the major study. In this study, the students' attitude instrument was piloted on 37 SHS 3 Science students in Jirapa SHS to establish the internal consistency and reliability of the questions. Jirapa SHS was chosen for pilot test because it runs similar courses. Also, students' demographic characteristics were similar because they were of the same year group. Participants were assured of confidentiality, and the instrument was responded to anonymously with no identification information. They were given sometime within the instructional hours to provide their responses after which all questionnaires were received.

3.5.2 Pre-intervention Stage

This stage involved the administration of the questionnaire and conduct of a pre test. The questionnaire sought responses on both experimental group and control group attitude towards titrimetry. Students were assured of their confidentiality and the item explained to them. The questionnaire was administered in the first week on commencement of the study to determine the attitudes students have towards titrimetry. The questionnaire was administered during chemistry lessons for prompt retrieval analysis. The pre test was also conducted the same week in the respondents own classroom under the researcher's supervision within a period of 40 minutes. The test was meant to assess students' achievement in titrimetry. The test was scored out of 30 marks and the data analysed, from the data analysed, it was revealed that science students have negative attitude towards titrimetry and the responsible factor was the teacher. Also, the pre test results showed poor achievement of students.

3.5.3 Intervention Stage

The intervention process involves the use of the contextual teaching and learning (CTL) model (FIG. 2) to teach a Titrimetry.

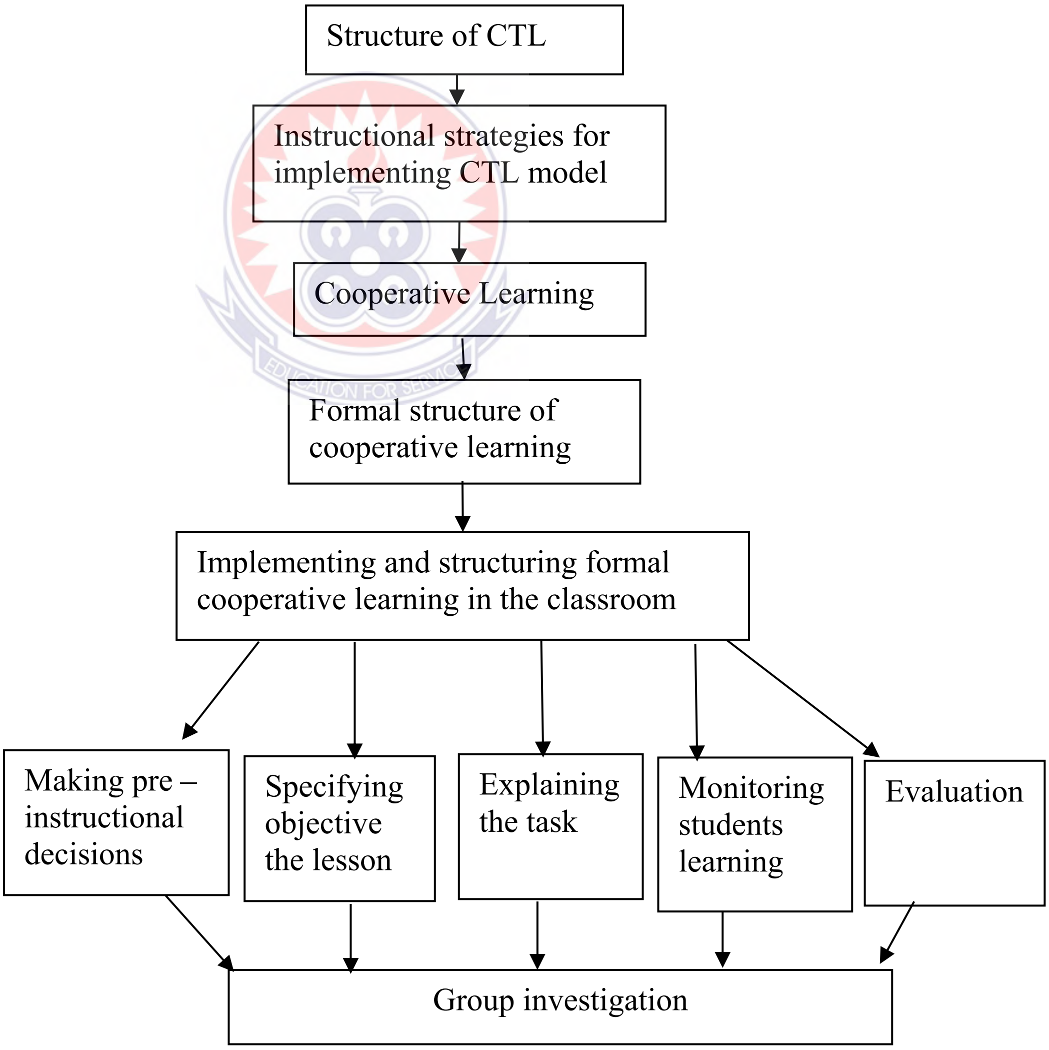

Figure 2. (CTL) Contextual teaching and learning

3.6 Pre - Test

Two teacher made tests were developed and administered before and after the intention to both experimental group and control group. .Tests consisted of both multiple choice and essay type items. These were constructed by the researcher and the questions drawn from the concept titrimetry for the pre test, whiles the post test was constructed from same concept thus, titrimetry. Each test had two sections, A and B with A made up of 10 compulsory multiple choice while B had two essay type questions. The post test scripts were scored out of 30 marks each. The scores were used to categorise the students into three ability groups, low, average and high achievers. The low achievers were those who scored less than 15 marks out of 30 on the post test, while the average and the high average were those who scored between 15 and 25, and above 25 out of 30 marks respectively. The post test was administered to both experimental group and control group after the intervention. Time allotted for students for both tests was 40 minutes. Each correct response in section A attracted a maximum of one mark whereas a question in section B attracted 10 marks.

3.7 Post -Test

A post test after the intervention was conducted on both the experimental group and control group. To ensure reliability the tests were administered in the respondents' own classroom under the researcher supervision. An equivalent form of the pre test was used for the post test to avoid effect of pre test sensitisation. According to Aryel al (2002) , pre test sensitisation is the effect of pre test on the respondents that causes them to respond differently regardless of the treatment from the way they would without the pre test. Post test sensitisation is a major threat to the validity of a test when very same test is repeated rather than parallel forms. Students were assured that the exercise would not influence their Continuous Assessment and that they were not obliged to write their names or an identification number. The received answer sheets were marked and scores recorded for analysis.

3.8 Post –intervention Stage

The procedure for the administration of the questionnaire was repeated using the same set of items to determine whether changes had occurred with regard to the students' attitude towards titrimetry after intervention. A post test was also conducted using equivalent form of the pre test to determine the impact of the cooperative approach on students' performance after the intervention.

