UNIVERSITY OF EDUCATION, WINNEBA

DEPARTMENT OF SCIENCE EDUCATION

THE IMPACT OF STUDENT TEAM ACHIEVEMENT DIVISION (STAD) TECHNIQUES ON STUDENTS' LEARNING OUTCOMES IN SOME SELECTED TOPICS IN CHEMISTRY

SAAH ALPHONSO TAYLOR

(8120120015)

A thesis of **SCIENCE EDUCATION**, faculty of **SCIENCE EDUCATION**. Submitted to the School of Graduate Studies, University of Education, Winneba, in fulfillment of the requirement for the award of the degree of **MASTER OF PHILOSOPHY IN SCIENCE EDUCATION**.

AUGUST, 2014

DECLARATION

I, Saah Alphonso Taylor declare that **The Impact of Student Team Achievement Division (STAD) Techniques on Students' Learning Outcomes in Some Selected Topics in Chemistry** is my work, that has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged as complete references.

Signature……

Date……

SUPERVISORS' DECLARATION

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

Principal Supervisor: Second Supervisor:

Dr. Ishmael Kwesi Anderson Prof. Mawuadem Koku Amedeker, Ph.D.

Signature…… Signature:……

Date:……. Date:……..

ACKNOWLEDGEMENT

I am abundantly grateful to the Almighty God for his Grace, Favor, Mercy and Strength. I could not have completed this work without the help from my Eternal Father.

I am grateful to my beloved sister Patricia Conteh-Morgan for her financial and moral support to my education. She has been an encouragement for me.

I am also grateful to my supervisors, Dr. Ishmael Kwesi Anderson and Prof. Mawuadem Koku Amedeker for their immense support and contributions toward the successful completion of this work. I would sincerely like to express my heartfelt gratitude to you, for your patience, in-depth constructive criticisms and valuable suggestions, which have immensely contributed to this work. God richly bless you.

I am grateful to all my lecturers in the Department of Science Education, University of Education, Winneba, especially: Prof. John K. Eminah, Dr. Thomas Tachie-Young, Dr. Emmanuel K. Oppong, Dr. Ernest Ngman-Wara, Dr. Joseph Nana Annan and Dr. Kojo D. Taale whose tuition and great thoughts have contributed in no small measure in conducting this research. I highly appreciate your encouragement and concern.

Special thanks go to the Form I and II Students of Datus International Senior High School for their great support in providing the needed information for this research work.

I remain grateful to my colleague students of the 2013 MPhil, Science Education batch: Dorothy, Deborah, Grace, Adane, Bawa, Ras, James, Mary, Eddie, Christopher, Bartels and Bentum. I highly appreciate your support and company.

DEDICATION

Dedicated to my deceased mom, Mrs. Constance Cole Taylor and son, S. Alphonso Taylor II; may they continue to rest in the bosom of Abraham and light perpetual shine on their souls.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

SHS =	Senior High School
STAD =	Student Team Achievement Division
WAEC =	West African Examination Council
CIP =	Cognitive Information Processing
CL =	Cooperative Learning
STAD =	Students Team Achievement Division
CRDD =	Curriculum Research and Development Division
OHP =	Over-Head Projector

ABSTRACT

This study investigated the effect of STAD as a learning technique on Senior High School students‟ conceptual understanding, their abilities to solve quantitative problems based on their qualitative understanding in some topics in chemistry and their attitude towards STAD. The study involves Forms I and II elective chemistry students of Datus International Senior High School of Community Seven of the Tema District of the Greater Accra Region. Convenience sampling technique was used to select 75 students which consisted of 20 girls and 55 boys. The individual teacher research strategy was adopted for the study in which the students were taken through a series of six interactive lessons by the intervention of STAD as a teaching learning technique. To determine the finding from the study, an independent t-test was conducted and showed that there was a significant difference from the pre-test and post-test score, p-value = 0.009 ($\alpha = 0.05$). This signified that the students performed better from the intervention of STAD. The study also showed that the students‟ attitude towards STAD as a teaching learning technique was positive. The findings further revealed that the students‟ attitudes towards the selected topics such as stoichiometry, nuclear chemistry, acids and bases, gases reactions and oxidation-reduction (Redox) reaction in chemistry improved positively. Therefore the use of STAD supports students-centered learning and made the lessons interactive by enabling students to learn cooperatively through group working and discussion. This study also made recommendations for the chemistry teachers who want to use STAD as a teaching learning strategy and the school that want to use STAD as a cooperative learning strategy.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter begins with the introduction to the problem of the study, the background of the study which discusses the need for an alternative teaching method Student Team Achievement Division (STAD) to the traditional method in the Senior High School (SHS). The statement of the problem is about the use of an alternative method of teaching to promote positive attitude towards science learning. Three research questions that guided the study have been stated, while the significance of the study is discussed in-depth. This chapter finally ends with the limitation and delimitation of the study.

1.1 Background to the study

Poor academic achievements and unhealthy attitude towards the learning of science and technology have been reported in the literature (Ajewole, 1991& Nwagbo, 2002). One of the major objectives of teacher learning is to effectively use instructional strategies that improve students‟ cognitive and affective outcomes. There are many different strategies of teaching learning methods. In recent years, one kind of student-centered approach such as cooperative methods has emerged as internationally accepted teaching strategies (Slavin, 2011).

Among the constraints that students face were the uses of archaic teaching methods. Literature has repeatedly drawn attention to the fact that teaching in secondary school science classes is very often highly teacher-centered and is characterized by a lack of

variety in the teaching methods (Johnson & Johnson, 1983; Adesoji, 1991; Becker, 1994; Agbeyewa, 1996; Adeoye, 1991; Poepping & Mella, 2001).

Ajelabi (1998) was of the opinion that the teaching method adopted by the teacher in order to promote learning is of topmost importance. Hence, it was concluded that there is the need to introduce, adopt or adapt the latest instructional techniques that are capable of sustaining the interest of the learners. According to Ajelabi (1998) there have been concerted efforts at getting learners more actively involved in the learning process and solving the problem of large class size through the development of methods and approaches that promote student-student interaction. The development of varieties of cooperative learning methods resulted in getting students more involved in the learning process.

Ajelabi further indicated in his findings that a lot of research works on the effects of inter-team competition on cooperative learning have been done around Africa. Considering the situation in the country nowadays among students, where competition is very much part of the education culture, a study of the effects of inter-team competition on students‟ learning outcomes is therefore desirable. For this reason the present study was carried out to investigate whether cooperative learning is necessarily in effect fulfilling many of the reported beneficial characteristics of learning or not. This was done by determining the effects of Student Team Achievement Divisions (STAD) learning strategies in promoting students‟ academic achievement and attitude to concepts in chemistry that high school students found difficult to understand.

Chemistry as a subject has many concepts; some of which are abstract in nature. High school students often find the abstract concepts difficult to understand (Ahiakwo, 1991). Let‟s consider topics like stoichiometry, acid and base or reduction-oxidation

(redox) reaction which are important concept in chemistry. These topics are about the components and activities of chemical reaction. They surround the relation between the quantities of substances that take part in a reaction or the formations of compound (products). These concepts have long been identified by researchers to be much dreaded by secondary school students (Ahiakwo, 1984, 1991: Akinmade & Adisa, 1984: Osborne, 2001).

Taylor and France (1991) found that there are widespread misconceptions among students and teachers in areas related to the predictions of equilibrium conditions, rate and equilibrium, acid -base or ionic solutions in water and applying equilibrium principles to daily life situations. Nowadays researchers have also identified students‟ lack of understanding in thermodynamics and chemical equilibrium as major factors influencing their conceptions about chemistry (Gltekin, 2010). West African Examination Council Chief Examiners‟ reports of 1999 to 2004 had also indicated that senior secondary school chemistry students found some chemistry topics difficult to understand. The present study is therefore interested in finding out if the treatment conditions (STAD) will enhance students understanding of the concept.

It has been shown that students‟ attitude is directly related to the popularity of the subject and to students‟ cognitive achievement (Johnson, 1978; & Simpson, 1994). The present research is therefore interested in finding out the effects of the treatment conditions on the subjects‟ attitude to some topics in chemistry. Most of the students find it difficult to develop ideas in their minds. Actually, they might have something to state in their mind, but they are often confused to express and develop their ideas into good scientific thoughts. It is such a common problem that is encountered by most of Science teachers in teaching science. There are claims which have been proven that the biggest problem that students have in writing is that they cannot put

their ideas and facts into paper since they are afraid if their ideas cannot be written correctly in terms of grammar (Campbell, 2002). This condition leads the students to a state of anxiety. In addition, Gills and his colleagues (2004) stated further that one of students‟ problems is that they have difficulty in arranging information or ideas logically to achieve coherence in their writing, which is the foremost requirement in writing their scientific ideas.

Furthermore, there are no limitations for the teacher to manage the class especially in teaching and learning process in science. One way which can be done by the teacher is The Cooperative Learning Method. Conducting the process of teaching and learning in the classroom may be a bit problematic since the teacher has students who are different from each other. Through Cooperative Learning Method, it is stated that the numerous problems students faced can be solved. Cooperative Learning Method has since becomes a good solution base and is considered as an effective way of teaching.

Among the Cooperative Learning Methods, Student Team Achievement Division (STAD) is a strategy of instruction whereby students work together in groups of varying composition to achieve common objectives. To be successful in this strategy, students share ideas rather than working alone and assist one another in order to maximize mutual benefits (Johnson& Johnson, 1981). This is unlike the use of Traditional teaching methods where students work individually or competitively (Slavin, 2001). In this method students are heterogeneously placed in a group of four to five.

There has been considerable debated agreements as to whether the positive outcomes of cooperative learning in promoting higher academic achievement more than other

methods result from cooperation within learning teams or from competition between learning teams (Kohn, 1992: Warring, Johnson, Maruyama, & Johnson, 1985).

Working with the Cooperative Learning Method, the differences of each student can be covered and they may share all information and work together in the group to produce or to accomplish the tasks given by the teacher.

Evidence from a number of disciplines suggests that oral presentation to large group of passive students contribute very little to real learning (Arons, 1990), especially, in Physics but is also in Chemistry teaching and learning. According to McDernott and Shaffer (1992), standard lecturer does not help most students to develop conceptual understanding of fundamental processes in important topics in Physic. This is however the same for the development of conceptual understanding of processes in chemical reaction, acid and bases, mole concept and redox reaction and many other topics in Chemistry. For many years, the lecturer method had been the most widely used instructional strategy in schools, college and universities in both the developed and developing countries; for instance, nearly eighty percent of all US college class room in the late 1970,s reported using some forms of the lecturer method to teach students and most universities in the sub-Sahara Africa have been using the traditional lecturer approach (Cashin, 1990; Antwi, 2013). Although the usefulness of other teaching strategies is being widely examined and encouraged today, the lecturer method still appears to be the prominent teaching method in all levels of education with its attended problems. According to Smith and Laslett (1993), the lecturer method involves the teacher doing all the talking with little or no in-puts from the students, which is problematic because the student takes on a passive role, and this can hinder learning. Students need to be active learners to keep their brain integrating new information. Students of today find it very difficult to sit for a long time and

listen to a teacher droning on a topic. Perhaps, it might be due to the fact that they are used to the television screen changing every half a second, and therefore have a difficult time staying focus for a long time during a lecturer session. In Ghana, the teaching syllabus for teaching and learning Integrated Science in Senior High Schools is developed by the Curriculum Research and Development Division (CRDD) of the Ministry of Education, to ensure effective teaching and learning of science; and therefore provided suggestion:

- Teachers must create learning situation and provide guided opportunities for students to acquire as much knowledge and understanding of science as possible through their own activities.
- Teachers must show, demonstrate and explain concepts in relation to real life situation.
- Students" learning experience should consist of opportunities to explore various scientific situations in their environment to enable them make their own observations and discoveries and record them.
- Teachers should help students to learn to classify, compare, analyze, look for patterns, spot relationships and come out with their own conclusions or deductions.
- Teachers must avoid rote learning and drill-oriented methods, but rather emphasize by participatory teaching and learning in science lessons (CRDD, 2007).

The above suggestion seek to strongly encourage participatory and child-centered learning here all attention and concentration should be on the students doing things on their own to arrive at conclusions, and not the teacher at the center of delivery. However, the lecture method seems to be most prominent strategy employed by most

science teachers in the various Senior High Schools in Ghana. The result is that, the learners are generally less apt to ask questions in class, and the teacher is the final authority of knowledge. The concomitant method of instruction for the majority of teachers in Ghana is the lecturer approach; delivering knowledge, as it were, into "empty, but willing vessels" (Hassard & Dias, 2009).

1.2 Statement of the problem

The statement of the problem of this research work is based on students‟ poor performance in the teaching learning process of science and technology. Therefore the need of an alternative process in the teaching learning process of science and technology has been necessitated. Research results have shown that cooperative learning methods enhance learning more than the individualized or competitive methods (Slavin, 1987). Students Team Achievement Division (STAD) is based on cooperative learning method. Therefore, the study will explore the use of STAD to implore students‟ understanding in Senior High Schools.

Cooperative learning is a strategy which involves team mates actively engaged in solving problems or working on a given task (s) in the hope to improve the students or pupils‟ conceptual understanding of abstract concepts (Slavin, 1987). This is evident in many studies indicating that cooperative learning is the suitable approach to ably improve students understanding of abstract concepts (Slavin, 1987). Cooperative learning as the name suggests, requires group, preferably students in small groups in order to support each other. Johnson and Johnson (2005) believed that it is a good opportunity to examine the effect of using cooperative learning strategy for students to participate fully is science (chemistry) lessons and help improve their interest in science and science related courses.

In comparison with cooperative learning, lecture-based teaching (teachers‟ center) has been reported to be less effective to the demands of high rates of cognitive and affective outcomes (Johnson & Johnson, 2005). In order to engage students in learning and to improve students‟ cognitive and affective outcomes, an alternative to lecture-based teaching could be cooperative learning (Tran & Lewis, 2012). In order to encourage students to improve their achievement and promote more positive attitude, an alternative to lecture-based teaching could be the Student Teams Achievement Divisions (STAD), one kind of cooperative learning approach (Slavin, 2011).

1.3 Assumptions of the Study

The following assumptions were made concerning this study:

- The students have had one or two years of basic chemistry concepts and so are familiar with some basic concepts in chemistry.
- The students have had some basic knowledge on chemical reaction, the mole concept, acid and base. These topics can be found in the elective science syllabus in Ghana Education Service Syllabus
- The students would do their pre-preparatory readings on assigned topics before coming to class.

1.5 Purpose of the Study

The purpose of this study was to investigate the impact of Student Team Achievement Division (STAD) technique as a teaching strategy on students‟ understanding of some selected topics in chemistry. The study focused on the students learning achievement

level on concepts such as like stoichiometry, reduction-oxidation (redox) reactions, acids and bases. These topics appear to be abstract to majority of chemistry students. An Action Research study in which the researcher identified a problem, and administered intervention and assessed the effects of the intervention was necessary for this work. The researcher identified the problem of poor performance, lack of interest, negative attitudes (laziness and truancy) and lack of enthusiasm towards the study of chemistry among form I and II elective science students of the Datus International Senior High School in Tema. Frequent tests were adopted to motivate students to learn chemistry and also deal with their attitudes, interest and enthusiasm towards the study of the subject. Pre-tests and post-tests results for each student were collected before and after the intervention period. This was computed to determine the average effectiveness of STAD as a learning strategy. Also, an observation checklist and students attitude questionnaire was designed to help collect data on the attitudes and levels of interest and enthusiasm. Data collected by the research instrument were subjected to analysis to determine the effect of the intervention on the student performance, attitudes and interest towards the study of chemistry.

1.5 Objectives of the Study

This research work is geared towards finding an alternative to the lecture or traditional teaching learning method. It will contain the following objectives to guide the researcher.

- The usage of Students Team Achievement Division (STAD) technique to improve the understanding of some selected chemistry topics.

- The investigation of the difference in impact of the use of the Students Team Achievement Division (STAD) technique on the understanding between male and female students in those selected chemistry topics
- The determination of the perceptions of students about the use of the Students Team Achievement Division (STAD) technique to teach those selected chemistry topics.
- The difference in perceptions between male and female students about the use of Students Team Achievement Division (STAD) technique to teach those selected chemistry topics

1. 6 Research Questions

The following research questions were addressed in this study:

1) To what extent does the use of Students Team Achievement Division (STAD) technique impact students‟ achievement in some selected topics in chemistry?
2) What is the student attitude towards the use of Students Team Achievement Division (STAD) technique as a learning strategy in chemistry?
3) What is the gender difference of the impact of the use of Students Team Achievement Division (STAD) technique on the understanding of some selected topics in chemistry?

1.7 Null hypotheses

The following null hypotheses were tested at the 0.05 level of significance. The null hypothesis of this research work is as followed:

1. There is no significant effect of the treatment of STAD technique on students‟ performance in the selected topics in chemistry.

1.8 Significance of the Study

The outcome of this study will most likely enhance the ability of policy makers and stakeholders of education in the country to make informed decisions on teaching methodologies that are geared towards improving students‟ performance (understanding) and interest in science and science related courses. Stakeholders will also indentify variables that may be modified to bring about improvements in the curricula and the possible writing of science books. Such venture might increase the interest of our students‟ interest in science and science related courses. Again, the finding of this research will help to give teachers insight into cooperative learning strategy which is more of students‟ centeredness and provides students with construction of their own knowledge. Most definitely cooperative learning strategy, however, requires more efforts in lesson planning, preparation and delivery. It is been suggested that cooperative learning is not only a great way of learning but it is also a very vast field of research and analysis (Slavin, 1995). Subsequently to this research and analysis; the design section exist which suggests the designing of course outline and groups‟ tasks. Slavin (1995) also suggests that cooperative learning is doubtlessly a great tool for slow learners, handicapped and disabled students. Cooperative learning method may encourage these students and molds them to work in a professional environment. Cooperative learning method is suitable for both the disabled and normal students and serves as another great way of encouraging disabled students or even very slow learners (Slavin, 2011) . According to research, when slow learners, disabled and handicapped students work in mainstream and homogeneous environments, they learn in a more productive and skillful manner (Slavin, 1995).

1.9 Limitation of the study

One of the weak points which have affected the findings of this research is that some students were non-attendees and so were not in school throughout the period. This will not lead to a hundred percent attendance as the researcher would wish it to be. Of course this will in turn affect the collaboration of data as well as the results of the study. Another factor is that some of the students felt shy to speak for fear of making mistakes or being laughed at and so were hesitant in their responses and answering of questions during the classes most especially at the early stage of the work. The period for the study was short (eight weeks). The longer period of study may have perhaps produced different results.

1.10 Delimitations of the study

The students were aware that they were participating in a study. This might have sensitized them for the intervention phase. This might have made them to be more participatory in the study. Been aware of the study they could have gone to do some extract studies by themselves aside of the assigned group that they belong. There were some occasions when some of the students were absent from the study due to their inability to pay school fees. This might have affected the result of the strategy. The Researcher would have loved to do the study with more students of chemistry from both high schools and tertiary (freshman students) in the entire Tema District. However, this research is intended to address the concern of the Datus high schools students in an effort of cooperative learning strategy in science only, specifically in some selected topics in chemistry. Also, considering the period allocated for chemistry in the eight weeks timeframe the study was confined to selected topics of stoichiometry, acid and base and reduction-oxidation reaction (redox reaction).

Due to the time factor and financial constraint of the study which should have covered the entire schools in the Tema metropolis, but it was limited to Datus International School.

1.11 Organization of the study report

The study was organized into five chapters.

Chapter one

This chapter caters for the background of the study. It outlined the statement of the problem, the purpose of the study and the research questions which guides the study. It covered the significance of the study, limitations and delimitations of the study. The chapter ends with definitions of terms.

Chapter two

This chapter reviews other studies which are of essence to this research study. It consists of reviews of related literature from which was derived a theoretical framework for the study.

Chapter three

This chapter discussed the methodology of the study including the research design, population and sampling procedure for the study. Instrumentation used for the study comprising a self-designed achievement test was outlined. The chapter concluded with data collection procedure and the method used to analyze the collected data.

Chapter four

Chapter four presents the data collected their analysis and discussion of the result emanating from the analysis of the data collected.

Chapter five

This chapter is the conclusion of the work. It includes a summary of the findings, conclusions and recommendations resulting from the outcomes of the study.

1.12 Summary

There was the need to critically look at how Chemistry is been taught in the Ghanaian Senior High Schools as this is considered to be one major factor for students‟ performance and attitude towards the subject. The main method used by most teachers has been the lecture method where the teacher being “the sage on stage” delivered his/her already prepared notes to the students. This chapter focused on the use of interactive teaching method such as Student Team Achievement Division (STAD) where the students are at the center of the teaching and learning process. The elective science students of the Datus International Senior High School were the sample for this study. In the next chapter, a view of the relevant literature on learning theories and cooperative learning strategies such as STAD will be thoroughly discussed.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter introduces the review of literature. The need for the review of literature shall first be considered, followed by some theories of learning. The chapter also considered some discussions on recent related studies on Student Team Achievement Division approach in relation to the topic of this study.

2.1 Need for Literature Review

For any specific research to occupy the place in the development of a discipline, the researcher must be truly familiar with both previous theory and research (Mahaboobjan, 2010). According to Mahaboobjan, to assure this familiarity a review of the research literature is done which allows the researcher to know the amount of work done in the concerned area. The clarity of the problem is possible with the thorough understanding of the knowledge generation on the area of research. It provides the source for hypothesis, avoid replication and suggest the method, procedure, source of data and statistical technique appropriate to the solution of the problem. The review of the related literature provides some insight regarding strong points and limitation of the previous studies. It enables researcher to improve their own investigation and to arrive at the proper perspective of the study (Boote & Beile, 2005). Several studies have attempted to determine if cooperative learning and the use of frequent testing of students in science teaching and learning have had any influence on the performance and attitudes of students. This chapter hopes to review literature related to this study for some possible solution to the issue at hand.

2.2 Theoretical Framework of the Study

The theoretical framework that underpinned the study was hinged on Jean‟s Piaget‟s theory of cognitive development, cognitive information processing (CIP) theory propounded by Atkinson and Shriffin (1968) and Lev Vygotsky‟s social constructivism theory. Piaget theory of cognitive development is a comprehensive theory about the nature and development of human intelligence, first developed by Jean Piaget. According to Piaget (1954), the theory deals with the nature of knowledge itself and how humans gradually acquire, construct and use it. Cognitive development is a progressive reorganization of mental processes as a result of biological maturation and environment experience. Thus children construct and understand the world around them, and then experience discrepancies between already and that they discovered in their environment (Piaget & Inhelder, 1973). To Piaget, the cognitive development of children towards formal thought could be facilitated through three cognitive processes: assimilation, accommodation and equilibration. Assimilation describes how humans perceive and adapt to new information. It is the process of taking one‟s environment and new information and fitting it into pre-existing cognitive schemas (McLeod, 2010). Assimilation may occur when humans are faced with new or unfamiliar information they refer it to previously learned information in order to make sense of it. According Piaget (1954), when children assimilate, they perceive new objects and events according to their existing schemata, mental modes or cognitive structures. Piaget emphasized the functional quality of assimilation, where children and adults tend to apply any mental structure that is available to assimilate new events, and actively seek to use these newly acquired mental structures. In this study, the students were required to do pre-preparatory reading of specific topics before actual lessons begun. In doing their pre-

reading assignments, the students may have perceived new concepts which they could assimilate according to their existing cognitive structures. Thus, in this first stage of their learning process, the students were made to go through the assimilation process. Accommodation, unlike assimilation may be described as the process of taking one‟s environment and new information, and altering one‟s pre-existing schemas in order to fit in the new information. In other words humans understand whatever information fits into their established view of the world, schema. But when information does not fit, a re-examination and adjustment of people‟s thinking takes place in order to accommodate the new information. According to Piaget (1954), accommodation results as children reframe or modify their existing schemas or mental representation of the internal world to fit their experience for learning to occur. Hence, children exercise existing mental structures in particular situation, accommodation-motivating disequilibrium, results and the children construct new mental structure to resolve the disequilibrium (Piaget, 1954). The state of disequilibrium and contradiction arising between the existing schemata and the more sophisticated mode of thought adopted by the new experience therefore, has to be resolve via equilibrium process. Obviously, accommodation appears to influence assimilation, and vice versa. Hence, as reality is assimilated, structures are accommodated. Equilibration refers to the biological drive to produce an optimal state of equilibrium between people‟s cognitive structures and their environment (Duncan, 1995). Piaget believed that all children try to strike a balance between assimilation and accommodation, which is achieved through a mechanism called equilibration. As children progressed through the stages of cognitive development, it is important to maintain a balance between applying previous knowledge (assimilation) and changing behavior to account for new knowledge (accommodation). Equilibration helps explain how children are able to

move from one stage of thought into the next. Thus in the view of Piaget (1954), students are actively involved in the construction of their own knowledge. It is therefore argued that knowledge is constructed through action and that children must continuously reconstruct their own understanding of phenomena through active reflection and events till they eventually achieve an adult"s perspective. Piaget (1954) hence posited that, the process of intellectual and cognitive development is similar to a biological act, which is adaption to environmental demands. Cognitive Information Processing (CIP) theory is often referred to as "information processing". Information processing is not really the name of a single theory; it is a generic name applied to various theoretical perspectives dealing with the sequences and execution of cognitive events. Schunk (1996) propounded that, information processing theories on how people;

- Attend to environmental events,
- Encode information to be learned to relate it to knowledge in memory,
- Store new knowledge in memory, and
- Retrieve it as needed.

Cognitive information processing (CIP) theory therefore describes how all the perspectives that focus on human cognitive processing such as connection, perception, encoding, storage, and retrieval of knowledge occur.

2.3 Theories of learning

There is no one, clear, universal explanation of how we learn and subsequent guide book as to how we should teach; rather, there are a range of theories, each with the background in a different psychological and epistemological tradition (Ormrod, 2012). To understand learning than, we have to understand the theories and the

rationale behind them. The theories of learning was discussed in Athens of how applicable they have been, and as discussed by various researchers in diverse studies elsewhere. Learning theories are conceptual framework that describes how information is absorbed, processed and retained during learning (Illeris, 2004; Ormrod, 2012). According to Illeris and Ormrod learning brings together cognitive, emotional, and environmental influences and experience for acquiring, enhancing, or making changes in one‟s knowledge, skills, values and world views. The broad range of theories that can be identified in, and applied to, learning in the classroom reflects the different ways in which epistemological tradition influence the experience we have and how we feel they impart on learning (Surgenor, 2010). While there are a wide range of different psychological theories that have been applied to learning, this study shall discuss the three dominant theories amongst them: Behaviourism, Cognitivism, and Constructivism. Behaviourism is mainly grounded in Objectivism and believes that knowledge is absolute and true, and is in dependent from and outside of the individual; it focuses only on the objectively observable aspect of learning (Surgenor, 2010). Cognitivism, mainly grounded in Pragmatism, refers to the acquisition of knowledge and active processing where no single truth exists (Brownlee, Boulton-Lewis & Berthelsen, 2008). Thus, Cognitive theories look beyond behavior to explain brain-based learning, while Constructivism, mainly based on Interpretivism, implies that knowledge is not uniform; it is constructed at an individual level, exists in multiple formats and varies from person to person. Hence, Constructivists may be seen as theorists who view learning as a process in which the learner actively construct or build his/her own ideas or concepts based on any given information. Here, information is subjectively interpreted by the learner based on

personal experience (Surgenor, 2010). Each of these approaches and their main theories are further discussed.

2.3.1 Behaviourism

Behaviourism is a well known orientation to learning that encompasses a number of individual theories. Developed by John Watson in the early decades of the twentieth century, behaviourism loosely includes the works of people like Thorndike, Tolman, Guthrie, Hull and Skinner (Ormrod, 1995). The primary tenet of behaviourism, as expressed in the writing of John B. Watson, B. F. Skinner, and others, is that psychology should concern itself with the observable behaviour of plants and animals not with unobservable events that take place in their minds (Dede, 2008). For Behaviourists, three assumptions underline their theories:

1. Learning is manifested by change in behavior.
2. The environment shapes behavior
3. The principle of contiguity (how close in time two events must be to for a bond to be formed) and reinforcement (any means of increasing the likelihood that an event will be repeated) are central to explaining the learning process (Grippin & Peters, 1984).

Hence, to the Behaviourists, learning is the acquisition of new behavior through conditioning and that "cause and effect" is what controls behavior, not the mind or reasoning; to them the keyword to behaviourism is "conditioning" or "training" (Dabbagh, 2006).

2.3.2 Implications of Behaviorism for Teaching and Learning

The operant conditioning of Skinner (1974), with its focus on unpleasant and pleasant consequences (reinforcement) as a means of shaping behaviour is perhaps the best known educational application of behaviourism, and has led to the development of tangible guidelines for learning strategies such as a focus on incremental learning and the need for consequences to be intermittent and timely (Slavin, 1991; Langford, 1989). Behaviourism focuses on one particular view of learning: a change in external behavior achieved through a large amount of repetition of desired actions, the reward of good habits and the discouragement of bad habits (Dabbagh, 2006). Dabbagh suggested that, Behaviourist theories of learning assume knowledge is an absolute, reflecting universal truth about reality. Therefore, human behavior, such as learning, as purposive, but are guided by unknowable inner states. This leads to the assumption that relationships between contextual instructional variables (stimuli) and observable, measurable student behavior (responses) are the means to generate learning as illustrated in figure 1.

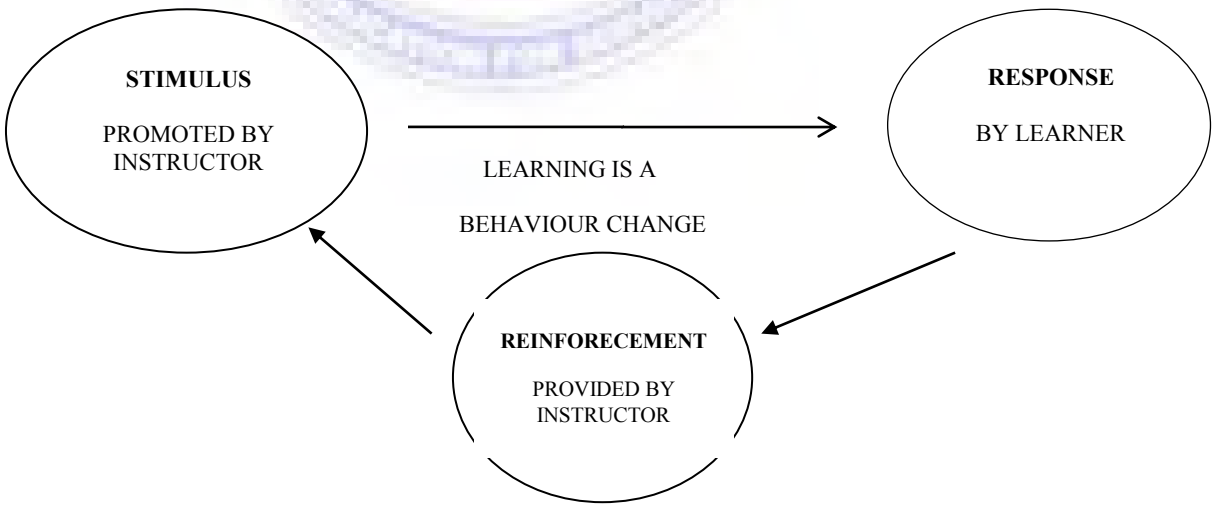

Figure 1 Behaviourist Approach‟s to Learning

In the context of teaching and learning, the Behaviourists‟ model for learning is teacher – directed, pedagogic and concrete (Slavin, 1991). It is all about “do as I say”, which involves the lower levels of Bloom‟s Taxonomy (recall) where the more gifted learner who is at the top of the learning pyramid might not benefit from a Behaviourist – dominated lesson. To Behaviourists, learning is indicated when a correct response follows the presentation of an instructional environmental stimulus (Dede, 2008).

In the classroom this view of learning could lead to a great deal of repetitive actions such as word drills and practice, praising students for correct outcomes and immediately correcting mistakes of student. Negative behavior such as lack of involvement in class activities, negative contributions to class discussions and the likes could be minimized by the facilitator using negative reinforcement such as punishment. Within the Behaviourists‟ view of learning, the “teacher” is the dominant person in the classroom and takes complete control of the teaching and learning process (Dede, 2008). Evaluation of learning comes from the teacher, who decides what is right or wrong, whiles the learner does not have any opportunity for evaluation or reflection within the learning process; they are simply told what is right or wrong (Slavin, 1991). The Behaviourist approach might be best suited to a class of young or less able learners, where the objectives are clear and easy; to measure. This form of teaching might also be necessary for moving things along; for instance keeping to deadlines such as exams, discouraging late – comers and people misbehaving during class. The conceptualization of learning using this approach could be considered “superficial” as the focus is on external changes in behavior. Hence, there is no interest in the internal processes of learning leading to behavior change, and as such, no place for the emotions involved in the learning process. Some

problems on Behaviourist approach to teaching and learning as noted by Dabbagh (2006) are as follows:

- The tendency of learning without understanding
- Problems with generalization
- The fact that the teacher can be seen as a technician rather than an educator since it relies almost exclusively on observerable behavior and does not account for individual through processes, the roll of behaviourism in learning is necessarily limited to the types of learning which can be easily observed such as factual recall, rather than clearly defined learning which involve internal conceptual change within the learner.

2.3.3 Cognitivism

The earliest challenge to the Behaviourists came in a publication in 1929 by Bode as cited in Hergenhan and Olson (2005). Bode, a Gestalt psychologist, criticized behaviourists for being too particularistic, too concerned with single events and actions and too dependent on overt behavior to explain learning, Gestalt (a German word meaning form, pattern or shape) psychologists proposed looking at the whole rather than its parts and at patterns rather than isolated events. Thus through the research of Gestaltists Max Wertheimer (1880 – 1943), Wolfgang Kohler(1887 – 1967) and Kurt Koffka (1886 – 1941), the Gestalts‟ view of learning have been incorporated into what have come to be labeled cognitive or information – processing learning theories (Ormrod, 1995; Gredler,1997). To Ormrod and Gredler, two key assumptions underlie this cognitive or information – processing approach:

1. That the memory system is an active and organized processor of information, and
2. That prior knowledge plays an important role in learning‟

According to cognitivists, the human mind is not simply a passive exchange - terminal system where the stimuli arrive and the appropriate response leaves; rather the thinking people interprets sensations and give meaning to the events that impinge upon his consciousness (Grippin & Peter, 1984). Thus humans generate knowledge and meaning through sequential development of an individual‟s cognitive abilities, such as the mental processes to recognize, recall, analyze, reflect, apply, create, understand and evaluate (Hergehahn & Olson,2005). For effective learning to occur, the learner requires assistance to develop prior knowledge and integrate new knowledge (Gredler, 1997). Gredler further states that the learner also requires scaffolding to develop schema and adopt knowledge from both people and the environment. The educators‟ role therefore is pedagogical in that he/she must develop conceptual knowledge by managing the content of learning activities into manageable portions which can be easily absorbed by the learner. In summary, cognitively oriented explanations of learning encompass a wide range of topics with a common focus on internal processes that are under the learner‟s control. “ Essential components of learning are the organization of the information to be learned, the learner‟s prior knowledge, and the processes involved in perceiving, comprehending and storing information” (Gredler,1997). As Di Vesta (1987) observes,” rather than seeking the general all – encompassing laws for controlling and predicting behavior as did the earlier grand theories of learning”, cognitive learning theory “is directed towards miniature models of specific facets of cognition, such as models of discourse analysis, models of comprehension, ways of aiding understanding and meaningful learning, the nature of the schemata, the memory system and the development of cognitive skill.”