3.9 Questionnaire

There was a questionnaire provided to both experimental group and control group who were randomly selected in the study to ascertain the causes of students' poor performance in titrimetry. The questionnaire was a structured one with 7 items to outline the causes of students' poor performance in titrimetry. The questionnaire can be found in the (Appendix D) and the analysis in Table 1a.

3.10 Validity of the instrument

The self-design test items in the instruments were presented to experts (the Head of Science Department, St. Francis Girls SHS, colleagues science teachers and my supervisor) to read and critique each item as suggested by Best and Khan (1995). This was to assess each item's content validity, accuracy and format.

Bell (2004) echoed that validity of any instrument is important because it determines whether an item measures or describes what is supposed to measure or describe.

3.11 Reliability of the instrument

Reliability as explained by Kirk and Miller (1986) is the extent to which a test or procedure produces similar results under constant conditions on all occasions. In order to ensure the reliability and effectiveness of the test items, it was pilot-tested with an SHS 3 class of sixty four mixed students from Lawra Senior High School in the Upper West Region of Ghana. Lawra Senior High School was chosen because it is a mixed school that will cater for gender balance and it is also located in the same region under the study. Pilot – testing identified questions that respondents had difficulty of understanding. It also brought out questions the students interpreted differently from the researcher intended. This ensured clarity in the instructions and questions. Improving research instruments through piloting is likely to improve on the quality of data, the result and interpretations.

After the baseline pre test, the researcher had discussions with the class on test time, clarity and understanding of the test items. These, lead to modification of some of the items in the test.

3.12 Data Collection Procedure

An introductory letter was taken from the Head of Science Education Department of University of Education, Winneba, to the Headmistress St. Francis Girls SHS-Jirapa. The first visit to the school was to seek permission from the Headmistress to work with the science teachers as well as their students. It also sought to create rapport with the science teachers and students that formed the sample and to inform them about the study and the process of administering the instruments. The researcher had a discussion with the two selected science teachers in the school which formed the experimental group separately on the use of the cooperative learning approach. The discussion was mainly on the concept of cooperative learning and its implementation. The two science teachers within the experimental group classes then had eight weeks constituting a school term to use the cooperative instructional approach in their lessons. The two other science teachers within the control group classes were to teach the same content topics using traditional methods (lecturing and teacher-directed discussions) after which all the students from the two classes were tested.

3.13 Data Analysis

The data collection from this study were edited, collated and analysed as mentioned by Blaxter, Dodd and Tight (1996).

The items in the tests were marked, scored and fed into a computer for analysis. The Statistical Package for Social Science (SPSS) version 16 for windows 2007 was used for the analysis. This is because it provided among other things a variety of ways to summarise the data and accurately describe variable of interest (Easterby-Smith, Thorps & Lowe, 1991). The treatment Verification check lists for both teachers and students in the experimental group classes were also coded and fed into a computer for analysis. Independent sample-test was used to find out whether or not there was a significant difference between the two science teachers' approach that could influence the final results. The same method was used to determine whether there was any significant change in the students' attitude towards matter.

3.14 Ethical Considerations

Every study requires the researcher to adhere to the ethics concerning research. The researcher took due cognisance of ethical responsibility in the collection and analysis of data, and the reporting of the information. Permission to conduct the study was obtained from the St. Francis Girls' SHS Headmistress. The researcher encouraged maximum participation of the respondents, and ensured that the respondents' rights to be informed, right to privacy and right to choose was respected by maintaining confidentiality of all the information given to aid this study.

This was done by ensuring that their names and other forms of identification were excluded from the data collection and the purpose of the study clearly explained to the participants. The last but not the least, all the students that took part were acknowledged and given a summary of the report from exercises so that goodwill is maintained for future research.

CHAPTER FOUR

RESULTS ANALYSIS AND DISCUSSION

4.0 Overview

This chapter presents the results that evaluated the impact of cooperative learning approach on mental, manipulative and work presentation skills in titration of students in the St. Francis Girls' SHS. It also presents result that relates to the level of appreciation of students to cooperative learning within the same school. The results were analysed at the 0.05 significance level. It focuses on the analysis and discussion of results of the study. The results obtained are presented to follow the order in which research questions were posed in chapter one.

4.1 Presentation of Results and Analysis

Research Question 1 :What are the causes of students' poor performance in titrimetry and also the effects of cooperative teaching and learning approaches on students' theoretical knowledge in titrimetry?

The causes of students' poor performance in titrimetry and their responses given by the students are contained in Table 1a.

Analysis of Questionnaire

Table 1a : A description in percentages by the students about the causes of poor performance in titrimetry.

Statement about learning groups	Number and percentage agreeing to statement	Number and percentage disgreeing to statement	Number with no view
When I use the glassware I achieve more than when I do not use them.	30 (86%)	5(14%)	0
When I use the glassware the lesson is always interesting and I do not easily forget than I do not use them.	28 (80%)	5(14%)	2 (5.7%)
You often have practical work before the WASSCE.	3 (0.09%)	32(91.4%)	0
I always have practical work three times each term.	5 (14%)	30(86%)	0
.I always find it difficult to identify or distinguish between different colour changes because I hardly do practical work.	29 (83%)	4 (11.4%)	2 (5.7%)
I always find it difficult to write laboratory reports because I hardly do practical work.	28 (80%)	5 (14%)	0
I always find it difficult of balancing of reaction equations because I hardly do practical work.	30 (86%)	5 (14%)	0

Table 1a reveals the causes of students' poor performance in titrimetry and the responses given by the students. Most of the students' responses gear towards items 1 and 2, eighty three percent (83%) students agreed to the fact that they understand better when they use the glassware against 14% who disagreed. Again, 86% students disagreed that they always have practical work three times each term against 14% who agreed. Interestingly 91.4% disagreed to the fact that they often have practical work before WASSCE as against 0.09% who agreed.

Results in Table 1a also indicate 80% agreed to the fact when they use the glassware lessons are always interesting leading to unforgetfulness. Eighty three percent (83%) students confirmed that they find it difficult to identify or distinguish between different colours changes because they hardly do practical works. Eighty percent (80%) also confirmed that they have difficulties in writing laboratory reports because they hardly do practical work. Eighty six (86%) agreed to their difficulties of balancing of reaction equations because they do not do practical work. All in all, these responses allotted or exhibited by the student are supported by many researchers and the researcher suggest that they are the ultimate causes of the students' poor performance in titrimetry

The causes of the students' poor performance in titrimetry could be attributed to the followings;

- **Lack of glassware or inadequate glassware.**

They include burettes, pipettes, conical flasks, stirring rods, beakers, volumetric flasks, white tiles, measuring cylinders, wash bottles, funnels, droppers, spatulas and chemical bottles.

Lack of glassware as mentioned could affect students' performance because students do not have opportunity to use or interact with them to become more conversant with their use.

- **The frequency of practical work or the number of times students have practical work before their final examination.**

This is also a major factor that contributes immensely to the students' poor performance in tritimetry because it has been observed by the researcher that students do not have enough practical work before the WASSCE.

- **Students difficulty in distinguishing between the different colour changes during titration.**

It has been observed by the researcher that most students find difficult to read the level of solutions in burettes or distinguish the different colour changes to determining initial and final volumes in the course of titration. Other students are not able to determine the correct endpoint during titration.

- **Lack of students' manipulating skills.**

Moreover, the researcher also observed that students face challenges of proper handling and usage of the major equipment which are the pipettes, burettes, funnels, chemical bottles, beakers and conical flasks. Students find it difficult in pipetting solutions and transferring it to the conical flasks.

- **Inability of students to write laboratory reports.**

Students also face problems with work presentation or how to write laboratory reports. It involves drawing a table of values and selection of consistent titre values for the calculations of average titre. Others find it difficult in balancing of reaction equations, calculating amount of species involved in the reaction and concentration of solutions.

Table 2a: Frequency distribution of achievement test scores for theoretical knowledge acquisition of 3 Science(A) students for both experimental and control groups.

Scores%	**0-10**	**11-20**	**21-30**	**31-40**	**41-50**	**51-60**	**61-70**	**71-80**	**81-90**	**91-100**
Experimental										
Baseline Pre Test	2	9	12	5	2	0	0	0	0	0
Post-test	0	0	1	4	6	10	5	2	2	0
Control										
Baseline Pre Test	1	11	10	6	1	1	0	0	0	0
Post-test	0	7	14	5	0	1	2	1	0	0

Table 2a shows that in the experimental group, majority of the students scored between 11-20 percent and 21-30 percent. None of the students scored above 50 percent in the baseline pre test. In comparison with the post-test scores, it can be seen that the students performed better as 19 students scored above 50 percent.

In the control group a large number of students scored between 11-20 percent and 21-30 percent. One student scored above 50 percent. A comparison between the baseline pre test and that of the post test scores showed very little improvement as just 4 students scored above 50 percent.

Table 2b: Frequency distribution of achievement scores for theoretical knowledge of 3 Science (B) students for both experimental and control groups.

Scores%	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
Experimental										
Baseline Pre Test	3	10	10	4	2	1	0	0	0	0
Post-test	0	0	3	3	10	8	3	2	1	0
Control										
Baseline Pre Test	2	15	8	2	2	1	0	0	0	0
Post-test	0	9	11	5	3	1	1	0	0	0

Table 2b shows that in the experimental group the same number of students; that is ten students scored between 11-20 percent and 21-30 percent. Only one person scored above 50 percent. In comparison with the post-test, ten students scored between 51-60 percent and as many as 14 students scored above 50 percent. This shows higher improvement in the post test. In the control group, 15 students scored between 11-20 percent and one student scored above 50 percent. In the post-test, 11 students scored 21-30 percent and only 2 students scored above 50 percent. The difference in performance here was not appreciable.

Table 2c: Mean scores in the Baseline pre test and post tests on theoretical knowledge for Experimental and Control groups within 3 science (A) science students.

Schools	Mean Scores		Mean Difference	P-Value
	Baseline Pre test	Post Test		
Experimental	23.67	53.44	29.77	0.010
Control	24.33	27.10	2.67	0.275

Results from Table 2c shows that the 3 Science (A) experimental group had mean baseline pre test score of 23.67 and post test score of 53.44. This gives a mean difference of 29.77 which is 27.10 more than the 3 Science (A) control group which had a mean difference of 2.67 from the mean baseline pre test score of 24.33 and mean post test score of 27.10.

The P-Value of 0.010 in 3 Science (A) experimental group indicates that the mean difference (the difference between the mean score of the post-test and the baseline pre test) is highly significant since the p-value is less than 0.05. On the other hand, the p-value of 0.275 in the 3 science A control group indicates that the mean difference in the mean scores of the post-test and baseline pre tests was not significant since it was higher than 0.05.

This implies that the intervention had a positive effect on the 3 Science (A) experimental group, thereby improving their theoretical knowledge in titrimetry compared with their counterparts that used the traditional approach (control group).

Table 2d: Mean scores in the baseline pre - test and post-test in theoretical knowledge acquisition for experimental and control groups within 3 Science (B) students.

Schools	**Mean Scores**		**Mean Difference**	**P-Value**
	Baseline Survey	**Post Test**		
Experimental	23.33	50.00	26.67	0.011
Control	22.00	25.00	3.00	0.090

Results from Table 2d shows that the 3 Science (B) experimental group had a mean baseline pre test score of 23.33 and mean post-test score of 50.00. This gives a mean difference of 23.67 more than that of the 3 Science (B) control group which had a mean difference of 3.00 from the baseline pre test score of 22.00 and post-test score of 25.00.

The p-value of 0.011 for the 3 Science (B) experimental group shows that the mean difference is significant. For the control group having a p-value of 0.090 which is higher than 0.05 indicates that the mean difference is not significant. The intervention therefore helped to improve the performance of the experimental group in the rural school. The traditional method however did not show any significant improvement in the control group.

Research question 2: What are the effects of cooperative teaching and learning approaches on students' manipulating skills in tritrimetry?

There is a significant change in students' manipulative skills in titrimetry after the intervention in the experimental group which is showed in Tables 3a, 3b, 3c and 3d.

Table 3a: Frequency distribution of achievement test scores for manipulative skill development of 3 Science (A) students for both experimental and control groups.

Scores%	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
Experimental										
Baseline Pre Test	2	13	11	4	0	0	0	0	0	0
Post-test	1	0	3	5	4	5	9	1	2	0
Control										
Baseline Pre Test	4	10	10	4	1	1	0	0	0	0
Post-test	2	9	7	8	2	1	1	0	0	0

Table 3a shows that in the experimental group, thirteen students scored between 11-20 percent and 11 students scored between 21-30 percent. None of the students scored above 40 percent in the baseline pre test. Compared with the post-test scores, nine students scored between 61-70 percent and a total of 17 students scored above 50 percent. This was an improvement over the baseline pre test.

In the control group, 10 students scored between 11-20 percent with one student scoring above 50 percent in the baseline pre test. One student scored above 50 percent. In comparison with post test nine students scored between 11-20 percent and 2 students between 41-50 percent.

Two (2) students scored above 50 percent. There was little improvement in performance but not very significant.

Table 3b: Frequency distribution of achievement test scores for Manipulative skills development of 3 Science (B) students for both Experimental and Control groups.