2.3.4 Implications of cognitivism for teaching and learning

Teachers/educators can apply concepts from cognitivists in the classroom to enhance their student‟ understanding. There are multiple strategies that enhance learning through cognitive processes such as using cues, questioning, advanced organizers, summarizing notes/notes taking and virtual field trips (Laureate Education Inc. 2008). Pitler, Hubbell, Kuhn and Malenoski (2007) have provided strategies to enhance student‟s ability to retrieve, use and organize information.

The first strategy encourages teachers to use cues, questions and advanced organizers to enhance learning.

- Cues, questioning, and advanced organizers focus on pertinent information and use higher – level questioning to encourage deeper learning.
- Advanced questions are effective learning tools when asked before the activity so that the students may concentrate on the essential idea(s).

These strategies seem to support the cognitive learning theory because cues and questions tap into student episodic memories (category of long – term memory that involves the recollection of specific event, situations and experiences) to access prior knowledge, as such throughout the lesson; students are able to focus on essential ideas. Once the essential ideas are established, advanced organizers enable students to organize information in a meaningful way, and this promotes understanding of the main concept(s). Advanced organization also provides a visual support for students to use (Orey, 2001). This is because students‟ are not only using words, but creating the visual, which support Paivio‟s dual coding hypothesis (Paivio,1971) a theory which suggests that the learner remember better when two processes are engaged visual learning and verbal learning (Sternberg,2006). While creating the advanced organizer, students would also be using higher – level thinking skills like applying, analyzing,

synthesizing and evaluating concepts which make learning a more effective process (Forehand, 2005).

Another way by which teachers could make learning more effective and meaningful is by linking new information to familiar information. Meaningful learning refers to the concepts that the learned knowledge is fully understood by an individual and that the individual knows how that specific fact relates to other stored facts (Gagne, 1970). For instance, if a teacher wants to teach about Energy and Energy Transformation, he/she must link the topic to familiar situation in the home or environment such as cooking, plucking of fruits and drawing of water from a well, to make the concept of Energy more real and meaningful to the learner.

Concept maps are also a type of advanced organizers that allow students to create an outline or web of pertinent information presented to them (Novak & Canas, 2008). To them, concepts maps allow students to outline the information in a way that is conceptually clear, and then, are able to connect the new concepts with prior knowledge or schema. Further, concept mapping supports dual coding of information where students can visualize the information, and therefore, be more likely to retain the information.

Summarizing notes and note – taking is another strategy suggested by Pitler and Malenoski (2007) that supports the cognitive learning theory. Summarizing is the ability to delete, substitute and /or keep information in order to record important information. Teachers may provide templates and ready – made notes for students to use and make meaning out of it. Pitler, Hubbell, Kuhn and Malenoski also suggest teaching, modeling and summarizing as well as giving student opportunity to create their own notes. Summarizing and note taking promote the cognitive learning theory because students create episodic memories through the experience of note taking

while also creating a visual that may aid later retrieval of the information. When students attempt to remember information, it is more likely that their brains would be able to make connections with the visual imprint that has been previously introduced into their memory (Berryhill, 2008).

Another tool that promotes the cognitive learning theory is the use of virtual field trips (Foley, 2003). Virtual field trips are web based tools, many provided on the internet which allow students to visit places that they would not be able to physically go otherwise. Virtual field trips enhance learning because they create experience, or episodes, that have a strong possibility to transfer into episodic memory (Nix, 1999). Effective teachers attempt to create experiences that will enhance episodic memories because these types of experiences are meaningful to the learner. Through virtual field trips, students no longer rely on the pictures in the textbook, but are actually able to witness the places or events in which they are learning about (Foley, 2003). From this, teachers are able to engage students in critical thinking activities that can further encourage life – long learning.

2.3.5 Constructivism (Helping students build their own understanding of science)

Constructivism is the philosophical and scientific position that knowledge arises through a process of active construction (Mascolol & Fisher, 2005). Constructivism goes beyond the study of how the brain stores and retrieves information to examine the ways in which learners make meaning from experience (Galloway, 2001). According to Galloway, while Constructivism does not necessarily deny the existence of an objective reality, it does deny the existence of an objective knowledge since "there are many ways to structure the world, and there are many meanings or perspectives for any event or concept.

Thus, there is not a correct meaning that we are striving for (Duffy &Jonassen, 1991). Constructivist education theory is based on the work of developmental psychologists Jean Piaget, Lev Vygotsky and education reformer and psychologist John Dewey (Bandura, 1986). Constructivism is founded on the belief that learners bring experiences and prior knowledge to the classroom and as such must connect new information to this background knowledge in order to make sense of it. Constructivist learning theory is based on the assumption that learners actively construct knowledge, and that knowledge cannot be passively transmitted from the mind of an expert into that of a novice (Moll, 2002). Constructivist teachers do not take the role of the "sage on the stage," instead, they act as a "guide on the side" providing students with opportunities to test the adequacy of their current understandings (Moll, 2002). On the other hand, students use inquiry methods to ask questions, investigate a topic and use a variety of resources to find solutions and answers. As students explore the topic, they draw conclusions, and as exploration continues, they revisit those conclusions. Exploration of questions leads to more questions.

2.3.6 Implications of Constructivism for Teaching and Learning

Constructivism upholds a more open – ended learning experience based on an individuals‟ experience (Dembo 1994). This type of learning is not as easily evaluated, nor is the results the same for every learner because constructivism sees every learner as different based on his or her own experiences. In the constructivists‟ view, rather than the transmission of knowledge, learning appears to be an internal process of interpretation, where learners do not transfer knowledge from the external world into their memories; rather, they create interpretations of the world based upon their past experience and their interactions in the world. The constructivist classroom

tends to shift focus from the teacher to the students and the classroom is no longer a place where the teacher ("expert") pours knowledge into passive students, who wait like empty vessels to be filled. The students are urged to be actively involved in their own process of learning by making meaning out of their own learning experiences. Key assumptions of the constructivism theory to the learning process according to Jordan, Carlie and Stack (2008) include the following:

- What the students currently believe, whether correct or incorrect, is important.
- Despite having the same learning experience, each individual will base their learning on the understanding and meaning personal to them.
- Understanding or constructing a meaning is an active and continuous process.
- Learning may involve some conceptual changes
- When students construct a new meaning, they may not believe it but may give it provisional acceptance or even rejection.
- Learning is an active, not a passive process and depends on the students taking responsibility to learn.

Summarily, in a constructivist learning environment, students are actively involved in student–centered learning activities, classes tend to be less rigid in their structure and students are engaged in achieving the learning outcomes (Jonassen, 1999). Group work and discussion are integral parts of a constructivist‟s classroom, and students are encouraged to seek information for themselves and from their peers (Littleton, Wood &Chera, 2006). Hence, the teacher‟s role changes from that of dispenser of information to a facilitator of information. Classes are designed to promote discussion, active learning, and reflection, and provision is made for modeling, coaching and scaffolding to support students when required. The learning process also requires the full

engagement of the students in practical and real world tasks. Finally, there are opportunities for students to reflect on their learning experiences (Jonassen, 1999).

2.4 Traditional Teaching Methods in Science (Traditional Instruction)

Traditional instruction is teacher – centered and characterized by direct instruction (Kinney & Robertson, 2003). According to Kinney and Robertson, direct instruction usually includes the presentation of material, thinking aloud by the teacher, guided practice, correction and feedback and modeling by the teacher. The teacher plays the role of the expert imparting knowledge and decides what, when and how students should learn with all students studying the same topic at the same time (Brown, 2003). A teaching style inventory administered to 381 faculty members at 200 United States of America public and private colleges and universities revealed that 60% of them taught using the teacher – centered mode of instruction assuming the role of expert, authority and model (Grasha, 1994). The results further revealed that the facilitator and delegator teaching styles, which are student – centered, were used less in mathematics and computer science classes than in any other discipline. The tendency is for teachers to use the same instructional methods with which they were taught and about which they feel comfortable.

In college and universities, the predominant mode of instruction has been the presentation of material through lecture and demonstration using whiteboard, chalkboard, overhead, power point or graphing calculator (Armington, 2003). The teacher talks and students listen and write. The teacher demonstrates step by step procedures which are reinforced with drill and practice and interaction is limited to students responding to the teacher‟s questions.

Some educators have a very negative view of the traditional lecture. According to Brown (2003), the teacher is responsible for thinking and the students memorize and recite. Hence teachers are focused on content, schedules and standards, but not on the needs of the students.

Felder and Brent (1996) describe the traditional lecture as stenography with the teacher reciting the course notes, the students transcribing the notes, and "the information not passing through anyone"s brain. Teachers that teach by lecturing operate under the assumption that if they do not lecture they will lose control of the class; they view their students as empty pails waiting to be filled and themselves as the "sage on the stage" (Mahmood, 2006). According to Brothen and Wambach (2000), faculty, students and administrators think that teaching means "speaking aloud from the front of the room". However, based on their research on a developmental psychology course, they concluded that lectures are inefficient means of delivering instruction. Basically, the teacher controls the instructional process; the content is delivered to the entire class and the teacher tends to emphasize factual knowledge. In other words, the teacher delivers the lecture content and the students listen to the lecture. Thus, the learning mode tends to be passive and the learners play little part in their learning process (Orlich, Harder, Callahan & Gibson, 1998). It has been found in most university by many teachers and students that the conventional lecture approach in classroom is of limited effectiveness in both teaching and learning. In such a lecture students assume a purely passive role and their concentration fades off after 15 – 20 minutes (Oni, 2012).

Some limitations which may prevail in traditional teaching environment are as follows:

2.5 Teaching in Classroom using Chalk and Talk is "One Way Flow" of Information

In such classroom situations, the teacher is the sender or the source of the information, the educational material is the information or message and the student is the receiver of the information as displayed in figure 2. This form of knowledge is termed as one way flow of message.

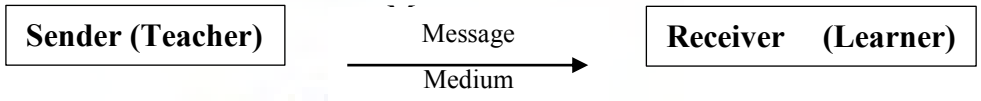

Figure 2 Mode of one way message channel

In terms of the delivery medium, the teacher can deliver the message via the "chalk - and – talk" methods and Over-Head Projector (OHP) transparencies. This directed instruction model has its foundations embedded in the behavioral learning perspective and it is a popular technique which has been used for decades as an educational strategy in all institutions of learning (Mayes, 1993).

The teacher may continuously talk for an hour without knowing students response and feedback. In other words, the teacher delivers the lecture content and the students listen to the lecture. Thus, the learning mode tends to be passive and the learners play little part in their learning process.

2.6 The material presented is only based on the lecturer's notes and textbooks making learning transient, and the student totally passive and dependent on the teacher.

The traditional approach to learning assumes that all students have similar levels of knowledge in the subject being taught and they absorb new material in a simper pace

(Marbach – Ad, Seal & Sokolove, 2001). Students are rarely given much choice about what they are to learn. Marbach – Ad, Seal and Sokolove further stated that the teacher is the Centre of any information given to learners, and they only receive information that is given by teacher from his lecture notes, textbook or any other material he/she has in hand. This approach aims to transmit values, attitudes and ideas form teacher to children, and also demand the children to master concepts and ideas in the books and in teacher‟s lectures. Learners are not given the importunity to search elsewhere for information and this is certainly less influential in improving student‟s knowledge Thus, the ease with which students absorb knowledge is the same ease with which it goes out (Antwi, 2013). The lecture method also allows students to become passive recipients of information that has been "predigested" by the teacher (Hansen & Stephens, 2000). Thus, student become dependent on the teacher to tell them what they need to know and can avoid taking responsibility for their own learning (Machemer & Crawford, 2007). Furthermore, students accustomed to being passive have a "low tolerance for challenge" (Hansen & Stephens, 2000) and finally learning as a result of lecture method is relatively superficial and transient (Phipps, Phipps, Kask& Higgens, 2001; Moust, Van Berkel& Schmidt, 2005). More emphasis tends to be placed on theory without any practical and real life applications/situations.

2.6.1 Encouraging rote learning (memorizing) of formulae, proofs, stating answer and principles, as well as defining terms; a situation which tends to promote learning form memorization but not understanding.

Rote learning is defined as an arbitrary, verbatim and non – substantive incorporation of new ideas into the cognitive structure (Ausubel, 1963). To Ausbel, information does enter the cognitive structure, but with no specific relevance to existing concept/

propositional frameworks. Partly for this reason, rote learning may involve interference with previous similar learning, and exhibit some of the difficulties in patterns of recall, including failing to notice associations. Studies have shown that with the traditional approach to teaching and learning, most students depend on rote learning and rote problem solving without developing the conceptual problem solving skills that all scientists value (Mazur, 1997; McDermott, 1993). The lack of conceptual understanding usually goes unnoticed because students can solve many standard problems in spite of the difficulties; they are talented and have memorized rules that are often true (Antwi,2013). For instance, the issue of rote learning was identified as a problem among learners, especially Ghanaian students during their final examinations in Physics. Reports from the chief examiner of the West African Examination Council (2002; 2004; 2008), confirm that many students have poor knowledge of science; they avoid questions requiring deductive thinking, and are unable to go beyond stating definitions. In his recommendations, he proposed that teachers should actively involve students in the teaching and learning process, and discourage rote learning as much as possible. Thus teachers were encouraged to adopt methods that would enhance learner‟ participation and understanding during teaching and learning process.

2.6.2 Teachers' and students' roles in traditional and constructivist classrooms

It is interesting to compare the constructivist‟s view of learning with traditional view of knowledge which is implicitly assumed by many teachers. In the traditional view, knowledge exists independent of the individual and the mind is a tabula rasa (a blank tablet) upon which a picture of reality can be painted. If the student is attentive, learning occurs when the teachers unload his or her almost perfect picture of reality

through well – designed and well – presented lectures. Most experienced teachers can attest that this model does not work for most students. Unfortunately, the traditional model focuses on the delivery system and not on the learner. In computer language, the focus is on output devices and not input devices. However, to the constructivists, the minds of the learners are not blank tablets upon which the teacher can write at well. The constructivist theory says the tablets are not initially blank and only the individual can do the writing. The constructivist teacher is a facilitator who encourages students to discover principles and construct knowledge within a given framework or structure. Thus, almost all those who advocate major reforms of schooling, particularly through the use of computers, have the view that learning needs to be more informed by constructivism (Clouse & Nelson, 2000). Constructivist learning theory could therefore be considered nowadays as "the theory" in learning which emphasizes the learner‟s experience in the learning process. Thus they believe that, students build on past experiences and previous knowledge to process new concepts. As children redefine old understandings of concepts and integrate new experiences into their old concepts, they mature in their knowledge and understanding. Notwithstanding the fact that constructivist learning theory emphasizes that learner‟s experiences, teaching and learning still remains teacher – centered in all the academic levels with its traditional lessons and practices, thereby making students passive during lesson delivery (Paris, 1988).

Learning has dramatically changed over recent decades when technical revolution has brought different opportunities to learning via the internet (Brown, 2000). Nowadays the traditional classroom teaching has changed more into a virtual environment where different issues about learning have to be taken into account. The students need to be motivated in the learning situation and the material has to be easily at hand. A teacher

in a traditional classroom is the primary source of information and authority, whiles in a constructivist classroom, the teacher acts as a facilitator, assisting students in pursuit of knowledge.

Traditional teachers disseminate knowledge whereas constructivist teachers interact with students, helping them construct their own learning.

Constructivist teachers value students‟ points of view and compel their participation in classroom activities, rather than expecting silent and passive attentiveness as is the norm in traditional classrooms. Students in a traditional classroom are passive; listening and reacting to the teachers‟ direct instruction, whereas in a constructivist classroom, students are active exchanging ideas with the teacher and with one another. Students in a traditional classroom are considered "blank slates" as all learning in the traditional area is isolated and unconnected with the world and students‟ backgrounds, however, students in a constructivist classroom are expected to connect all learning to prior knowledge, and this lead to greater internalization and comprehension of facts and concepts. Students in constructivist classes work in groups rather than alone as is usual in the traditional classroom (Smerdon, Burkam & Lee, 1999).

2.7 The Concept of Gender

The term „gender‟ has emerged to replace „sex‟ in the educational and social science studies for some time now. There might be many reasons attached to the shift to the use of term „gender‟. Perhaps, gender is often used euphemistically in many studies to avoid the negative connotations of the word „sex‟.

It appears „sex‟ seems to connote the unwanted sexual idea while „gender‟ does not. Also „sex‟ directly refers to the *biological* classification of people while „gender‟

refers to the social nature of the issue. However, both are important analytical tool though, in the context of males, females, and science, the „gender" is now frequently used. According to Sjøberg (2002b), the distinction between sex and gender also indicates that femininity or masculinity are not biologically determined, but are socially constructed or negotiated, and that they may change over time and may be different from one culture to another. For this study, gender is used whenever there is a discussion on differences between male and female on any aspect of science learning.

2.8 The Concept of Attitude

Curtis (1926) played a pioneering role of introducing the concept of attitude from social science to the field of science education. Since then, the concept of attitude has attracted various definitions and explanations in many areas of learning including social psychology and the social sciences. Attitudes are complex and difficult to measure (Page-Bucci, 2003).

Attitudes towards science may be used to refer to as general and continuing positive or negative feelings about science. Though there might be interrelationship between beliefs, attitudes and behaviour; attitudes towards science may be viewed as a convenient summary of a wide variety of beliefs about science, which in turn permits the prediction of science related behaviour.

The term belief might therefore, be referred to as the information that a person accepts to be true.