Scores%	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
Experimental										
Baseline Pre Test	3	14	8	3	2	1	0	0	0	0
Post-test	0	4	3	4	6	8	2	2	1	0
Control										
Baseline Pre Test	5	10	11	1	2	1	0	0	0	0
Post-test	3	7	10	6	2	2	4	0	0	0

Table 3b shows that in the experimental group, 14 students scored between 11-20 percent and one student scored above 50 percent in the baseline pre achievement test. In comparison with the post-test scores, it can be seen that the students performed better as 6 students scored between 41-50 percent, 8 students between 51-60 percent and 13 students scoring above 50 percent. In the control group 10 and 11 students scored between 11-20 percent and 21-30 percent respectively. Only one student scored above fifty percent in the baseline pre test. In the post-test scores, 7 students scored between 11-20 percent and 10 students, between 21-30 percent. Two students scored above 50 percent. There was therefore no significant achievement in the control group.

Table 3c: Mean scores in the baseline pre test and post-test on manipulative skill achievement for experimental and control groups in 3 Science (A) within both 3 Science (A) students and 3 Science (B) students.

Schools	**Mean Scores**		**Mean Difference**	**P-Value**
	Baseline Pre Test	**Post Test**		
Experimental	22.20	51.20	29.00	0.000
Control	21.80	24.70	2.90	0.321

The results from Table 3c shows that the 3 Science (A) experimental group had a mean baseline pre test score of 22.20 and the variable post-test score of 51.20. This gave a mean difference of 29.00 which is 26.10 more than that of the 3 Science (A) control group which had a mean difference of 2.90 from the mean baseline survey test score of 21.80 and mean post test score of 24.70. On p-value of 0.000 for the contrary the p-value of 0.321 which is higher than 0.05 indicates that the mean difference is insignificant. This implies that the cooperative method adopted as intervention here helped to improve the manipulative skills of the students whereas the traditional method used in the control group did not make any significant impact.

Table 3d: Mean scores in the baseline pre test and post test on Manipulative skill achievement for experimental and control groups within 3 Science (B) students.

Groups	Mean Scores		Mean Difference	P-Value
	Baseline Pre test	Post Test		
Experimental	22.50	45.00	19.50	0.000
Control	21.00	25.30	4.30	0.072

Results from Table 3d shows that the 3 Science (B) experimental group had a mean difference of 19.50, calculated from a mean baseline pre test score of 22.50 and post-test score of 45.00. The p-value for the experimental group is 0.000 which is less than 0.05. the mean difference is therefore significant. The 3 Science (B) control group had a mean baseline pre test score of 21.00 and mean variable post-test score of 25.30, giving a mean difference of 4.30. the p-value of 0.072 indicates that the mean difference is insignificant. The implication is that the use of cooperative learning helped to improve the manipulative skills of the students in the experimental group whereas the traditional method did not have significant impact in terms of improvement of same skills in the control group.

Research question 3: What are the attitudes of students towards the use of cooperative teaching and learning approaches in Titrimetry?

The students' observational guide was used to determine the changes in attitude that were likely to occur as a result of the use of cooperative learning approach on students from both 3 Science (A) and 3 Science (B) in their science classes. Some of the indicators used were; perseverance, ability to ask and answer questions, cooperation with one another to solve problems and respect for evidence.

Attitude of students obtained from treatment verification checklist

The students' observational guide checklist was also used twice a week for a period of eleven weeks after which mean scores of marks accumulated were calculated. Attitudinal scale on the students' observation guide were, 4 indicating very good, 2 indicating fair and 1 indicating poor in the measurement of the attitude exhibited in Table 4a.

Table 4a: Results of Attitude of students obtained from treatment Verification checklist

Week	**Mean scores for Experimental groups**	
	3 Science (B)	**3 Science (A)**
One	2.7	2.6
Two	2.8	2.7
Three	3.0	3.0
Four	3.4	3.5
Five	3.4	3.6
Six	3.6	3.6
Seven	3.7	3.7
Eight	3.9	3.8
Nine	3.6	3.9
Ten	3.8	3.6
Eleven	3.8	3.7
Total mean score	**3.4**	**3.4**

In Table 4a, the mean score values show that attitudes of students from both 3 Science (A) and 3 Science (B) classes towards cooperative learning approach improved sturdily from the first to the eleventh week. The 3 Science (B) experiment group had a total mean score of 3.4 the 3 Science (A)experimental group also scored 3.4. Both figures on the observation guide scale are significant. This might imply that attitudes of students from 3 Science (B) and 3 Science (A) classes towards cooperative learning approach were better.

4.2 Discussion

In order to determine the impact of the cooperative learning approach, the data collected were analysed statistically. The results obtained were then used to answer the research questions that guided the study.

Analysis of the data in Table 2c & 2d indicate that, the score of students from both 3 Science (A) and 3 Science (B) experimental classes were statistically significant after they used of cooperative learning approach in their science lessons. The post-test score implied that the experimental groups from both 3 Science (B) and 3 Science (A) benefited greatly, hence, there are ability to outscore their respective control groups in the post test achievement test. This strongly confirms the findings of Pintrich, Smith, Garcia and McKeachie, (1993) and Vermunt (1992) that, the use of relevant learning strategies allows students to actively process information, thereby influencing their mastery of material and subsequent academic achievements. This means that the experimental group from both 3 Science (B) and 3 Science (A) classes achieved better results after the cooperative learning approach was implemented.

In cooperative learning the use of extra exercise such as assignments significantly contributed to the good performance in the post test scores. This confirms the findings of Vermunt (1998), which stressed on the achievement of good results through interesting extra exercises. When students are successful, learning then becomes interesting and permanent. Consequently, students then view the subject matter with a very positive attitude which was equally exhibited in the outcome of checklist results. Such attitudes enhance self-esteem of students.

On knowledge retention, Millis, McKittrick, Mulhall and Feteris (1999) and Gross and Davis (1999) further argued that, higher concept gain and knowledge retention of students involved in small group activities is better than those who perform only in competitive or individualistic environments.

Through group interactions, learners get the opportunity to share ideas and provide feedback to each other, as well as make use of different perspectives and alternative in learning (Mills, 2002). In Gilles' (2003) view, situations where students assist their peers to learn through explaining topics to each other have been correlated with academic achievement.

The findings suggest that small group learning can be used to assist pupils to find solutions to problems in science even in deprived areas. This research also confirms the findings of Narrow (1998), who reported that, team work and collaboration is beneficial to female students. Potthast (1999) mentioned that, using a series of small group in learning experiences increased students' scores on tests as compared to a group not using small group format. The finding also gives credence to Freedman's (2002) assertion that participating in cooperative groups during scientific investigations had positive outcomes in attitudes and achievement levels for students.