Scientific attitudes imply certain ways of thinking and certain ways of approaching problems. It also implies an attitude of wanting to find explanations that are secular and do not refer to authority (Schreiner & Sjøberg, 2004). In contrast, attitudes

towards science may be viewed as a wide variety of beliefs about science. Though, scientific attitudes are considered important outcomes from science and technology in schools, the focus of the thesis is more on attitudes towards science.

2.8.1 Some determinant of attitudes formation

Attitudes towards science and their formation are often scantily expressed and not well understood. Probably, our understanding of the nature of this problem might have been better; however, our understanding of its remediation may be missing. As a consequence, some arguments have been raised for a research focus on attitudes towards science (Osborne, Simon & Collins, 2003).

Earlier studies on pupils' 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 and Oliver, 1990). The significant role that teachers play in pupils‟ attitudes 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 Sundberg *et al*. (1994), who studied the attitudes towards science of 2,965 United States college pupils. Hendley *et al.* (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‟ attitude towards science are significantly influenced by how they perceived their science teacher and to a lesser extent by the science curriculum (Atwater, Wiggins & Gardner, 1995).

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; Myers & Fouts, 1992; Piburn & Baker, 1993).

A sample of 699 pupils from 27 high schools in America, through a study conducted by Myers and Fouts (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 a major longitudinal study conducted in North Carolina (Simpson and Oliver, 1990). Teaching method has also been cited as one of the strongest influence on pupils‟ attitudes towards science. Evidence has been provided by Woolnough (1991), that the quality of teaching of school science is a significant determinant of attitude towards school science. A review of Woolnough‟s work according to Osborne *et al.* (2003), revealed six factors that were responsible for pupil choice or non-choice of the sciences. The two strongest factors were the influence of pupil‟s positive experience 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 (Reiss, 2000; Osborne and Collins, 2001).

2.9 Student Team Achievement Division (STAD)

Cooperative learning has been shown to promote more positive attitudes of students toward their own learning than do competitive or individualistic learning environments because students work together for shared goals (Johnson & Johnson, 2005). Student Team Achievement Division (STAD) is a cooperative-learning strategy in which small groups of learners with different levels of ability work together to accomplish a shared learning goal. In this technique students are grouped in four or five to work together for one common goal is one of Slavin‟s cooperative learning approaches. To apply this approach, teachers should follow the basic steps: (1) form groups of four or five students, (2) identify the objectives and focus on outcomes of course expected, (3) explain the process, and present new information to students, (4) give students sufficient time to understanding the materials, (5) give worksheets to students so that students may help one another learn materials through quizzing and group discussions, (6) test students‟ understanding in both the individual student and group levels through quizzes to see the expected outcomes, (7) score the quizzes and give each individual student in each group an improvement score, and (8) add the individual improvement score to give a group score.

In a six-week experimental study in a secondary school in America, Whicker, Bol & Nunnery (1997) claimed that the responses of most students in cooperative learning groups were favorable. Similarly, Vaughan (2002) suggested that students in the STAD group had positive attitudes toward mathematics after STAD was implemented. These results were supported by previous research studies (Johnson &

Johnson, 1989; Mulryan, 1994; Cavalier et al., 1995; Nhu-Le, 1999) which showed a strong relationship between cooperative learning methods and greater positive attitudes of students toward their own learning. For example, Nhu-Le (1999) investigates the effects of cooperative learning on tertiary students‟ attitudes toward chemistry in Vietnam. The results showed that students liked working in cooperative learning groups, exchanging information and knowledge, working together, and assisting one another. Similarly, Mulryan (1994) and Mengeluo and Xiaoling (2010) investigated students‟ attitudes and showed that in cooperative situations, students believed that their teachers paid more attention to their feelings. Students also experienced that their peers liked to help one another and they were more motivated to learn.

In addition, cooperative learning leads to a greater affective perception of others, greater positive attitudes, and more humanity. Recently, several other researchers investigated students‟ attitudes toward cooperative learning, and their attitudes toward subject matter in the Vietnamese setting of higher education (Le, 2010). The results of these studies reported that students working in the cooperative learning group believed that they enjoyed and liked doing cooperative activities and obtained more knowledge because cooperative learning improved their attitude toward their relationship with their peers, decreased conflict in the group; and enhanced their self-esteem(Le, 2010; Thanh-Pham, 2010). Also, students in the cooperative learning group felt more interested and were less anxious, perceived cooperative learning as a valuable way to effectively acquire knowledge. The positive effects of cooperative learning, found in the literature, have led to the following hypotheses: (1) students who were taught by STAD learning will have greater achievement in chemistry than those taught through lecture-based teaching, and (2) students who were taught by

STAD learning will have positive attitudes toward chemistry than those taught through lecture-based teaching.

Several studies have examined the effects of cooperative learning methods on student learning. Humphreys, Johnson, and Johnson (1982) compared cooperative, competitive, and individualistic strategies in science classes and found that students who were taught by cooperative methods learned and retained significantly more information than students taught by the other two methods. Sherman and Thomas (1986) found similar results in a study involving high school general mathematics classes taught by cooperative and individualistic methods. Adams (1996) used STAD as the experimental treatment in a study involving low achieving students. They found that the cooperative learning group scored significantly higher on a world geography test. Esan (1999) found that cooperative learning resulted in significantly higher achievement in industrial arts students at the knowledge and comprehension levels of Bloom's taxonomy, but not at the application level when compared to students taught by competitive methods.

2.10 Related Studies on STAD

As was seen above, depending on different factors including the number of students which make groups, and the aim for learning, there are various models and techniques of cooperative learning. Many studies have been conducted on the effect of CL in general or specifically on each of its models and all these studies have proved the positive influence of CL methods in comparison to the competitive individualistic methods. For instance, in a review of 46 studies related to cooperative learning, Slavin (1980) found that cooperative learning resulted in significant positive effects in 63% of the studies, and only two studies reported higher achievement for the comparison

group. Johnson (2009) conducted a meta-analysis of 122 studies related to cooperative learning and concluded that there was strong evidence for the superiority of cooperative learning in promoting achievement over competitive and individualistic strategies.

However, the present study took advantage of STAD as a popular and highly-used model of CL in language education. STAD (Students Team Achievement Division) according to Sahin (2010) is one of the many strategies in cooperative learning, which helps promote collaboration and self-regulating learning skills. The reason for the selection of STAD is good interaction among students, improved positive attitude towards subject, better self-esteem, and increased interpersonal skills. STAD also adds an extra source of learning within the groups because some high achievers act as a role of tutor, which result in high achievements. Finally, it enables the students according to the requirements of the modern society by teaching them to work with their colleagues competently and successfully. Due to these advantages, many second language researchers have tried to investigate the effect of using this cooperative technique on students‟ learning. Some of these studies are mentioned here.

Balfakih‟s (2003) research have indicated that in teaching 10th grade chemistry, students team achievements division (STAD) is a more effective teaching method than the traditional-teaching method. In a similar study, Killen (2007) tried to study the effects of cooperative learning on the achievement of ninth-grade students in a diverse cultural general biology class. The experimental group having the combination of both black and white students had a significant increase on the academic achievement scores. Adams (1996) used STAD as the experimental treatment in a study involving low achieving students. They found that the cooperative learning group scored significantly higher on a world geography test.

As is seen, most early studies dealt with cooperative learning in other content areas outside the field of language learning such as social studies, science, and mathematics. However, after the effectiveness of gaining in language acquisition of non–native speakers had been documented, ESL and EFL researchers turned their attention to the approach. They shared the belief that the approach may possibly have benefits in second or foreign language learning (Tang, 2000). Therefore, researchers began to conduct studies on the influence of using cooperative techniques on language learning that due to the shortage of time and space we focus only on those related to the STAD.

The subjects were classified into 3 groups of 30 high achievers, 24 moderate achievers, and 28 low achievers. The researcher taught all classes herself for 20 periods. The questionnaire on the students‟ view on interaction was given before teaching. After teaching, students were given the test and the same questionnaire on interaction including their opinion of the STAD approach. The finding indicated that all students‟ listening and speaking achievements were satisfactory. No difference was found between pre– teaching and post–teaching on the views of the high and low achievers, but the moderate achievers‟ views in general decreased significantly after teaching. Their opinions on the STAD approach were at the satisfactory level but no significant difference was found among the three groups.

The subjects were divided into two groups-the experimental group taught by the STAD approach and the control group taught by the teacher‟s manual for six weeks. The instruments used in this study were reading achievement tests and cooperation tests. The results revealed that the gained English reading achievement scores of the students taught by the STAD approach were not significantly different from those of the students taught by the teacher‟s manual approach at the alpha‟s level of 0.05. The

gained scores of the high, medium, and low achievers taught by the STAD teaching approach were not significantly different from one another, also at the alpha‟s level of 0.05. The last finding, the high, medium, and low achievers taught by the STAD teaching approach were not significantly different in their cooperation at the alpha‟s level of .05.

Considering the above practical studies, one can easily recognize the positive effect of using STAD as a popular model of CL on second language learning. Most of these studies have dealt with the general influence of STAD on language learning, or its effect on general skills like reading or speaking. However, as far as the researcher knows, there is a paucity of research on the effect of STAD on the acquisition of the components of language. Hence, the current study is an attempt to investigate the influence of using this cooperative technique by teachers on the acquisition of vocabulary as a main language component of Iranian EFL Pre-Intermediate Learners.

2.11 Formative Assessment in Teaching and Learning.

Assessment is vital to the education process. In schools, the most visible assessments are summative. Summative assessments are used to measure what students have learnt at the end of a unit to promote students, to ensure they have met required standards on the way to earning certification for school completion for school completion or to enter certain occupations or as a method for selecting students for entry into further education (CERI,2008).

But assessment may also serve a formative function. In classrooms, formative assessment may refer to frequent, interactive assessments of students‟ progress and understanding to identify learning needs and adjust teaching appropriately. Teachers using formative assessment approaches and techniques are better prepared to meet diverse students‟ needs – through differentiation and adaptation of teaching to raise

levels of student achievement and to achieve a greater equity of student outcomes (Beaton, Mullis, Martin, Gonzalez, Kelly, & Smith 1996).

Formative assessment methods have been important to raising overall levels of student achievement. Quantitative and qualitative research on formative assessment has shown that it is perhaps one of the most important interventions for promoting high – performance ever studied. In their influential 1998 review of the English – Language literature on formative assessment, Black and William (1998b) concluded that:

"…formative assessment does well for learning. The gains in achievement appear to be quite considerable and as noted earlier, among the largest ever reported for educational interventions".

Black and William (1998b) define assessment broadly to include all activities that teachers and students undertake to get information that can be used diagnostically to alter teaching and learning. To Black and William, assessments become formative when the information is used to adapt teaching and learning to meet student needs.

Boston (2002), also propounded that, when teachers know how students progressing and where they are having difficulties, they can use this information to make the necessary instructed adjustment such as re – teaching, trying alternative instructional approaches or offering more opportunities for practice. To Boston these activities can lead to improved student success. Those who study assessment and evaluation techniques have noted that well – designed classroom testing programs bear a positive relationship to later students" achievement (Cotton, 1991). According to Cotton, when attitudes toward testing are studied, students who are tested frequently and given feedback are found to have positive attitude towards tests. They are generally found to regard tests as facilitating learning and studying, and as providing effective feedback;

an outcome which has surprised some researchers, who had anticipated more negative student attitude towards testing.

According to Bishop and Glynn (1999) formative assessment builds students‟ "learning to learn" skills by:

1. Placing emphasis on the process of teaching and learning and actively involving students in that process.
2. Building students in that process.
3. Helping students understand their own learning and develop appropriate strategies for "learning to learn".

Bishop and Glynn further propounded that students who are actively building their understanding of new concepts (rather than merely absorbing information), who have developed a variety of strategies that enable them to place new ideas into a larger context and who are learning to judge the quality of their own and their peer‟s work against well – defined learning goals and criteria are also developing skills that are invaluable for learning throughout their lives.

Mischo and Rheinberg (1995) reported in their studies that the establishment of learning goals and tracking of student‟ progress towards those goals makes the learning process more transparent; thus students do not need to guess what they need to do to perform well. Hence, when students are guided to develop their own ways of "learning to learn" skills (also sometimes referred to as "meta cognitive" strategies), they become equipped with own language and tools for learning. Thus, they are more likely to transfer and apply these skills for problem solving into daily life, strengthen their ability to find answers and develop strategies for addressing problems with which they are not familiar. In other words, they develop strong "control" strategies for their own learning resulting in positive achievement.

Koller (2005), in a study conducted on effects of assessment on students‟ intrinsic motivation, self – esteem and academic self – concept revealed that tracking students‟ progress during the learning process produced positive effects and promoted self – learning attitudes of students.

Research works conducted by all the researchers discussed above involved the use of two groups of participants; experimental and control groups. One group (experimental) was exposed the new instructional intervention while the other group (control) received no intervention while the other group (control) received no intervention, which obviously led to the experimental groups outperforming the control groups in most cases with the exception of a few of them.

There could be problems or issues associated with experimental research which includes some of the points discussed below. One major problem has to do with using non – equivalent groups. According to Brophy (1983), groups in an experiment may not be comparable. Brophy further explains that not only are many researchers also teachers, but many subjected are also students, as such, with the classroom as a laboratory; it is difficult to implement randomizing or matching strategies. Often, students self – select into certain sections of a course on the basis of their own agendas and scheduling needs. Thus when, as often happens, one class is treated and the other used for a control, the groups may not actually be comparable. Another issue could be the potential for low internal validity. Internal validity refers to the degree to which a researcher can be sure that treatment was responsible for the change in the experimental group (Wiersma, 2000). If the researcher does not start with equivalent groups, then the researcher cannot be sure that the treatment was the sole factor causing change. Other confounding factors may have contributed to the change,

therefore, not using random sampling methods to construct the experimental and control groups, increases the potential for low internal validity (Wiersma, 2000).

In this study, the one – group pretest – posttest design (Intact group design) was used. The bases for using this design are that; it looks at change over time for individual participants of a study (Campbell & Stanley, 1963). This made it possible to assess the rate at which each participant made progress throughout the study. With this design also, conducting a legitimate experiment without the participants being aware of it is possible with intact groups, but not with random assignment for subjects to groups (Dimitrov & Rumrill, 2003).

2.12 Summary

Learning theories tend to have major implications for the teaching and learning process and such cannot be overemphasized in developing conceptual change in learners. In employing any kind of teaching method, teachers must be abreast with its effect on the learners in order to appropriately use it to bring about effective learning. Overall, teachers should realize that learners construct new understanding using what they already know and prior knowledge; hence the teaching and learning process ought to be student – centered instead of teacher – centered. The use of STAD approach enables learners to be active in the learning process, to construct knowledge, to develop problem solving skills and to discover alternative solution (Martin, Heller & Mahmoud, 1991). This study is geared towards alternative to make students proactive and participatory then been passive. The presentation of teaching materials by means of the STAD approach helps students to process and develop information, to find alternative solutions, to take an active part in the learning process and to develop their problem solving skills. In the next chapter, there will be a thorough discussion on the methodology used for the study.

CHAPTER THREE

METHODOLOGY

3.0 Overview

The content of this chapter is about the methodology employed in the study. It includes the research design in which the study was situated. It continues with the diagnosis of the perceived problem. It also includes the population, sample and the sample technique used for the selection of the participants for the study. The chapter concludes with the validity and reliability of the research instrument, intervention, collection of the data (qualitative data by observation checklist and quantitative data by pre-test and post-test) and the mechanism for the data analysis.

3.1 Methodology of the Study

The study employed mixed methods, where both quantitative and qualitative approaches were followed. According to Johnson and Onwuegbuzie (2004), mixed methods research involves combing in a single study technique, methods, approaches and language of both qualitative and quantitative traditions. Burns and Groove (1993) define quantitative research as a formal, objective and systemic process to describe and test relationship and examine cause and effect interactions among variables using mathematical means or statistical analysis of data. Qualitative research on the other hand seeks to discover the meaning that participants attach to their behavior, how they interpret situations and what their perspectives are on particular issues (Measor & Woods, 1984). Mixed methods approach is more than simply collecting and analyzing either qualitative or quantitative data. It also involves the use of both approaches in tandem so that the overall strength of a study is greater than either qualitative or quantitative research (Creswell & Plano-Clark, 2007).

In order to gather the quantitative data, a series of pre-tests and post-tests were conducted to assess students‟ performance before and after the interventions, so as to check effective improvement in their performance. Researchers have developed a variety of tools to measure the average effectiveness of course in promoting conceptual understanding. One of such tools is the introduction of the data into the SPSS software for analysis.

3.2 Research Design

Quasi-experimental research design was adopted for this work. According to Labaree (2011), the essential of this form of research followed a characteristic cycle whereby initially an exploratory stance is adopted. This helps the researcher to learn and understand the problem under consideration so that some form of intervention strategy could be developed. The intervention is carried out during which time pertinent observations are made in various forms to collate and examine data to improve on the intervention strategy. The new intervention strategy is carried out and the cycle process repeats, continuing until a sufficient understanding of the problem is achieved. The quality of a research is determined by how the collected information is used to solve the stated problem of the study (Anderson, 2006). This study adopted a pre-test, post-test quasi experimental design (Campbell & Stanley, 1971). The design used in this study measure the respondents achievement level was the pre-test-post-test design. This design was selected because it may help test the cause and effect relationship between the independent variable and the dependent variables. The methodology of the research is the stepwise design of how the work was done. It was the approach which illustrated the characteristic of the participants treated with the use of Student Team Achievement Division (STAD). This study was meant to

determine the influence of STAD on the performance of students in some selected topics in chemistry and Students‟ perception about STAD learning approach. Therefore the study was experimental in its design using STAD, the learning approach as the independent variable whiles the mean achievement scores in those selected topics in chemistry was the dependent variable. An experimental design is employed where participants are assigned to different conditions (Robson, 2002). The different conditions include the testing section; the approach is done in three modules which alternate with the various groups per day:

i. The students in a group solve the task on a competitive level. They worked individually. They are awarded the marks as individuals. This is the inter-group competition.

ii. The students in a group solve the assigned task together as a unit but are tested individually. They are awarded the marks to the individual as his/her performance in the group for the correct answers. This is the group without competition I.

iii. The students in a group solve the assigned task together as a unit but are tested individually. They are awarded the marks to the individual based on the average accumulated mark of the group. This is the group without competition II.

There is measurement of the effects of this manipulation on one or more dependent variables and there is control of all other variables. This study fitted this description of a quasi-experimental design in that the effect of cooperative learning (STAD) approach was compared with the traditional teaching method at the end of the eight weeks treatment period to determine whether it has a significant effect on secondary school students‟ mean achievement scores in chemistry. An experimental design is a

strong design for a researcher to test hypotheses to reach valid conclusions between independent and dependent variables (Best & Kahn, 2003). Wiersma (2000) stressed that a true experimental design requires experimental and control groups. However, in this study the same group as treated after the diagnosis has been made on the level of knowledge on those selected topics in chemistry. Hence, the same group is used as a control as well as experimental based on the outcome of pre-intervention and post-intervention results. The research design used in this study was quasi-experimental. In this type of design, students groups are formed for the sole purpose of treatment. The students were reviewed for a week per topics (Acid and base, stoichiometry, electrochemistry and gases reaction) and given a pre-test before treatment and grouped and given post-test items to their performance level. They are then given treatment such as the students‟ team achievement division (STAD). The group again is assessed with post-test items to ascertain the impact of the treatment. It has been further explained that the research design is potentially useful in that it controls all threats to validity and all sources of bias (Best & Kahn, 2003).

3.3 Population

In this study, the accessible population comprised all science students of the senior high level at the Datus International Senior high School of Community Seven in the Tema Municipality of the Greater Accra Region Ghana. Tema district was chosen for the study because the researcher is more familiar with the area in respect to the science education delivery in the senior schools. However, due to a number of constraints such as finance, time, resources and accessibility not all of the population was used for the study. The targeted population however, was all the Form Two (II)

and One (I) students of the Datus International Senior High School. The students were chosen due to the following reasons:

- They were free examination stress as they were not in the examinable WASSCE class
- They have stayed in the school for at least a year, and so, have been exposed to some substantial aspect of the chemistry
- They have also experienced chemistry teaching at the Senior High level and would appreciate a new approach of teaching

3.4 Sample

Considering some factors such as finance, time and accessibility, it was practically impossible to access information from the accessible population. It became appropriate therefore to measure from a smaller group of the population. Mouton (1996) defines a sample as elements selected with the intention of finding out something about the total population from which they were taken. The sample for this study was the Form Two (II) and One (I) Elective Chemistry Students of the Datus International Senior High School. These groups of students were easily accessible to the researcher since he is a teacher of the school. The researcher who is an experienced chemistry teacher in the school has been teaching in the school for some time and coupled with terminal reports and WASSCE results of the students offering chemistry formed important basis for this study. The classes consist of fifteen girls (12) and thirty boys (33) in form II and eight girls (8) and twenty two boys (22) of form I. The advantage of sampling are that the cost is lower, data collection is faster and since the data is smaller it is possible to ensure homogeneity and to improve the

accuracy and quality of the data. The elective chemistry students from the form II class formed the sample for the study.

3.5 Sampling Technique

For this study, a convenience sample technique was used (Creswell, 2009). The procedure for selecting the respondents is very important in order to get vital data for the analysis of the work. Convenience sampling technique is a type of non-probability sampling which involves the sample being drawn from that of the population which is close at hand. Thus, a sample population is selected because it is readily available and convenient. This technique was chosen because the researcher is a teacher in the school and therefore knows the students‟ performance in chemistry. These students were selected because they have some substantial level of chemistry and might have learnt some basic chemistry concepts and as such might not have developed much negative attitudes towards chemistry learning compared to the students in senior high school of form II and I classes who are not pure (elective) chemistry students. The cooperative learning approach such as STAD might be seen by Senior High School (SHS) I and II students as an alternative new method; hence they are likely to appreciate it.

Also, the researcher is aware of some basic chemistry concepts that the students also have knowledge in them. The form III students did not participate in the study because they were preparing for the WASSCE.

All the elective chemistry students in senior high section of the two form I and II classes in the school were the participants of the study. The total participants of the study were seventy five. A total of twenty girls and fifty five boys make up the total sample. Again, the Researcher had to observe the science syllabus and teach using the

cooperative learning (STAD). The sample represented the participants the researcher would wish to use due to the fact that they bear similar characteristics as the target population. The reason opting for sampling is also in line with Sarantakos‟ concept (1998) where sample is noted to produce comparable and equally valid results. Sarantakos‟ (1998) further explained that samples offer more detailed information and a high degree of accuracy because; they deal with relatively small numbers of units.

3.6 Research Instruments

For the purpose of this study, there was a need to gather data on students‟ learning outcomes and opinion on their attitude towards chemistry teaching. Due to these, frequent tests were used to collect data on students‟ performance over the time (Achievement Test). A series of qualitative conceptual questions and quantitative questions adapted from the Ultimate Chemistry KOV‟S Series were given to the students as pre-test and post-test to assess their understandings and measure their performance in solving problems (Quaittoo, 1996). The students‟ attitude towards chemistry teaching and learning was also investigated through the use of questionnaire together with an observation checklist. The tests were pre-test and post test. The observation and tests were meant to provide consistent and uniform measurements of the students‟ performance (Amedahe, 2002).

3.6.1 Nature of the Likert scale

The Likert scale was developed by Rensis Likert in 1932. It requests the respondents to make a judgment about their level of agreement, most often, on a 5-point scale with a statement. The justification for the use of 4-point scale is given later in this section. The number assigned to each response becomes the value for that response. These

numbers are arbitrary values, because it becomes difficult to know the exact „quantity" of opinion, experience, interest and agreement (Schreiner, 2006). This format offers the respondents fixed alternative responses. The respondents are to give their answers by choosing the alternative appropriate to their view.

The Likert-type scale was preferred to other attitudinal scales such as Thurstone scales, Guttman scales and Semantic Differential scales. Among these attitudinal scales, Likert-type scales are easy to construct. As early as 1967, Tittle and Hill commented:

The Likert scale is the most widely used method of scaling in the social sciences today. Perhaps this is because they are much easier to construct and because they tend to be more reliable than other scales with the same number of items (Tittle and Hill, 1967 cited in Page-Bucci, 2003:8)

Likert scales also provide the researcher with opportunity to compute frequencies and percentages, as well as statistics such as the mean and standard deviation of scores. This, in turn, allows for more sophisticated statistical analyses such as Analyses of Variance and factor analyses to be performed on the data (Page- Bucci, 2003). In addition, Likert scales are often found to provide data with relatively high reliability (Oppenheim, 1992 Gable & Wolf, 1993).

3.6.2 Instruments of the study

The study used three instruments to gather the data from the respondents.

Three instruments used for the study were:

1. Achievement Test on Selected Topics (ATST) based on the Ultimate Chemistry of the Kov"s Series, consisted of six tests (three pre-tests and three

post-tests). In addition, the tests reflecting the subject content and curriculum statement objectives in chemistry concepts such as Acid and Base, Stoichiometry, Electrochemistry and Gas reactions were adopted. The purpose of the tests was to measure the achievement level of the respondents in solving problems before and after the intervention. For each of the lesson taught before the intervention, students were given an assignment on the topic to be treated. They were directed to the specific pages in the chemistry textbook, The Ultimate Chemistry: KOV"S Series to read before the lesson started (Quaittoo, 1996). They were then given a pre-test after a general review of the assigned topic to assess whether or not they did the pre-reading, and how well they understood the materials. Data from the pre-test test were gathered as students" baseline knowledge in those topics. They were then taken through the topics with the intervention of STAD with additional sub-topics but under the same general topic. They were then given test as post-tests. The data gathered from the students" post tests to determine the achievement score after the intervention. The format in Table 1 was used to collect both students" pre-test and post-tests scores. The essence of the post-tests was to assess their performance level as a result of the intervention.

2. **Table 1. Student's Pre/Post Test Results for Concept Tests**

Students	Lesson 1	Lesson 2	Lesson 3
	Pre-test/post-test	Pre-test/post-test	Pre-test/post-test
1. Devor Theophilus			
2. Charles Princess			
.			
.			
.			
.			
.			
.			
.			
.			
75 Abotsi Stephen			
Average			

The two sets of tests contained both multiple choice and essay type test items derived in line with the assignments from which the students worked on before the intervention of STAD and after the intervention. This test was administered at the end of 2-week period each of the lesson delivery. Although STAD was used as an intervention to obtain its impact on students‟ achievement however, thirty percent (30%) of their scores was included in their terminal grade. At each testing period, students were given forty five (45) minutes to complete the work.

The reliability coefficient of the test items was calculated based on the significant alpha value of 0.05.This was how the instrument was used to measure the respondents‟ achievement on the selected topics in chemistry.

3. Students‟ attitude to chemistry questionnaire (SACQ). The questionnaires also measured the students‟ attitudes towards STAD. Three dependent variables were used to measure on the respondents‟ attitude scale. These variables are

the presentation level, intuition and cognitive processing. An attitude scale questionnaire was developed based on the questionnaire used by Miller and his colleagues on related research projects (Miller et al. 1993; Nichols & Miller 1994). The items were Likert-type questions that measured students‟ attitude. The items were ordered using a 5-point scale with „strongly agree‟ and „strongly disagree‟ at the extremes. The SAQC was divided into four parts which included the personal data of the respondents, the cognitive quotient of the respondents, their presentation levels and their intuition levels. The instrument was administered on the sample of senior high school forms I and II Elective Chemistry students in Datus International Senior High School of Tema district of the Greater Accra Region of Ghana.

4. The assessment of the implementation of the Student Team Achievement Division learning technique by the teacher was done by observations and interview. The use of verification checklist was used for this section of the study (Sabina & Sabina, 2006). The checklist was divided into stages which involved engagement, exploration, transformation, presentation and reflection.

3.7 Pilot-test

The researcher used the form III students of the school for a pilot test for the work. The essence of using a pilot test before the actual work was to ensure that the intervention, test items are valid and reliable.

Also, the SHS III students were busy preparing for their WASSCE exams and therefore need not interfere with their regular teaching and learning process.

3.8 Description of the Variables

The variables that emerged from the study were:

i. Independent variable consisted of

   a. Treatment with Student Teams - Achievement Divisions strategy

   b. Without treatment with STAD

ii. Dependent variables consisted of

   a. Cognitive achievement in selected chemistry topics

   b. Attitude to selected chemistry topics

   c. Attitude towards STAD

iii. Pre-test

iv. STAD treatment

iv. Post-test

3.9 Validity of the instrument

The self-designed test items of the instruments were presented to experts (school examiners) 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 it is supposed to measure or describe.

3.10 Reliability of the Instrument

Reliability as explained is the extent to which a test or procedure produces similar results under constant conditions on all occasions (Kirk & Miller, 1986). In order to ensure the reliability and effectiveness of the test items, it was pilot tested in the form III class before the actual commencement. Pilot-testing identified questions that

respondents had difficulty understanding and those they interpreted differently than the researcher intended. Thus, once a test is developed, it is either pilot-tested before pre-tested with a small sample of potential respondents prior to the real respondents (Amedahe, 2002).

This ensures clarity in the instructions and questions. Improving on a research instruments through piloting is likely to improve on the quality of data, the results and interpretations.

Afterwards the researcher had discussion with the class on test time, clarity and understandings of the test items. These, led to modification of some of the items in the test. The reliability coefficient of the test was calculated based on the significant Cronbach‟s alpha value of 0.05.

3.11 Intervention

All the treated students from the schools for this study were examined based on their second term science topics before and after the intervention, which can also be termed as Base line survey and Post-tests. The topics that were examined were under the section „Elective chemistry‟. All these topics are documented in the senior high school syllabus endorsed by the Ghana Educational Service. The intervention took a form of collaborative learning approach. The study specifically looked at the mean achievement score and interest in chemistry learning by students through the cooperative learning approach such as STAD in the teaching and learning process. The following basic steps were utilized for the implementation of the STAD approach:

(1) Formation of groups of four students. The selection was done based on the result of the baseline test. There as at least a girl in a group. The selection was a mixture of low achievers (slow learners) and high achievers (fast learners).

(2) Lesson notes on different topics were given, which was prepared on weekly basis for the eight weeks of treatment for the study. The duration for each lesson was 70 minutes (double periods).The essence of this instrument was to guide the researcher on the steps and procedure during the treatment.

(3) Identification of the objectives and focus on outcomes of course expected

(4) Explained the process, and presentation of new information to students

(5) Students were given sufficient time to understanding the materials

(6) Students were given worksheets so that they may help one another learn materials through quizzing and group discussions

(7) Students were tested for understanding in both the individual and group levels through quizzes to see the expected outcomes. In this testing section, the approach is done in three modules which alternate per day:

I. The students in a group solved the task on a competitive level. They worked individually. They were awarded the marks as individuals. This is the inter-group competition. The aim of this stage was to measure the individual independent cognitive (qualitative and quantitative) performance. It also considered the time at which the task was achieved.

II. The students in a group solved the assigned task together as a unit but are tested individually. They are awarded the marks to the individual as his/her performance in the group for the correct answers. This is the group without competition I. The aim of this stage was to measure the

individual dependant cognitive (qualitative and quantitative) performance considering the time at speed at which the task was solved.

III. The students in a group solved the assigned task together as a unit but are tested individually. They are awarded the marks to the individual based on the average accumulated mark of the group. This is the group without competition II. The aim of this stage was to measure the individual cognitive (qualitative and quantitative) performance but with the awareness that his/her effort affects his /her group member scores. It also considered the time at which the task was achieved.

(8) The teacher then gave work for the students to solve at home.

The science teacher (researcher) has vast knowledge on the use of the cooperative learning approach for the treatment with STAD. There was at least a female pupil in each of the formed groups. Each day"s learning activities were assigned to members in each group to perform different aspects of the given task. The solutions to the task from each group were arrived at after members had discussed among themselves their individual solutions before reaching a consensus. Students then present their findings in turns. The teachers then summarized the task, major correct points agreed on by all the members in each of the groups in the class on the whiteboard. This approach was practiced for a period of eight weeks in the treated classes. After the end of the treatment week all the students were examined to ascertain the impact of the cooperative learning approach in the form of post-test. The school for this study was selected based on the facts that the researcher is located in the school, the participants have been taught at fundamental level and prerequisite concepts such as energy

changes in chemical reaction and the mechanism of chemical reaction necessary for the understanding of chemistry. During the implementation of the intervention, Treatment Verification Checklist, developed by Reid, Forrestal and Cook (1989) adapted by the researcher will be applied to observe the teaching and learning process. This was done to decide if cooperative learning method was implemented as intended. The Treatment Verification checklist touched on the following areas:

1. Achievement shown by pupils from chemistry concepts using cooperative learning (STAD) approach in the teaching learning process

2. Attitude towards the selected chemistry topics based on STAD as shown by the students and the observation provided more information which could not have been done with other methods (Eastaby-Smith, Thrope & Lowe, 1991). It was done by a questionnaire containing some items. It shows the mean engagement score from the treatment of STAD. It also offered first hand information without relying on the reports of others. Observation was further useful to discover whether or not people do what they say they do or behave in a way they claim to behave (Amedahe, 2002).

3.12 Data Collection Procedure

An introductory letter was served from the Head of Science Education Department of the University of Education, Winneba, to the Datus Administration Office and the head teachers of the school for the study. It was also to inform them about the study and the process of administering the instruments. The purpose of the study was explained to the staff of the science department and their consent sought verbally.

The procedure for data collection was in three main phases and ran for eight weeks. The phases were;

1. Pre test per selected topic for the week

2. Treatment for the week

3. Post test per selected topic for the week

3.12.1 Pre-test

The instruments was administered in the following order; students attitude to chemistry questionnaire, followed by the achievement test on chemistry topics. The attitude questionnaire was administered first in order to avoid the influence of the chemistry achievement test on students‟ attitude and STAD.

3.12.2 The module of treatment per groups for the study

Module 1: (Student Teams Achievement Divisions with inter-group competition).

In this module the treatment of this group involved the following steps:

i. Teacher presented the topic in form of lecture, demonstration and discussion
ii. Students in four-member heterogeneous teams within the group engaged themselves in intensive cooperative study of the learnt material, by studying worksheets, performing experiments, checking and drilling each other.
iii. Each student in all the teams was given a worksheet to be submitted in order to asses each student contribution to the team‟s effort.
iv. Teacher gave questions on the topic to the students in form of quiz
v. Students answered the questions individually without assistance from their teammate.
vi. Teachers gave take home assignment.
vii. Teachers recognized and rewarded marks to team members based on the individual performance.

Module 2: (Student Teams Achievement Divisions without inter-group competition I)

In this module the treatment of this group involved the following steps:

i. Teacher presented the topic in form of lecture, demonstration and discussion
ii. Students in four member heterogeneous teams within the group engaged themselves in intensive cooperative study of the learnt material, by studying worksheets, performing experiments, checking and drilling each other.
iii. The students in a group solve the assigned task together as a unit
iv. They are tested individually
v. They are awarded the marks to the individual based on his/her performance
vi. Teachers gave take home assignment

Module 3: (Student Teams Achievement Divisions without inter-group competition II)

In this module the treatment of this group involved the following steps:

i. Teacher presented the topic in form of lecture, demonstration and discussion
ii. Students in four member heterogeneous teams within the group and engaged themselves in intensive cooperative study of the learnt material, by studying worksheets, performing experiments, checking and drilling each other.
i. The students in a group solve the assigned task together as a unit
ii. They are tested individually
iii. They are awarded the marks to the individual based on the average accumulated mark of the group.
iv. Teachers gave take home assignment

3.12.3 Post-test

After each week of treatment, post – test was administered to the groups. Students‟ attitude to chemistry and STAD questionnaire and the achievement test on chemistry was re-administered.