Table 3c and 3d showed that students from experimental groups in both the 3 science B and 3science A classes statistically improved their manipulative skills significantly through the use of cooperative learning compared with their various counterparts who used traditional method. Cooperative learning which is a form of student-centered learning gave the students the opportunity to involve themselves actively in the practical activities: handling and using the available titration equipment. This is in line with Austin's (1993) group learning report that students' involvement through group learning is one of the most important predictions of success in college.

Another factor that leads to improvement in manipulative skills in titration is the interactive engagement of students in cooperative learning. Hake's (1998) finding confirmed this. He found that pre and post tests data for over 6,000 students in introducing physics course found significant improvement for students test scores measuring conceptual understanding to be twice as high in classes promoting interacting engagement through the use of cooperative learning than in traditional method.

In cooperative learning, the use of active engagement contributes to the achieved high performance. This is supported by Redish, Saul and Steinberg (2004). In their study they showed that improved learning gains can be due to the nature of active engagement of group members and individuals as found in cooperative learning and not in extra time spent on a given topic. Law? Sokoloff and Thornton's (1997) findings further confirmed that the use of cooperative learning surpasses traditional method of improving conceptual understanding for basic scientific concepts. Cooperative learning has the tendency to do away with misconceptions. Hake, Redish and Laws et al (1997) provide considerable support to active engagement through cooperative learning for addressing student fundamental misconceptions.

The improvement in the manipulation skills could also be attributed to the appropriate frequency of practical work organised for students in cooperative learning setting. Springer, Stanne and Donovan (1999) findings support this.

Table 4a indicated that the mean score for both 3 Science (A) and 3 Science (B) experimental group in positive attitudinal change toward the use of cooperative learning was 3.1 out of a maximum score of 4. The study also revealed that, generally the experimental groups recorded higher achievement in the post test than their control group counterparts hence, the realisation of the development of positive attitude. Tesser (1993) explained the term 'attitude' as a hypothetical construct that represents an individual's degree of like or dislike for an item. Tesser further argued that, attitudes are expected to change due to knowledge and skills learned, observation and involvement in or exposure to an event or process. The correlation between attitude and achievement as this research sought, indicated that the higher achievement obtained during the post test could partly be as a result of positive attitudinal change. To support this argument, Smith and McNelis (1993) also confirmed that students with negative feelings towards science education always receive lower grades. It can therefore be concluded that, the high achievement recorded in the experimental groups' achievement test scores may be due to the positive opinion they developed towards science. These findings confirmed those of Eshun and Abledu (1999), who commented that, low ability learners in heterogeneous small group make the most significant gain. Also, learners in the average performance level obtained greater mean gain than those in high performer level. Further research by Haris and Tarwater (1996) also suggested that, learners with previously average success, welcome working in small groups as their grades improve through group effort.

On the other hand, Mills (2003) stressed that, there is evidence that, high achieving students often dislike group work due to their dependence on others to obtain marks. However, there was no sign of resentfulness by very good students in the various groups in this present study. There was willingness by all students to come to the classroom with a strong readiness to work in smaller groups. This commitment to work created a bonding among pupils which in turn leads to higher academic self-esteem and positive feelings towards peers and the instructor. According to Johnson and Johnson (1989), small group learning experiences are preferred by students as compared to competitive, individualistic and most 'traditional' instructional methods. Opportunities for science learning arise when children attempt to reach consensus as they work together (Barnes & Todd, 1977).

In this situation, each student was obliged to apprehend and justify his or her solution to the group and to listen to the explanation of other members of the group. The cooperative learning approach seemed to have made students understand scientific concepts better. The learning setting provided students with greater opportunity to work through engaging with each other in attentive listening, speaking clearly, turn taking, giving time to make points, treating each other with respect and appreciating the contribution of others. This is true regardless of differences in ability level, sex, disability, ethnic membership, or task orientation.

The students from both 3 Science (B) and 3 Science (A) experimental groups developed considerable commitment and caring for each other no matter what their initial impressions were, after cooperating with each other in their science studies. They also appear to like their science teachers more than before due to the way the students were involving their teachers and perceived them as being more supportive and accepting academically and personally

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.0 Overview

This chapter deals with the summary of the main findings and conclusion derived from the study as well as recommendation and suggestions for the further studies.

5.1 Summary of the main findings of the study

The main aim of the research has been to find out skills students lack in carrying out Titrimetry and devise interventions that would help them to acquire the necessary skills to improve upon

their performance using cooperative learning approach

The specific objectives of the study were to determine;

1. The extent to which cooperative learning helps to improve the theoretical knowledge of the students in Titrimetry
2. How cooperative learning served to improve the manipulative skills of the students in Titrimetry
3. The effect of cooperative learning on student's presentation of work
4. The attitude of students towards the use of cooperative learning in Titrimetry

The study was based on the premise that cooperative learning could help improve performance of students in Titrimetry. The target of the study was therefore to improve the performance of students in Titrimetry through cooperative learning. The instruments used in the study were achievement tests and observation.

Purposive and stratified random samplings were employed to select the school. In all one hundred and twenty (120) students were used for the sampling. The marked and scored items in the tests were analysed using the statistical package for social science (SPSS) version 16.0 for windows. The treatment verification check list for both teachers and pupils in the experimental group were also coded, fed into the computer and analysed.

The main scores obtained in the base line survey and post test for experimental group and their respective control groups within both 3 science B and 3 science A classes were compared for the various skills tested for; theoretical knowledge, manipulative skills and work presentation skills and work presentation with reference to the P-values. It was revealed that in all cases there was significant difference between students' performance in the post test and the baseline pre test in the case of the experimental group. This implies that there was improvement in their performance.

From the treatment verification check list showing the attitude of the students from both 3 science B and 3 science A classes towards the use of cooperative learning, it came to light that there was significant and steady improvement from the first to the eleventh week. This means that the students appreciated and identified with the method.

5.2 Conclusion

There are different methods of teaching and learning. It is important for the teacher or the facilitator to think through the subject, topic, material, he or she is going to use and the age group of the student he or she is teaching in order to select the appropriate method. In doing this the teacher should not lose sight of the fact that naturally, students learn best through play way, sharing ideas in a free atmosphere.

Cooperative learning, from the result of this study should be given much attention, incorporated as much as possible into any approach of teaching since in addition to having the ability to improve the performance of the students academically, it also makes them develop positive attitude towards learning in general.

Cooperative learning also has the potential to broaden students' knowledge and improve interpersonal relationship among student, as well as between students and their teachers through effective interaction.

5.3 Recommendations

Having considered the findings of this research, for effective teaching and learning of science, it might also be necessary to consider the following recommendations.

1. Teacher must endeavour to use cooperative learning in science teaching or incorporate it in any method of teaching in order for the students to reap the benefits.
2. Well stuffed libraries should be built in schools and communities for students where they can go and make research on their own in groups and as individuals to upgrade their knowledge and complete their assignments.
3. Students should be introduced to the internet. The internet should be made available to the students so that they can easily access information to improve their knowledge.