3.13 Data Analysis

The data collected from this study was edited, corrected, and analyzed as mentioned by editing data detect errors and possibly corrected (Blaxter, Dodd & Tight, 1996). The items in the tests were marked, and score placed into the computer for analysis. Statistical Package for Social Sciences (SPSS) version 16, windows 2007 was used for the analysis. This is because it provided among other things, variety of ways to summarize data and accurately describes variables of interest (Easterhy-Smith, Thorpe & Lowe. 1991). Independent sample t-test was used to find out whether or not there was a significant difference in STAD approach that could influence the final results. The same method was used for the analysis of any significant change in the students‟ attitude towards some selected topics in chemistry and STAD.

Data analyzed comprised the scores on achievement tests, scores on attitude questionnaire. A t-test was performed to compare the means of the pre-test scores and post-test scores on achievement and attitude measures of the groups before and after the treatment. All analyses were tested for significant alpha‟s level of 0.05.

CHAPTER FOUR

RESULTS, ANALYSIS AND DISCUSSION

4.0 Overview

The content of this chapter is about the discussion of results, and analysis and in the study. It includes the data obtained in the achievement test items and questionnaire of attitude of the students towards some selected topics in chemistry. The results obtained are presented in line with the order in which the research questions were posed in chapter one.

4.1 Demographic Data of the Respondents

Demographic description may be referred to as how people are classified into groups using common characteristic such as race, gender, income level or age. Demographic information provides data regarding research participants and is necessary for the determination of whether the individuals in a particular study are representative of sample of the target population for the generalization purposes (Lee & Schuele, 2010). The demographic description profile of a respondent in this study is looked upon as age and gender.

4.2 Age of the Respondents

The table 2 and 3 below shows the ages of the students of form one (I) and two (II) who participated in the study. The ages were tabulated into frequency counts.

Table 2 Ages of students in form I

Age (Years)	Frequency	Percent (%)
14	2	7.0
16	10	33.0
17	7	23.0
18	5	18.0
19	4	13.0
20	1	3.0
21	1	3.0
Total	**30**	**100**

Majority of the students of form I are between the age ranging from sixteen (33.0%) to seventeen (23%). Two of them are fourteen years (7.0 %). One person is twenty (3.0%) while another person is twenty one years (3.0%).

The following table below shows the ages of the students of form I. It also includes the frequency of the students at specific age group. Form I is made of thirty students. Eight of them are girls and boys are twenty two.

Table 3 Ages of students in form II

Age (Years)	Frequency	Percent (%)
15	2	4.4
16	5	11.1
17	10	22.2
18	12	27.0
19	9	20.0
20	6	13.3
21	1	2.0
Total	**45**	**100**

The table above shows that majority of the students are between the ages of 17 to 19 years. Two of them are 15 (4.4%), five are 16 (11.1%), ten are 17 (22.2%), twelve are

18 (27.0%), nine are 19 (20.0%), six are 20 (13.3%), and one 21 (2.0%). The Ghana Education Service presents its educational structure in a 6:3:3 or a 6:3:4 formats.

Thus, a child is expected to endure six years of Primary Education, three (3) or four (4) years of Tertiary Education (Parliament of Republic of Ghana, 2010). With this structure of education a child usually starts schooling in Ghana at an average age 17 years. Hence, majority of the students fall within the standard age for their academic sojourn. However, low numbers (fewer females) of girls are continuously offering science courses Government of Ghana (1995).

4.3 Sex of the respondents

The numbers of male and female students of forms I and II are represented in the tables below. Table 4 accounts for the sex of the respondents in form one (I).

Table 4 Sex of the students of form I

Sex	Frequency	Percentage (%)
Male	22	73.33
Female	8	26.67
Average	**30**	**100**

The numbers of male and female students are represented in the tables 5 below. It accounts for the respondents in form two (II).

Table 5 Sex of the students of form II

Sex	Frequency	Percentage (%)
Male	33	73.33
Female	12	26.67
Total	**45**	**100**

4.4 Presentation of Results by the Research Questions

Research Question 1: To what extent does the use of Students Team Achievement Division (STAD) technique impact students' achievement in some selected topics in chemistry?

This question sought to find out if the treatment of STAD as a leaning strategy had an impact on students‟ performance in some selected topics in chemistry. Students‟ test scores were used to calculate the mean of their performance. The respondents in this study were given a pre-test to determine their performance in elective chemistry covering the topics of Acid and Base, Redox reaction, Stoichiometry, Electrochemistry and gases reactions as prescribed by the Ghana Education Service (GES) syllabus. A post-test was also administered to measure the impact of the Student Team Achievement Division (STAD) as a learning strategy in those selected topics in chemistry.

The mean achievement scores of the respondents‟ pre-test and post-test results are shown in Table 6.

Table 6. The frequency distributions of the respondents mean achievement scores

Class	LESSONS	N	Mean Pre-Test (SD)	Mean Post-Test (SD)	P-Values
Form I	Lesson One	30	34.30 (15.63)	43.47 (20.99)	0.000
Form I	Lesson Two	27	30.04 (15.21)	51.78 (38.40)	0.007
Form I	Lesson Three	30	34.30 (15.63)	46.70 (18.59)	0.000
Form II	Lesson One	40	32.38 (17.62)	42.00 (20.29)	0.001
Form II	Lesson Two	42	31.34 (17.49)	41.98 (21.16)	0.001
Form II	Lesson Three	45	26.60 (17.10)	39.56 (22.39)	0.000

Significant at 0.05; $p < 0.05$ Standard Deviation (**SD**) Number of respondents (**N**)

The table above shows that form one (I) students registered an improved mean scores during the third lesson. They gain a significant difference of 0.000. Likewise, the students from form two (II) also marked an improved performance during the third lesson. They registered a significant difference of 0.000.

To determine whether the performance between students‟ mean scores in the pre-test and post-test were statistically significant, an independent sample t-Test was used for the six lessons. Table 6 shows the significant difference between the pre and post test scores for the lessons.

Table 7. Significant Differences between Pre and Post-Test Scores of the Students for the Lessons

Class	Tests	N	Mean	Standard Deviation	P-Vales
Form I	Pre-Test	30	34.30	15.63	0.000
	Post-Test	30	43.47	20.99	
Form I	Pre-Test	27	30.04	15.21	0.007
	Post-Test	27	51.78	38.40	
Form I	Pre-Test	30	34.30	15.63	0.000
	Post-Test	30	46.70	18.59	
Form II	Pre-Test	40	32.38	17.62	0.001
	Post-Test	40	42.00	20.29	
Form II	Pre-Test	42	31.34	17.49	0.001
	Post-Test	42	41.98	21.16	
Form II	Pre-Test	45	26.60	17.10	0.000
	Post-Test	45	39.56	22.39	

Significant (**Sig.**) at 0.05; $p < 0.05$ Number of respondents (**N**)

The independence sample t-test analysis shows that the difference in performance between students‟ mean pre-test scores and mean post test scores were statistically significant for all the six lessons ($p = 0.000, 0.007, 0.000, 0.001, 0.001$ & 0.000). This signifies that the students had a better understanding in those selected topics in chemistry after they have been treated with the intervention of STAD than before.

The average mean values of the pre-test of the six lessons were calculated to be 31.49 and the post test was 44.24. The graph below shows the pre and post test scores in figure 3.

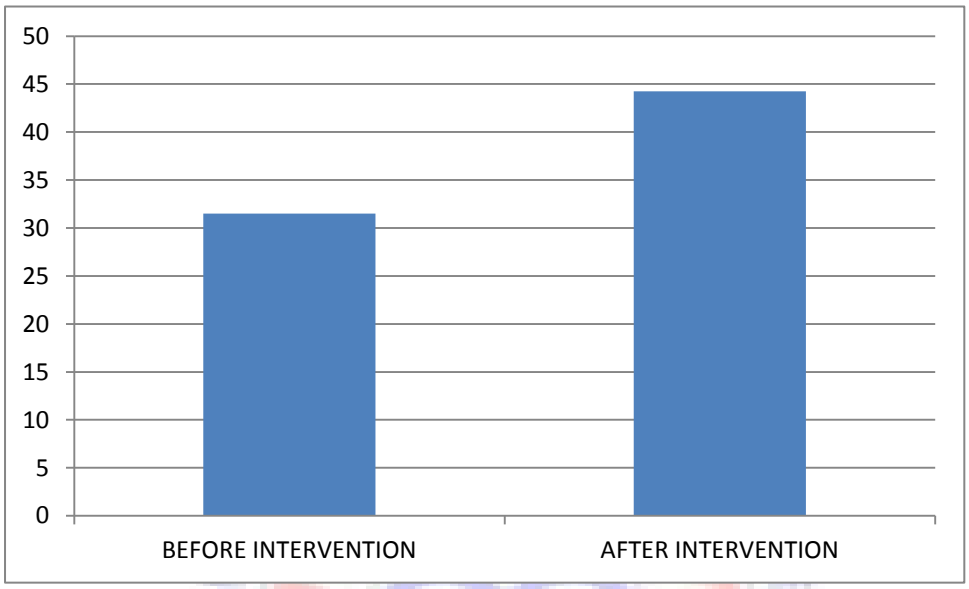

Figure 3 Graph of the performance of the respondents before and after intervention

The graph shows the students‟ performance in the mean achievement in the selected topics before the intervention (31.49) and after intervention (44.24). The difference in mean of the graph illustrates how the respondents performed in the various topics subject. The increased in the mean of the graph represents an improvement in the performance of the respondents of their conceptual understanding of the selected topics due to the appreciation of the STAD technique.

Research Question 2: What is the students' attitude towards the use of the Students Team Achievement Division (STAD) technique as a learning strategy in chemistry?

Three dependent variables were used to measure on the respondents" attitude scale toward STAD: cognitive processing, presentation level and intuitive stage. An attitude scale questionnaire was developed to assess the various aspects of student motivation. The result is shown in table 8.

Table 8: Percentage of the students five rating scale of their attitude towards STAD

Statement	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)	Mean
1. Do you have meaningful work at the end of your task?	0	2.50	32.50	42.50	22.50	3.88
2. Do you clearly express your own thoughts when using STAD?	0	2.50	20.00	40.00	37.50	4.13
3. Do you have clarity in learning your lesson in this STAD strategy?	0	5.00	37.50	22.50	35.00	3.85
4. Does this approach enable you to participate in sharing information, making decisions, and solving problems?	0	2.50	37.50	30.00	30.0	3.87
5. Does this STAD approach help everyone reach their goal equally?	0	2.50	22.50	40.00	35.00	4.08
6. Do you have confidence as a student in answering your questions?	2.50	12.50	35.00	35.00	15.00	3.48
7. Does this learning helps in a way to make decision for your career?	15.00	10.00	25.00	35.00	15.00	3.75
8. Does the lesson become more interesting with this approach?	0	5.00	40.00	30.00	25.00	3.73
9. Do you feel actively involved in all activities through this approach?	0	10.00	35.00	35.00	20.00	3.65
10. Do you feel intellectually challenged through this method?	0	18.00	42.00	30.00	10.00	3.33
11. Will you prefer this STAD approach to the traditional approach?	2.50	12.50	35.00	35.00	15.00	3.60
12. Does this approach train you to be a good leader and a good follower?	0	15.00	30.00	30.00	25.00	3.80

13. If you were to make a recommendation, which will you recommend that STAD be used for teaching?	0	10.00	35.00	35.00	20.00	4.42
14. Can you make conclusion per discussion that will go in line with what your teacher wants?	2.50	12.50	35.00	35.00	15.00	3.80
15. Can you interpret information from graph all by yourself?	0	10.00	35.00	35.00	20.00	3.22

The means of the each of the fifteen questions in the questionnaire was taken and is shown in table 8. The items were Likert-type questions intended to measure student attitude towards STAD as a learning technique and chemistry. The items were ordered using a 5-point scale with „strongly disagree" and „strongly agree" at the extremes.

The students have diverged views in their attitude towards STAD as a strategy for learning. Some of them thought that the direct learning was okay for them. On the other hand most thought that STAD as a learning strategy gives them a better performance in their lesson.

Research Question 3: What is the gender difference in perception of the use of Students Team Achievement Division (STAD) technique on the understanding of some selected topics in chemistry?

Students" perception towards STAD as a teaching and learning strategy were determined through the use of questionnaires and observations. The students responded to pre and post questions about their perceptions towards STAD as a teaching and learning strategy and their learning environment. Their pre and post responses were compared to see if there was any significant difference in their mean values. Pre response is a reflection of the students" responses on their perception towards STAD as a teaching and learning strategy before the intervention and post is

the reflection of the students‟ feedback after the intervention of STAD as a learning strategy. This study has already revealed that the group treated with STAD recorded higher achievement test scores in the post test. The female respondents were observed to be most involved during the intervention of STAD. They also contribute equally to the tasks given to their group. Table 9 represents the perceptions of the boys towards the use of STAD. Also table 10 represents the perceptions of the girls towards STAD. The data proved the point we considered in question 11 from the attitude questionnaire. They were asked for their preference, „Using STAD, to the Traditional Teaching Method? The research also carried out interviews with the respondents in line with the question of their preference. This was done to get authenticity of the question and to correctly determine the level of perception. The level was determined as followed:

Format to determine the level of perception of the respondents who agreed with the technique of STAD

$$\text{Male perception} = \frac{\boldsymbol{Agree}}{\boldsymbol{Total\ no\#\ of\ students}} \mathbf{x}\ 100$$

$$\text{Female perception} = \frac{\boldsymbol{Agree}}{\boldsymbol{Total\ no\#\ of\ students}} \mathbf{x}\ 100$$

Nb. Agree (Strongly agree and agree)

Format to determine the level of perception of the respondents who disagreed with the technique of STAD

$$\text{Male perception} = \frac{\boldsymbol{Disagree}}{\boldsymbol{Total\ no\#\ of\ students}} \mathbf{x}\ 100$$

$$\text{Female perception} = \frac{\boldsymbol{Disagree}}{\boldsymbol{Total\ no\#\ of\ students}} \mathbf{x}\ 100$$

Nb. Disagree (Strongly disagree and disagree)

Table 9: Percentage of boys' perception towards STAD

Statement	No# of Respondents	Percentage (%)	Stance of Respondents
Strongly Disagree	6	8	Disagree
Disagree	10	13.3	
Neutral	20	26.7	Neutral
Agree	14	18.7	
Strongly Agree	5	6.7	Agree
Total	55	73.4	

Table 10: Percentage of girls' perception towards STAD

Statement	No# of Respondents	Percentage (%)	Stance of Respondents
Strongly Disagree	0	0	Disagree
Disagree	1	1.3	
Neutral	5	6.6	Neutral
Agree	6	8	Agree
Strongly Agree	8	10.7	
Total	20	26.6	

These findings confirmed the position of Eshun and Abledu (1999) who stated that low ability learners in science who often happened to be the females in heterogeneous small group make the most over-all significant gain and therefore preferred group working.

4.5 Discussion

In order to find the impact of cooperative learning such as Students Team Achievement Division (STAD), the data collected were analyzed statistically using the Independent Sample t- Test. In earlier chapters, results were mainly presented and

analyzed based on the specific research questions with brief comments on them. The results then obtained were used to answer the research questions that guided the study.

Research Question 1: To what extent does the use of Students Team Achievement Division (STAD) technique impact students' achievement in some selected topics in chemistry?

The analysis of the data in Table 6 indicates that the test of the respondents improved significantly after the intervention of the STAD learning strategy. The respondents of the study were given a pre-test to measure their performance in elective chemistry covering the topics of Acid and Base, Redox reaction and Stoichiometry as prescribed by the Ghana Education Service (GES) syllabus. A post-test was also administered to measure the impact of the Student Team Achievement Division (STAD) as a learning strategy in those selected topics in chemistry.

The achievement test scores of the respondents with respect to their pre-test and post-test results proved the positive impact of STAD to the performance of the students. This confirms the findings of Pintrich, Smith, Garcia and McKeachie, (1993) that the use of relevant learning strategies allow students to actively processed information, thereby influencing their mastery of materials and subsequent academic achievements. The result of this research goes in line these previous researchers as represented in table 6. It means that after the intervention of the STAD technique the respondents achieved better results. The results with as respect to question number indicate that there was an overall effective improvement in the students‟ conceptual understanding and consequently their performance over the time of the intervention as shown in table 6. The graph of figure 3 also showed that a significant difference was statistically realized reflecting the improvement in the pre-test and post-test of the

students. Another factor that might have improved their performance is the realization that the scores of the post-test would be used to form part of their continuous assessment grades. Another point of their good performance is their highly interactive nature of the lessons. These results reaffirmed the previous studies of Van Amburgh, Devlin, Kirwin, and Qualters (2005), who emphasized that active engagement of students in the lessons, improves attitude and performance than the Traditional classroom instruction and this was proven after the intervention of STAD as reflected in table 7 on the respondents‟ performance from the study.

In cooperative learning strategy the use of extra exercise and assignment significantly contribute to their good performance of the post test. The frequent exercises for students was done during the intervention of STAD of three modules of the study and it confirms the findings of Moryadee (2001), who stressed on the effect of extra exercises to enhance the performance of students and these results are represented in figure 3. When students are successful then learning becomes interesting and permanent. Consequently, students then viewed the subject matter with a positive attitude. Such attitude then enhances self esteem of the students.

On knowledge retention, Millis, McKittrick, Mulhal and Feteris (1999) further argued that higher concept gain and knowledge retention of students involved in small group activities is better than those who perform in individual and competitive environment. This was proven in this study as the respondents retained what they were taught and they had a better performance after the intervention of STAD as indicated in figure 3.