4. It is recommended that school laboratories be well equipped with practical materials. These materials should be made available for them to practice in their groups, compare and share their findings.
5. It is recommended that in the preparation of the school curriculum the developers should refer to and emphasise the use of the internet and show sites where relevant information can be accessed.

5.4 Suggestions for Further Studies

In acquisition of skills in science that could not be researched. I therefore suggest that other scholars take up research into the following areas to bring out how they can impact on the students' performance in science;

1. Students' attitudes and beliefs
2. Students' interest in science education
3. Socio-economic status of parents

The study covered a comparatively smaller area in Ghana due to certain limitations. Further studies can be made to cover a large area or the entire country.

REFERENCES

Ackerman, E. S. (2005). Volumetric Analysis of Martian Rampart crater, *lunar and planetary Science 40, 20-25.*

Aikenhead, G.S., & Ryan, A.G. (1992). The development of a new instrument:Views on

Science, Technology and Society (VOSTS). *Science Education, 76(5), 477 – 491.*

Amedahe, F. K. (2002). *Introduction to Education Research. Cape Coast:* University of Cape Coast.

Ameyibor, K., &Wiredu M.B. (1991) *Chemistry for Senior Secondary School*.London and

Brasingstoke: Unimax Publishers.

Anamuah – Mensah, J., &Apafo, N. (1986). Students' perceived difficulties with Ordinary level chemistry topics. *Chemistry and industry Proceedings*, 12, 38 – 39

Barnes D., & Todd, F. (1977). Communicating and learning in small-group. *Journal For Research in Mathematics Education, 22(5), 390 – 408*

Basilli, P. A., & Sanford, J.F. (1991). Conceptual change strategies and cooperativegroup

work in chemistry. *Journal of Research in science Teaching . 28(4), 293-304116 -119*

Bell, J. (2004). *Conducting small investigations in education management.*London: Sage Publications.

Bell, J.W. (1999). *Doing your research Project; A Guide for the first-time Researchersin education and social Science (3rdEd.). London: Sage Publications.*

Bell, J.W, & Kahn, J. V. (1995). *Research in Englewood Cliff.* New Jersey: PrenticeHall

Blaxter, L., Dodd, K., & Tight, M. (1996). *How to Research.* Buckingham: OpenUniversity Press.

Breakwell, G. M., &Breadsell, S. (1992). Gender, parental and peer influences upon Science attitude and activities. *Public Understanding of Science, 2, 183-197.*

Brooks, J. G., & Brooks, M. G. (1999). *In search of understanding:* The case for *Constructivist classroom.* Alexandria: Association for Supervision and Curriculum Development

Brown, H. (1999). *Foundational methods: understanding teaching and learning.*Toronto: Pearson Education.

Business Dictionary for Business Students (2000). Skill *definition and meaning* .Oxford: Clarenton

Cohen, L., &Manion, L. (1994). Research *Methods in Education (4th ed.).* London.Routledge.

Derek, C. (2007) Students' attitudes towards chemistry lessons.: the interactioneffect between grade level and gender. *Research in education, 12, 1573 – 1898.*

Driver, R., Asoko, H., Leach, J., Mortimer, E., &Scott, P. (constructingScientific knowledge in the classroom. *Education Researcher, 23(7), 5 – 12.*

Easterby-Smith, M., Thorpe R., & Lowe, A (1991). *Management research: an Introduction.* London: Sage Publications

Ebenezer, J.V., & Connor, S. (1998). *Learning to teach science: A Model for the 21st century.* New Jersey: Prentice-Hall.

Ebenezer, J.V., &Zoller, U. (1993). Grade 10 students' perceptions of and attitudes Towards science teaching and school science. *Journal of Research in ScienceTeaching, 30, 175 – 186.*

Eshun, B. A, &Abledu, G. K. (1999). Effect of alternative assessment on the attitudes and achievements in mathematics of female pre-service teachers inGhana. *African Journal Of educational Studies in Mathematics and Science, 1,17 – 25*

Fredua-Kwarteng, Y., &Ahia, F. (2005). *Mathematics and science analysis.*Retrieved September 25, 2008, from*http://www.ghanaweb.com/GhanaHomePage/NewsArchieve /artikel.php?ID*

Freedman, S.W. (2002). Inside city schools: *Investigating Literacy in Multicultural Classrooms.* New York: Macmillan.

GAST (2000). Teacher training activities Retrieved February 8, 2013, From *http://unesdoc.unesco.org/activities/0000/000088/008817eb.pdf*

Gilles, R. M., & Adrian, F (2003). *Cooperation learning: the social andintellectual outcomes of Learning in Groups.*London. Farmer Press

Gillies, R. M., (2003). The Effects of cooperative Learning on Junior High SchoolStudents,

Government of Ghana. (2004). *Report of the Education Reform Review Committee.* Accra: Ministry of Education.

Hake, R. R. (1998). Interaction-engagement versus traditional method: a six-thousand-student survey of mechanics test data for introductory physics courses.*American Journal on physics,*66, 64-74.13

Harris, G. A, &Tarwater, J. T (1996). *The nine hour sequence for the general pre-service elementaty teacher.*Houston. Texas Technical University.

Hendley, D, Parkinson, J., Stables, A.,& Tanner. H. (1995). Genderdifferences in pupil attitudes to the national curriculum foundation subjects of English, Mathematics, Science and Technology in key stage3 in south wale *Educational Studies. 21, 85-97.*

Hussain, S. (1990). *Development of a standardized text of physics for class IX & X*Unpublished Master's dissertation, University of the Punjab. Lahore: Pakistan.

Jenkins, E. W (1994). Public understanding of science and science education for Action.

Journal of curriculum Studies, 26(6), 601 – 620.

JICA (2007). *Education assistance to Ghanaian students.* Retrieved July 7, 2011,From*www.jica.go.jp./ghana/english/office/otherpdf/eduNL - 201005.pdf*

Johnson D. W., & Johnson, R.T. (2000). *Cooperative Learning Method.* RetrievedAugust 11, 2009 from*http://www.cooperation. Org/pages/cl-methods.html*

Johnson, D. & Johnson, R. (1975). *Learning together and alone, cooperation,Competition, and individual. Englewood Cliffs:* Prentice – hall.

Johnson D. & Johnson, R (1989). *Cooperation and competition, Theory and Research.* Edina: Interaction Book Company.

Johnson D. & Johnson, R(1994). *Learning together and alone cooperative,competitive, and individualistic Learning.* Needham Heights: Prentice – hall.