Through group interaction, learners get the opportunity to share idea and provide feedback to each other, as well as making use of different perspectives and alternatives learning (Millis, 2002). In Gillies‟s view (2006), situations where students

assist their peers to learn through explaining topics to each other have been correlated with academic achievement.

The findings of this study suggests that small group, learning can be used to assist students to find solutions to problems in science and other subject areas. This research also confirms the findings of Narrow (1998), who reported that, team work and cooperation is beneficial to both male and female students equally as represented in figure 3. Narrow further suggested that girls are more comfortable sharing in small groups and they often do not work productively in competitive environments. Potthast (1999) also suggested 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 findings also give credence to Freedman‟s assertion (2002) that participating in cooperative group during scientific investigation has positive outcomes in attitude and achievement levels of girls.

Research Question 2: What is the level of students' attitude towards the use of Students Team Achievement Division (STAD) technique as a learning strategy in chemistry?

This second research question was meant to determine the change in attitude that resulted from the intervention of STAD as a learning strategy for the student in the chemistry class.

Tesser (1993) explained that the term "attitude" as a hypothetical construct that represents an individual‟s degree of like or dislike for an item. Tesser further argued that a person‟s attitude is expected to change due to knowledge and skill acquired from an event or process. This study examined both the female and male students‟

attitude towards chemistry and the relationship between attitude towards chemistry and chemistry achievement.

That study revealed that after the intervention of STAD the respondents recorded higher achievement scores in the post test hence the development of a positive attitude. The correlation between the attitude and achievement as the research sought indicates that the higher achievement obtained during the post test could partly be as a result of positive attitude change. In order to support this argument, Smith and McNelis (1993) also confirmed that students with negative feelings towards chemistry lesson always received lower scores. It can therefore be concluded that the higher achievement recorded after the intervention may in fact be due to the positive opinion developed towards chemistry. These finding confirmed Eshun and Abledu (1999) who commented that low ability learners in heterogeneous small groups make the most significant gain. Also, learners in the average performer level obtained a greater mean gain than those in the high performer level. Further research by Haris and Tarwater (1996) also suggested that learners with previously averaged achievement 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 the dependence of other to obtain marks. However, there was no sign of resentfulness by those very good students in the various groups in this study. There was willingness by the students to come to the classroom and with the sense of readiness to solve the tasks that were assigned to them.

The increase of students-students interaction and active student participation in the interactive class lesson also led to the significant improvement in the respondents‟ attitude towards the use of STAD as a learning strategy. As shown in table 7. Before

the intervention the emphasis had been on individual student‟s mastery of content and ability to recall facts, definitions and proving and working with formula. This was done without recourse to students‟ conceptual understanding. The students seemed to be in competition with each other and so there were less or no interactions among them during the class lessons. This could have led to poor attitude for the subject since students who could not “chew” or “pour” facts were at the disadvantage.

Another factor to the students‟ improved change in attitude was the keen interest and support the teacher provided the students during the teaching and learning process. The students saw the teacher as a guide and not a sage on stage, hence they were able to interact freely and seek help whenever the need arose. This trend led to the students‟ improved attitude to the learning strategy. The teacher took personal interest in each of the student and as such knew each of them by name.

This commitment to work created a bond among the students which in turn lead to higher academic self-esteem and positive feelings towards peer and the instructor. According to Johnson and Johnson (1989), small group learning experiences are preferred by students as compared to competitive, individualistic efforts. Opportunities for science learning arise when children attempt to reach consensus as they work together (Barnes & Todd, 1977).

In this situation, each student is obliged to explain and justify his or her situation to the group and to listen to the explanation of other in the group. The cooperative learning approach seemed to have made students understand some scientific concept better. The learning setting provided the student with greater opportunity to work through engaging 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 trued regardless of the differenced in ability level, sex, disability, ethnic membership or task orientation.

Research Question 3: What is the gender difference in perception of the use of Students Team Achievement Division (STAD) technique on the understanding of some selected topics in chemistry?

This question terms to determine the differences in perception of students in learning some selected topics in chemistry using STAD as a cooperative learning approach. The question is based on the fact of the respondents having differences in attitude to those selected topics when STAD in intervened as a learning approach. Comparing the two phases (before and after the intervention of STAD), the difference however was noticed after the intervention.

The finding suggested that cooperative learning approach such Students Team Achievement Division (STAD) helped greatly in the performance of the students and therefore shall be recommended for use by all school where the teaching learning process of science is active. The researcher observed during the study that the girls were always excited and quick to form the groups for the tasks of the day. This goes in line with the girls most preference of STAD approach as evidence in table 10.

As it relate to the pre and post stages, the pre is a reflection of the students‟ responses on their attitude towards STAD as a teaching and learning strategy before the intervention and post is the reflection of the students‟ feedback after the intervention of STAD as a learning strategy. This study reveals that the group treated with STAD recorded higher achievement test scores. The female respondents were most involved in the intervention. They also contribute equally to the tasks given to their group. In general, the findings of the study seem to indicate that small group using the

cooperative learning approach ensures active participation of both the male and female students in their lesson. Considering question eleven about the preference of STAD to the Traditional method, 90% of the twenty females preferred STAD. Better performance of student has been supported by Narrow (1998) who commented that students preferred team work and cooperation among peers. This is beneficial to the students and has been proven in this study as reflected in table 10. Similarly, Rennie (1990) found that small learning groups were beneficial in motivating girls to participate in science (chemistry) lessons and it has proven in this study and reflected in table 10. This study has shown that girls preferred small group working as compared to competitive working. Female significantly gain from the group working and would rather deal with it (STAD) than the Traditional Teaching Method.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter presents the summary of the findings as well as conclusions of the study. It also contains recommendations for stakeholders, suggestion for further research and contributions of the study to science education.

5.1 Summary of major findings

The aim of the study was to investigate the impact of Student Team Achievement Division, as a learning strategy on the outcome of students in some selected topics in chemistry. Action Research was used for this study. The students were assessed both before and after each lesson and scores were recorded as pre and post test scores respectively. An average of the difference in the mean scores of the pre-test and post-test showed an improvement in the achievement score of 12.75. An independence sample t-test measurement of the pre-test and post-test results showed that there was significant difference in the overall achievement scores, $p = 0.009$ at (0.05).

5.2 Summary of findings of the study

This section of the study focuses on the summary of the major findings from the study. It first deals with the summary of differences in the performance of the students before and after their exposure to STAD as a cooperative learning technique. Secondly, it discussed the summary of students‟ conceptual understanding leading to achievement in their problems solving abilities. The last part of the summary focused on the difference in students‟ attitude before and after the intervention of STAD as a

learning strategy. The results of the study are summarized and presented in line with the research questions.

1. *Is there any difference in the performance of students before and after the use of STAD as a learning technique in some selected topics in chemistry?*

   The average performance of the students in the post-test score after the intervention was significantly better than the average performance in the pre-test. An average of the difference in the means of the pre-test and post-test showed an achievement score of 12.75. It also signified that the use of STAD as a learning technique led to an improved performance in students‟ conceptual understanding.

2. *What is the level of attitude of student towards the use Students Team Achievement Division (STAD) technique as a learning strategy in chemistry?*

This study examined both the female and male students‟ attitude towards chemistry and the relationship between attitude towards chemistry and STAD as a learning strategy. The study revealed that after the intervention of STAD the respondents recorded higher achievement scores in the post test hence the development of a positive attitude. The correlation between the attitude and achievement as the research sought indicates that the higher achievement obtained during the post test could partly be as a result of positive attitude change.

3. *What is the gender difference in perception of the use of Students Team Achievement Division (STAD) technique on the understanding of some selected topics in chemistry?*

The question is based on the respondents having differences in perception to those selected topics when STAD was intervened as a learning approach. Comparing the two stages (before and after the intervention of STAD), the difference however was noticed after the intervention. The finding suggested that cooperative learning

approach such Students Team Achievement Division (STAD) helped greatly in the performance of the students and therefore shall be recommended for use by all school where the teaching learning process of science is active. The female students were observed to have high and positive perception for the use of STAD as a learning technique. Concerning question eleven of the questionnaire they agreed at a rate of 90% of the use of STAD.

5.3 Conclusion

According to Kim and Bonk (2002), the use of cooperative learning strategy has shown to improve students‟ learning outcomes as represented in table 6. Also, Kim and Bonk (2002) found out that small learning groups were beneficial in motivating girls to participate in science classes. The finding from the study is in line with Bonk suggestion that, due to the intervention female students retain more knowledge in the cooperative strategy than the traditional method. This research therefore concludes that, cooperative learning approach should be used in teaching science concepts. On the understanding of scientific concept, cooperative learning approach has made students to understand chemistry concepts better. All students indicated their consent to engage in cooperative learning attitude after the research from the Datus International High School. The finding is affirmed by the work of Johnson, Johnson and Smith (1991) that, learning in small groups helps peers to work together to maximize their own and each other learning as reflected in figure 3. They also argued that, learning in small groups produces higher achievement both positive relationship among and between students and higher psychological adjustment than do the competitive and individually experience.

It has been emphasized that, cooperative learning creates natural, interactive contexts in which students have reasons for listening to each other, asking questions, clarifying issues and restating points of view. The students interact with their teachers to share their views and discuss problems of the course of the learning process.

5.4 Limitation of the study

Ideally a large number of Senior High School (SHS) across the nation should have been targeted in the study. However, this study targeted only Datus International Senior High School in the Accra Region due to lack of funds, proximity and accessibility. This was done in order to cut down cost and for effective management of time to complete the study within the time limit, and also to enable the researcher to undertake adequate data collection. The study was also limited to only two forms (SHS I and II) of the school. Another drawback of the study was the use of individual research strategy. In this strategy, the findings may not be shared with others, unless the teacher chooses to present findings at a faculty meeting, make a formal presentation at a conference, and submit written materials to a listener, journalist or newsletter. Hence, the possibility of other teachers in other secondary schools getting to know the findings and recommendations could be low. Also, the teacher being a researcher might have unfair judgments towards certain circumstances which may not be a true reflection of the actual situation. Lastly, it was also the challenge of the use of the observations of the students. There was difficulty in the interpretation of seen behavior and some level of complexity in categorizing observation.

5.5 Recommendations from the study

In view of the findings from this study, the following recommendations have been suggested for schools. The Recommendations have been grouped into two.

A. Recommendation for the chemistry teachers who want to use STAD as a learning strategy
B. Recommendations for schools that want to use cooperative learning strategy such as STAD.

5.5.1 Recommendations for teachers of chemistry.

- The chemistry teachers should use innovative and more effective student-centered strategy. Such strategy should promote meaning learning of difficult chemistry concepts. The teachers could develop or adapt appropriate package for use with the students.
- A common problem with many students in the senior high school is their laziness towards learning especially in doing assignment. This study revealed that one effective measure teachers could use to nip this attitude of students in the bud is to adapt the use of concept tests at the beginning of every lesson. With the score been part of the continuous assessment. This could make them prepare adequately before coming to class.
- Another experience for chemistry teacher is the student lack of attention and passive participation during teaching and learning. The study also revealed that one major remedy for such student‟s behaviors is the use of a post test after every lesson. Students being mindful of the fact that there would be a test after the lesson become motivated to put down salient points and actively carried out instructions given by the teachers. During lessons, they are prompted to seek help from peers and teacher when in difficulty, and

encouraged to ask and response to questions during lessons. It is therefore highly recommended that teachers use post test after lessons to promote attentiveness and active participation of students during lessons.

5.5.2 Recommendations for schools that want to use cooperative learning strategy such as STAD.

- Schools district authorities should organize workshops for teachers on theory and practice of the use of STAD as a cooperative learning approach in the classroom. The facilitators of such workshops should be experts in the fields of cooperative learning strategy so as to clear all doubts teachers may have about the approach and other group activities.
- Cooperative learning strategy should be used in urban and deprived schools. This is because, this study has proved that students at any schools and all levels perform better or achieve more in their conceptual understanding.
- The study revealed that, small as well as smaller groups‟ studies were all effective in using the cooperative learning approach. Thus, teachers should use group sizes based on their population size of their class. For example, six or five students to a group in large classes and four or three students to a group of relatively small classes.
- Students must be put into mixed ability groups to practice peer tuition. This is so because students explain concept to each other, they do so at their own cognitive maturity level. Their understanding of scientific concept may be improved as student solved problems together.
- The school must organized periodic in-service trainings for non-professional teachers as and when they join the staff or take teaching

appointment. During the training, child-centered intuitional strategy such as cooperative learning (STAD) should be used and stressed on.

5.6 Implementation of the study

The findings from the analysis in the study research questions help to achieve its goals, which are to demand effect of a new intuitional approach to teaching chemistry for students‟ performance in the subject, establish a relationship between qualitative understanding of concepts and quantitative problem solving skills of the students. It also finds out the influence of a new intuition method on students‟ attitude and interest in the study of chemistry on the senior high level in Ghana. The new intuitional approach has a positive effect on students‟ performance by improving their conceptual understanding and consequently their quantitative understanding of chemistry. It also changes the students‟ attitude towards the study of chemistry. For instance, their eagerness to be in the next class was profound, they consider chemistry as an interesting subject, enjoy chemistry lesson and did not consider the subject as a boring one. However, it took time (about two weeks) before students got adjusted to the use of STAD, as it was completely new to them. The following implementations could therefore be drawn:

- The conventional practice of teacher-centered approach where she or he to decide what goes on and how learning takes place in the classroom have negative effect on students‟ learning. The students tend to shun the subject, do not take responsibility for their own learning, and do not make any effort to seek information on their own and so almost always rely on teachers to think and seek information for them. Hence students‟ poor performance in chemistry and their negative attitude towards its study in schools. From this study, it is important for teaching and learning of chemistry in senior high

schools to be full of activities related to everyday life. The students should be made to come to conclusion and understand concepts through their own effort with the teacher as a "guide" on the side and not a "sage on stage". The students should be made to seek for clarification and help from their peers and also be made to interact with them more and more than to always rely on notes and facts from teachers. This would help to avoid the problem of "chew, pour, pass and forgot" syndrome where students complete courses in chemistry and are still unable to solve simple everyday problem related to the study of chemistry. For instance, most students in Ghana are not still conversant with the correct specifications of formula and when to use them in chemistry.

- There is therefore the need to modify teaching and learning of science especially chemistry at the senior high schools for an improved performance of students in the subject. Science and chemistry teachers or educators, policy makers are well as the Ministry of Education all have important role to play in this exercise.
- Also, teachers who want to use a new intuitional method in class should be firm in their stance. From the study, it was realized that it took some weeks before the students got adjusted to the new teaching approach. Hence, if a teacher is not firm, he or she might rescind his or her decision and resort to the traditional lecture approach with the fear that the use of the new intuitional approach will not work.

REFERENCES

Adams, D. & Hamm, M. (1996). *Cooperative learning: Critical thinking and collaboration across the curriculum*. Springfield, Illinois: Charles C Thomas Publishers.

Adeoye, F. A. (1999). *Assessment procedure, cognitive style and gender as determinant of students' performance in hierarchical cognitive tasks in physics*. Ph.D. Thesis, Dept of Teacher Education, University of Ibadan.

Adesoji, F. A. (1991) *A comparative analysis of problem solving and self-learning technique in teaching electrolysis*. Ph.D Thesis Dept of Teacher Education Obafemi Awolowo University, Ile-Ife.

Agbeyewa, J. O. (1996). The effect of enhanced problem solving in structural strategy on students concept learning in secondary school physics. *Research in Curriculum Studies, 1(1), 43-48.*

Ahiakwo, M. L. (1984). *Topic difficulties in chemistry.* M.Ed Thesis, Dept. of Teacher Education, University of Ibadan, Ibadan.

Ahiakwo, M. L. (1991), *Cognitive styles and students problem solving competence in chemistry.* Journal of the Science Teacher Association of Nigeria, 27(1), 31-39.

Ajelabi, P. A. (*1998). The relative effectiveness of computer assisted and text assisted program instruction on students leaning outcomes in social studies.* Ph.D Thesis, Dept. of Teachers Education, Ibadan.

Ajewole, G. A. (1991). *Effect of guided discovery and exposition method on students achievement in biology;* Journal of Science Teachers Association of Nigeria, 26(2), 19-25.

Akinmade C. T. and Adisa J. (1984). *A study of student area of difficulties in chemistry. Nigeria Journal of Curriculum Studies 2(2), 84-90*

Amedahe, F. K. (2002), *Fundamental of educational research:* Mimeograph. Cape Coast: Univesity of Cape Coast

Anderson, T. (2006). *Getting the mix right again: An updated and theoretical rationale for interaction :* International Review of Research in Open and Distance Learning

Antwi, V. (2013). *Interactive teaching of mechanics in a Ghanaian University context.* Netherlands: Utrecht University/Flsme Scientific Library

Armington, T.C. (2003). *Best practices in developmental mathematics* (2nd Ed.) NADE Mathematics Special Professional Interest Network.

Arons, A. B. *(1990). A guide to the introduction of physics.* New York: valley.

Arosan, E. Blaney, N. Stephen C. Sikes, J. and Snapp, M (1978). *The Jigsaw classroom.* Beverly Hills, US. Sage.

Ary, D., Jacobs, L. C., & Razavieh, A. (*2002*). *Introduction to research in education,* Belmont, CA : Wadsworth/Thomson Learning.

Atkinson, R. C., & Shiffrin, R. M. (1968). *Human memory: A proposal system and its control processes.* In K. W. Spence and J. T. Spence (Eds.): The psychology of learning and motivation (Vol. 2). London: Academic Press.

Atwater, M., Wiggins, J., and Gardener, C. (1995). A study of urban middle school students pupils with high and low attitudes towards science. *Journal of Research in Science Teaching*, 32, 665-677.

Ausubel, D. P. (1963). *The psychology of meaningful verbal learning.* New York: Grune & Stratton Inc.