Kennedy, M.M. (1998). Education Reform and Subject Matter Knowledge. *Journal of Research in Science Teaching,* 35,249-263

Kim, K., & Bonk, C. (2002). *Cross-cultural comparisons of online collaboration.*Retrieved September18, 2002 from

http://jcmc,Indiana.education, edu/edu/vo18/issue1/kimandbonk.html.

Kirk, J., & Miller, M. L. (1986). *Reliability and validity in qualitative research.*Beverly Hills: Sage Publication.

KNUST (2011). *Entry requirements and guidelines for selecting and undergraduateProgramme.* Kumasi: the academic affairs section.

Law, P., Sokoloff, D., & Thornton, R. (1997). Promoting Active Learning, UsingThe Results of Physics Education Research. Uni-serve science news, 13, 140 – 155.

Linsey, T.J., Bennett M. B., & Collins, S. P. (2007). Volumetric analysis of sensoryBrain. *Raffle Bulletin supply, 14, 7 – 15.*

Mathews, R. (1986). *Enriching teaching and learning through learningCommunities.* Boston: Prentice Hall.

Mendelson, E. (1982). Historyof science. In Grolier, Incorporated. *The new book of Knowledge, (*pp. 17, 60, 77). Danbury Connecticut: Grolier

Millis, B. J.(2002). Fulfilling the promise of the 'seven principals' through Cooperative learning: Action agenda for the University Classroom.

Journal onExcellence in College Teaching, 2, 139 -144. Mills, B., Mikittrick,

P., &Feteris, S. (1999). Cooperative learning that works. *Physical Education, 34, 11 -16*

Mills, B., J.,&Cottell, P.G. (1998). *Cooperative learning for high education Faculty.* Phoenix: The Orys Press.

Mills, P. (2003). Groups project work with Undergraduate Veterinary Science Students. *Assessment and Evaluation in High Education, 28, 527 – 538*

Narrow, S. (1998). Attitudes towards science and mathematics: A review of the literature and its implications in schools. *International journal of education,*25(9), 1039 – 1045.

NUL. (1999). *Science opens doors and its fun too*: Who needs science? Retrieved September 20, 2012 from*http//eripts.cr5c.uiuc.edu/npin/repar/texts/parschoo/sciencedoor.html.*

Nelson, J.H,.& Kemp, K. C (1997). Chemistry: *The Central Science LaboratoryExperiments*. Boston: Prentice – Hall.

Osborne J. Simon S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education*,25(9), 1049-1079.

Osborne, J., & Collins, S. (2001). Pupils' views of the role and value of the Science curriculum: a focus-group study. *International Journal of Science Education*,23(5), 441 – 467.

APPENDICES

APPENDIX A

SAMPLE TEST QUESTIONS AND MARKING SCHEME

1. State the importance of the following apparatus in titration.

   a) Pipette b

   b)) Burette c) Wash bottle d) Conical flask

   e) Volumetric flask

2. Define the following terminologies

   a) Standard solution b) Concentration c) Titre d) End point

3. Give reason for the following

   a) Attention should be focused more on the conical flask during titration

   b) Rinse the burette and pipette with the respective solution that should go to them.

4. State the appropriate indicators for the following titration

   I. Strong acid against strong base

   II. Weak acid against weak base

   III. Weak acid against strong base

   IV. Strong acid against weak base

5. Balance the following chemical equation.

a $HNO_3 + Na_2CO_3 \longrightarrow NaNO_3 + H_2O + CO_2$

b $H_2X + NaOH \longrightarrow Na_2X + H_2O$

c $HCL + X(OH)_2 \longrightarrow XCL_2 + H_2O$

d $H3A + NaOH \longrightarrow Na_3A + H_2O$

Complete the following reaction equations

6.a) $YHNO_3 + M(OH)_y \longrightarrow$

b) $(COOH)_Y + YNaOH \longrightarrow$

c) $YHCL + X\ (OH)_Y \longrightarrow$

7. Evaluation of process skill

- Washing and rinsing of glass and plastic materials used for titration (burettes pipettes, conical flask, funnel)
- Correct usage of conical flask
- Proper swirling of conical flask
- Ability to determine correct end point in the course of titration
- Correct reading of volume in the pipettes and burettes
- Correct determination of exact end point

MARKING SCHEME

1. (a) Pipette for measuring and transferring a definite volume of solutions especially during titration.

b) Burette; for measuring volume of solutions during titration.

c) Wash bottles: For holding water for rinsing and topping main volumes o n solution in a vessel.

d) Conical flask: For holding liquid and alkalis during titration.

e) Volumetric flask: For preparing standard solutions or for measuring volume accurately.

2. (a) Standard solution: it is a solution whose concentration is accurately known.

b) Concentration: it is a measure of known amount of substance in specified volume.

c) Titre: This is the volume of solution in the burette which has reacted with the other solution in the conical flask at the end point.

d) End point: this is the point at which the base has been completely neutralized by the acid; this is shown in colour change by the addition of an indicator.

3. (a) In order to determine accurately the end point. (the last drop that changes the colour of the solution of the permanently)

b) The rinsing is necessary in order not to decrease the concentration of the respective acid and base by the water left on the sides of the burette and after washing.

4. a) i. Strong acid against base, methyl orange or phenolphthalein

ii. Strong acid against weak base ; methyl orange

iii. Weak acid against strong base; phenolphthalein.

iv. Weak acid against weak base; No indicator.

5. i. $2HNO_2 + Na_2CO_3 \rightarrow 2NaNO_3 + H_2O + CO_2$

ii. $H_2X + 2NaOH \rightarrow Na_2X + 2H_2O$

iii. $2HCl + X(OH)_2 \rightarrow XCl_2 + 2H_2O$

iv. $H_3A + 3NaOH \rightarrow Na_3A + 3H_2O$

6. i. $YHNO_2 + M(OH)_y \rightarrow M(NO_3)_y + YH_2O$

ii. $(COOH)_y + YNaOH \rightarrow YCOONa + YH_2O$

iii. $YHCl + X(OH)_y \quad XCl_y + YH_2O$

7. i) Washing and rinsing of glass and plastic material before and after titration observed.

   ii) Correct handling and usage of pipettes and burette observed.

   iii) Proper swirling of conical flask observed.

   iv) Ability to determine last drop that gives a permanent colour change at end point.

   v) Ability to read volumes of solutions in pipette and burette correctly.

8. Titration of solution A against solution B

   Burette content: solution A

   Volume of pipette: $25cm^3$

   Indicator used: Methyl orange

   Colour change from yellow to red

Burette Readings/cm^3	1	2	3
Final Readings	23.20	23.00	23.00
Initial Readings	0.00	0.00	000
Titire	23.20	23.00	23.00

Average titre value= $\frac{23.00+23.00}{2}$ = $23.00\ cm^3$

(i) $1000cm^3$ of H_2SO_4 contains 0.1 mol H_2SO_4

:. $23cm^3$ of H_2SO_4 contains $\frac{23}{1000}\ x\ 0.1 = 0.0023$ mol of H_2SO_4

Equation for the reaction is,

$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$

From the equation, 1 mol of H_2SO_4 = 2 mol of NaOH

0.0023 mol of $H_2SO_4 = \frac{0.0023\ x\ 2}{1}$ mol of NaOH = 0.0046 mol NaOH

Thus 25cm^3 of NaOH contains 0.0046 molNaOH

:. 1000cm^3 NaOH will contain $\frac{1000\ x\ 0.0046}{25}$ mol NaOH = 0.184 mol NaOH

Concentration of NaOH = 0.184 moldm^{-3}

ALTERNATIVE METHOD

Equation for the reaction is $H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$

From the equation$n_{A=1}$, $n_{A=2}$

$\Rightarrow \frac{\boldsymbol{n_A}}{\boldsymbol{n_B}} = {}^{\mathbf{1}}/_{\mathbf{2}}$

Number of mole (n) = concentration (c) X volume (v)

Number of moles of H_2SO_4 $(n_A) = C_AV_A$

Number of moles NaOH $(n_A) = C_BV_B$

C_A = $0.1moldm^{-3}$

V_A = $23.00cm^3$

C_B = ?

V_B = $25cm^3$

$\frac{C_AV_A}{C_BV_B} = {}^{\mathbf{1}}/_{\mathbf{2}} \Rightarrow \mathbf{C_B} = \frac{\mathbf{2\ x\ CAVA}}{\mathbf{25}} = \frac{\mathbf{2\ x\ 0.1\ x\ 23}}{\mathbf{25}}$moldm^{-3}= 0.184moldm^{-3}

OR

$\frac{C_{H2SO4} x\ V_{H2SO4}}{C_{NAOH}\ V_{NAOH}} = {}^{\mathbf{1}}/_{\mathbf{2}} \Rightarrow C_{NAOH} = \frac{2\ x\ C_{H2SO4} x\ V_{H2SO4}}{V_{NAOH}}$

$= \frac{\mathbf{2\ x\ 0.1\ x\ 23}}{\mathbf{25}} = 0.184\text{moldm} - 3$

ii. The concentration of B in gdm^{-3}

From the equation $C = \frac{\boldsymbol{P}}{\boldsymbol{M}}$, P = CM

Where P = mass concentration

C = concentration

M = molar mass

$P_{NAOH} = C_{NAOH} \times M_{NAOH}$

$= \frac{0.184mol}{dm3} \times 40g/mol$

$P_{NAOH} = 7.36gdm^{-3}$

APPENDIX B

TREATMENT VERIFICATION CHECKLIST ON COOPERATIVE LEARNING METHOD USED BY THE RESEARCHER ON TEACHERS IN S. H. S

SCHOOL..DATE..........................

Please tick either YES or NO in response to the following statement in the box provided.

ENGAGEMENT PHASE (stage 1)

The teacher provided the class with cooperative activity. **YES** ☐ **NO** ☐

EXPLORATION (stage 2)

Teacher encourages students to pursue individual goals which are congruent to group's common goal. **YES** ☐ **NO** ☐

TRANSFORMATION PHASE (stage 3)

Teacher inspire students to reshape their information gathered by organizing clarifying and synthesizing their learning concepts. **YES** ☐ **NO** ☐

PRESENTATION (stage 4)

Teacher gives students opportunity to present their finding in a way that every member of the group contributes. **YES** ☐ **NO** ☐

REFLECTION PHASE (stage 5)

Teacher assists students to identify strengths and weakness in the process

YES ☐ **NO** ☐

ASSESSMENT PHASE OF COOPERATIVE LEARNING

1. Do all students get the same grade for group project? **YES** ☐ **NO** ☐
2. Are students assigned same tasks within a group project and assessed separately? **YES** ☐ **NO** ☐
3. Do peers assess contributions to the group process for an additional grade or additional points? **YES** ☐ **NO** ☐
4. Do all students get the same grade for original task and then get different grades for an additional task? **YES** ☐ **NO** ☐
5. Do all get the same grade for the original task and then an exam task based on the group work as asses individual student's understanding? **YES** ☐ **NO** ☐

APPENDIX C

TREATMENT VERIFICATION CHECKLIST FOR SHS STUDENTS LEARNING WITH THE COOPERATIVE LEARNING METHOD

SCHOOL:..DATE:........ ....

Attitude by learners in groups	v. Good (4)	Good(3)	Fair (2)	Poor (10
Individual contribution to task Cooperation with one another to solve problems. Willingness to ask questions Willingness to answer questions Ability to probe into issues not understood Exhibition of procedural skill Critical and systematic thinking Exhibition of curiosity Willingness to share ideas Willingness to accept others views Reporting finding sequentially Ability to work independently Perception toward science Using scientific concept in everyday life Assessing result of an experiment Grouping objects and or events based on common characteristics Perseverance Respect for evidence Flexibility in idea Ability to predict correctly Ability to put information together as a whole (synthesis)				

Ability to extend conclusions to similar situation Ability to critical observe Ability to show understanding of knowledge Ability to explain consequences based on a trend Ability to summarize from generalized information Ability interpret pictorial information Ability to skillfully handle objects and tools to accomplish a task Ability to predict from graph Ability to use measuring equipment accurately				

Very Good (4) - attitude exhibited by all the groups in the class

Good (3) - attitude exhibited by $\frac{3}{4}$ and above but not all group

Fair (2) - attitude exhibited by $\frac{1}{2}$ and above but not $\frac{3}{4}$ of all group

Poor (1) - attitude exhibited by less than $\frac{1}{2}$ of all the group

APPENDIX D

UNIVERSTY OF EDCATION, WINNEBA

DEPARTMENT OF SCIENCE EDUCATION

Questionnaire

A questionnaire to ascertain the causes of students' poor performance in titrimetry

The following questionnaire is part of a study being conducted as an M. ED. Thesis research.

Please do not write your name on the questionnaire to ensure the confidentiality of your responses. Thank you for your cooperation. Please select the option below thatbest represents the causes of students' poor performance in titrimetry.

Statement about learning in group	**Agree**	**Disagree**	**No view**
1.When I use the glassware I achieve more than when I do not use them.			
2.When I use the glassware the lesson is always interesting and I do not easily forget than when I do not use them..			
3. You often have practical work before the WASSCE.			
4.I always have practical work three times each term.			
5.I always find it difficult to identify or distinguish between different colours change because I hardly do practical work.			

6.I always find it difficult to write laboratory reports because I hardly do practical work.			
7.I always find it difficult of balancing of reaction equations because I hardly do practical work.			