Balfakih N. M. A. (2003). The effectiveness of student team-achievement division (STAD) for teaching high school chemistry in the United Arab Emirates. *International Journal of Science Education* 5(5): 605 – 624. From http://www. informaworld.com/smpp/content~db=all~ content= a713864989 (Retrieved 10 December 2010).

Bandura, A. (1986). *Social foundations for thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice Hall

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

Beaton, A. E., Mullis, I. V.S., Martin, M. O., Gonzalez, E. J., Kelly, D. L. & Smith, T. A. (1996). *Mathematics achievement in the middle school years: IEA's third international mathematics and science study (TIMSS).* Chestnut Hills, MA: Boston Colleg.

Becker, H. J. (1994). *Chemiechida krische lentuick ungen in der Bunders-Republic Deutschland situations Analysis and B.lang.* Frankfurt. Germany

Bellanca, J., & Fogarty, R. (1991). *Blueprints for thinking in the cooperative classroom.* Madison, Wis.: Magna Publication

Bennett, N., & Cass, J. (1988). *The effects of group composition on group interactive learning.* Madison, Wis.: Magna Publication

Berryhill, M. (2008). *Visual Memory and the Brain*. Retrieved on May 21, 2012 from http://www.visionsciences.org/symposisa2008_4.html

Best J. W, & Kahn JV (2003). *Research in Education.* Ninth Edition., Prentice-Hall of India Private Limited, New Delhi.

Bishop, R., & Glynn, T. (1999). *Culture Counts: Changing Power Relation in Education.* Palmeston North: Dunmore Press

Black, P., & William, D. (1998b). *Inside the black box: Raising standards through classroom assessment.* Phi Delta Kappan, 8 (20): 139-148

Blaxter, L. Dodd, K., & Tight, M. (1996). *How to research.* Buckingham: Open University Press

Boote, D. N., & Beile, P. (2005). Scholars before researchers: *On the centrality of the dissertation literature review in research preparation. Educational Researcher,* 34 (6), 3-15

Boston, C. (2002). The concept of formative assessment. *Practical Assessment, Research & Evaluation,8 (9).* Retrieved July 16, 2013 from http://PAREonline.net/getvn.asp?v=8&n=9 Boston, MA.

Brophy, J. (1983). Classroom organization and management. *Elementary School Journal 83 (4),* 265-85

Brothen, T., & Wambach, C. (2000). *A research based approach to developing a computer-assisted course for developmental students.* In J. L. Higbee and P. L. Dwinell (Eds), *The Many Faces of Developmental Education (*pp. 59-72). Warrenburg, MO: National Association for Developmental Education.

Brown, J. S. (2000). Growing up digital: How the web changes work, education, and the ways people learn. *Change magazine March/April: 11-20*

Brown, K. L. (2003). From teacher-centered to learner-centered curriculum: *Improving learning in diverse classrooms. Education, 124*(1), 49-54.

Brownlee, J., Boulton-Lewis, G., & Berthelsen, D. (2008). Epistemology beliefs in childcare: Implications for vocational education and course design. *British Journal of Educational Psychology, 78, 457-471*

Burns, M. (1981, September). *Groups of four: Solving the management problem.* Madison, Wisconsin. Magna Publication.

Burns, M. (1987). *A collection of math lessons from grades 3 through 6*. New Rochelle Publication.

Burns, N., and Groove, S. (1993). The *practice of nursing research: conduct, critique and utilization (2nd Edition). USA;* W.B. Sanders Philadelphia, Pennsylvania

Campbell, Allen. 2002. *Free writing technique. Copyright Lynchburg College.* Madison, Wisconsin. Magna Publication

Campbell, D. T., & Stanley, J. C. (1963). *Experimental and quasi-experimental design for research on teaching.* In N. L. Gage (Ed.), Handbook of research on teaching (pp. 171-246). Chicago, IL: Rand McNally.

Campbell, D. T., and Stanley, J. C. (1971), "*Experimental and quasi-experimental design for research on teaching*. In N. L. Gage (Ed.), *Handbook on teaching. Chicago* , IL: Rand McNally

Campbell, Patricia B. (1992). *Encouraging girls in math and science.* Campbell-Kibler Associates. Series includes the pamphlets "Nothing Can Stop Us Now: Designing

Cashin, W.E. (1990). *Improving lectures in Teaching College*: College reading for the new instructor, edited by Weinmer and R. A. Neff, 59-63. Madison, Wis.: Magna Publication

Cavalier, J. C., Klein, J. D., & Cavalier, F. J. (1995). *Effects of cooperative learning on performance, attitude, and group behaviors in a technical team environment. ETR&D, 43*(3), 61-71.

Chief Examiner (2002). *The West African Examination Council, Certificate Examination, Annual Report 2002. Accra, Ghana:* Ghana Publishing Corporation.

Chief Examiner (2004). *The West African Examination Council, Certificate Examination, Annual Report 2004. Accra, Ghana:* Ghana Publishing Corporation.

Chief Examiner (2008). *The West African Examination Council, Accra, Certificate Examination, Annual Report 2008. Accra, Ghana:* Ghana Publishing Corporation.

Chief Examiner (2012). *The West African Examination Council, Certificate Examination, Annual Report 2012. Accra, Ghana:* Ghana Publishing Corporation.

Clinkenbeard, P. R. (1991). *Unfair expectations: A pilot study of middle school.* Madison, Wis.: Magna Publication

Clouse, R. W., & Nelson, H. E. (2000). School reform, constructed learning, and educational technology. *Journal of Educational Technology System, 28 (4),* 289-303

Cotton, K. (1991). *Computer-Assisted Instruction.* Northwest Regional Educational Laboratory, School Improvement Research Series. Retrieved from http://www.nwrel.org/scpd/sirs/5/cu10.html

Creswell, J. W. (2009), *Designing and conducting mixed method research*. Thousand Oaks, CA: Sage Publication

Creswell, J. W. and Plano-Clark, V. (2007). *Designing and conducting mixed methods research.* Thousand Oakes, CA: Sage Publications

Creswell, J. W., & Miller, D. L. (2000). Determining Validity in Qualitative Inquiry. *Theory Into Practice,* 39(3), 124-130

Curriculum research and Development Division (CRRD), (*2007). Senior High School Integrated Syllabus.* Accra: Ministry of Education

Curtis, F. D. (1926). A determination of the scientific attitudes. *Journal of Chemical Research.* Edina, MN: Interaction Book Company. Cooperative, competitive, and individualistic goal structures on achievement

Dabbagh, N. (2006). Instructional Design Knowledge Base. Retrieved August 6, 2013, from http://classweb.gmu.edu/ndabbagh/Resources/IDKB/models_theories.htm

Daurio, S. P. (1979). *Educational enrichment versus acceleration.* Edina, MN: Interaction Book Company. Cooperative, competitive, and individualistic goal structures on achievement

De Avila, E. A., & Duncan, S. E. (1984). *Finding out/Descubrimiento*. Madison, Wisconsin. Magna Publication.

Dede, C. (2008). *Theoretical Perceptive Influencing the Use of Information in Teaching and Learning.* Cambridge, MA, USA: Harvard Graduate of Education.

Dembo M. (1994). *Applying Educational psychology* (5th Ed.). White Plains, NY: Longman Publishing Group. Department of Pharmacy Practice and Center for Effective University Teaching, Northeastern University, Boston, MA. Department of Pharmacy Practice and Center for Effective University Teaching, Northeastern University,

Deutch M. (1962). *Cooperation and trust: some theoretical notes.* In M. Jones (Ed) Nebraska symposium on Motivation. Lincoln, N.E. University of Nebraska press, 275-320.

Di Vesta, F. J. (1987). *The Cognitive Movement and Education.* In J. A. Glover & R. Historical Foundations of Educational Psychology (pp. 203-233). New York: Plenum Press

Dimitrov, D. M. & Rumrill, Jr. P. D. (2003). *Pretest-posttest design and measurement of change* 20 (2), pp. 159-165

Duffy, T. M. & Jonassen, D. H. (1991). Constructivism: *New implication for instructional technology? Educational Technology, 32 (5), 7-11.*

Duncan, R. M. (1995). Piaget and Vygotsky revisited: Dialogue or assimilation? *Developmental Review, 15, 458-472*

Eastaby-Smith, M., Thrope, R., & Lowe, A. (1991). *Management Research: An introduction.* London: SAGE Publications.

Ebenezer, J.V. and Zoller, U. (1993). Grade 10 students‟ perceptions of and attitudes towards science teaching and school science. *Journal of Research in Science Educational Studies*, 21, 85-97.

Edwards, K. J., & De Vries, D. L. (1972). *Learning games and student teams: Their effect on student attitudes and achievements* (Report No. 147). Baltimore: Johns *Effective Programs for Girls in Math, Science, and Engineering," and "Working Together, Making Change," among others.*

Esan A.O (1999). *Effect of cooperative and individualist problem solving strategy on student learning outcomes in secondary school mathematics.* Ph.D Thesis Dept. of Teacher Education University of Ibadan, Ibadan.

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

Felder, R. M. & Brent, R. (1996). Navigating the bumpy road to student-centered instruction. *College Teaching.* 44 (2), 43-47.

Foley, K. (2003). *The big pocket guide to using and creating virtual field trips* (3rd Ed.) Tramline.

Forehand, M. (2005). *Bloom's taxonomy*: Original and retrieved. In Michael Orey (Ed).

Franklin, Margaret (1990). *Add-ventures for girls: building math confidence (Middle School).* University of Nevada. A manual for elementary school is also available.

Freedman, S. W. (2002). Inside City Schools: *Investigating Literacy Multicultural Classroom.* New York: Teachers‟ College Press.

Fu-yun-yua, Y. (1998). *The effects of cooperation with inter-group competition on performance and attitude in a computer assisted science instruction.* Journal of Computer in Mathematics and Science Teaching, 17(4), 381-395.

G. A. Davis (Eds.), *Handbook of gifted education* (pp. 178-196). Compacting on classroom practices. *Journal for the Education of the Gifted. Cooperation in the classroom* (3rd. ed.). Edina, MN: Interaction Book Company. Cooperative, competitive, and individualistic goal structures on achievement

Gable, R.K. and Wolf, M.B. (1993): *Instrument Development in the Affective Domain*. Edina, MN: Interaction Book Company. Cooperative, competitive, and individualistic goal structures on achievement

Gagne, R. (1970). *The Conditions of learning (Second Edition).* New York: Holt, Rinehart, & Winston Holt.

Galloway, C. M. (2001). Vygotsky‟s Constructivism. In M. Orey (Ed.),*Emerging perspectives on learning, teaching, and technology.* Retrieved September 10, 2013, from http://projects.coe.uga.edu/epltt

Genesee, F. & Upshur, J.A. (Eds.). (1996). *Classroom-based evaluation in second language education.* Cambridge: Cambridge University Press.

Gillies, R. M. (2006). Teachers' and students' verbal behaviors during cooperative and small-group learning. *British Journal of Educational Psychology, 76*(2), 271-287.

Gills, M. G., Ashton, P. T., & Algina, J. (2004). Changing preservice teeachers‟ epistemological beliefs about teaching and learning in mathematics: An intervention study. Contemporary Education Psychology, 29, 164-185

Gltekin,C. (2010).Identifying alternative conceptions of chemical kinetics among secondary School and undergraduate students in Turkey. *Journal of Chemical Education, 87*(4), 449-455.

Government of Ghana (1995). *Report on the Science Technology and Mathematics Education (STME) Zonal Clinic.* Accra: Girls Education Unit, Ghana Education Service, Ministry of Education

Grasha, A. F. (1994). A matter of style: The teacher as expert, formal authority, personal model, fascinator, and delegator. *College Teaching, 42*(4), 8-19

Gredler, M. E. (1997). *Learning and instructions: Theory into practice.* Upper Saddle River, NJ: Prentice Hall, Inc.

Grippin, P. & Peters, S. (1984). *Learning Theory and Learning Outcomes.* Lanham Md.: University Press of America.

Haris, G. A., & Tarwater, J. D. (1996). *The Ninth-Hour Sequence for the General Pre-service Elementary Teacher at Texas Technical University*. Houston, Texas

Hassard, J. & Dias, M. (2009). *The Art of Teaching Science: Inquiry and Innovation in Middle School and High School, 2nd edition. New York: Routledge, 201-216.*

Hendley, D., Parkinson, J., Stables, A. and Tanner, H. (1995). Gender differences in pupil attitudes to the national curriculum foundation subjects of English, mathematics, science and technology in Key Stage 3 in South Wales.

Hensen, E. J. & Stephens, J. A. (2000). *The ethics of learner-centered education: Dynamics that impede progress.* Change, 32, 40-47

Hergenhan, B. & Olson, M. (2005). *Theories of Learning*, 7th Edition: Pearson Education

Humphreys, B., R. T. Johnson and D. W. Johnson. (1982). *Effects of cooperative, competitive and individualistic learning on students' achievement in science class. J. Res. Sc. Teach. 19(5): 351-356.*

Hung, D., Tan, S. C., & Koh, T. S. (2006). *Engaged learning: Making learning an authentic experience.*

Illeris, K. (2004). *The three dimensions of learning*. Malabar, Florida: Krieger Publishing Company.

Johnson D.W and Johnson R. T. (1983) *Socialization and achievement crisis: are cooperative learning experience solutions.* L. Brickman (Ed), Applied Social Psychology annual 4. Beverly Hills. US:Sage.

Johnson D.W and Johnson R. T. (1983) *Socialization and achievement crisis: are cooperative learning experience solutions.* L. Brickman (Ed), Applied Social Psychology annual 4. Beverly Hills. US:Sage.

Johnson D.W Johnson R. Warring, D. and Maruyama, G. (1978). Different cooperative learning procedure and grass-handicap relationships. *Exceptional children,* 53(3), 247-252.

Johnson D.W. and Johnson R.T (1994). *Learning together and alone: Cooperative, competitive and individualistic learning.* 4th Edition. Boston: Mlyn and Bacon.

Johnson, D. W., & Johnson, R. (2005). *New Developments in Social Interdependence Theory.* Genetic, Social, & General Psychology Monographs, 131(4), 285-358. http://dx.doi.org/10.3200/MONO.131.4.285-358

Johnson, D. W., & Johnson, R. T. (1981). *Effects of cooperative and individualistic learning.* Edina, MN: International Book Company.

Johnson, D. W., & Johnson, R. T. (1989). *Cooperation and Competition: Theory and Practice*. Edina, MN: International Book Company.

Johnson, D. W., Johnson, R. T., & Holubec, E. (1990). *Circles of learning.* Edina, MN: International Book Company.

Johnson, D. W., Johnson, R. T., & Maruyama, G. (1983). *Interdependence and competitive learning.* Boston: Allyn & Bacon.

Johnson, D. W., Johnson, R. T., & Smith, K.A. (1991). *Active Learning: Cooperation in the College Classroom.* Edina, MN: Interaction Book Company

Johnson, D., W. (2009). *Reaching out: Interpersonal effectiveness and self-actualization* (10th Ed.). Boston: Allyn & Bacon.

Johnson, D.W. maruayama, G, Johnson R.T, Nelson D, and Skon, L. (1981). Efects of competitive and individualistic goal structure on achievement: A Meta Analysis. *Psychological Bulletin*, *89*, 47-62. Johnson, D., Skon, L., & Johnson, R. (1980). *Effects of cooperative and individualistic learning.* Edina, MN: International Book Company.

Johnson, R. B. & Onwuegbuzie A. J. (2004) *Mixed Methods Research:* A research paradigm whose Time Has Come In: Educational Researcher, 33/7, 14-26.

Johnson, R., Johnson, D., & Stanne, M. (1985). *Effects of cooperative and individualistic learning.* Edina, MN: International Book Company.

Johnson, R., Johnson, D., Stanne M. B., & Garibaldi, A. (1990). *Impact of group learning.* Edina, MN: Interaction Book Company

Johnson, R., Johnson, D., Tiffany, M., & Zaidman, B. (1983*). Are low achievers slow learner?* Edina, MN: International Book Company.

Jonassen, D. (1999). Designing constructivist learning environments. In C. Reigeluth (Ed.), Instructional design theory and models: *A new paradigm of instructional theory (pp.215-239*). Mahwah, NJ: Lawrence Erlbaum Associates.

Jordan, A., Carlie, O., & Stack A. (2008). *Approaches to learning: A guide for teachers.* Berkshire: McGraw-Hill, Open University Press.

Joyce, B. R. (1991*). Common misconceptions about cooperative learning.* Edina, MN: Interaction Book Company

Joyce, B. R., & Weil, M. (1986). *Models of teaching* (3rd. ed.). Madison, Wisconsin. Magna Publication.

Julian J, and Perry, F. (1967). *Cooperation contrasted with intra-group and inter-group competition.* Sociometry, 30, 79-90.

Kagan, S. (1989/1990). *The structural approach to cooperative learning*. Beverly Hills: Sage Publications.

Killen, R. (2007). *Effective teaching strategies: lessons from research and practice* (4th ed.). Melbourne: Thompson Social Sciences Press.

Kim, K. & Bonk, C. (2002). Cross-cultural comparisons of online collaboration. Retrieved September 18, 2009 from JCMC Website: http//:jcmc.indiana.edu/edu/vol8/issue1/kimandbonk.html

Kinney, D.P., & Robertson, D. E (2003). Technology makes possible new models for delivering developmental mathematics instruction. *Mathematics and Computerized Education, 37 (3), 315-328.*

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

Kohn, A. (1992). *No contest: the case against competition.* New York: Houghton Mifflin.

Koller, O. (2005). *Formative assessment in classrooms: A review of the Empirical German literature, in OECD, Formative assessment: improving learning in secondary classrooms.* OECD, Paris.

Kulik, J. A., & Kulik, C-L. C. (1984). *Effects of accelerated instruction on students*. Beverly Hills: Sage Publications.

Kulik, J. A., & Kulik, C-L. C. (1991). *Ability grouping and gifted students. In N. learning experiences on inter-ethnic interaction.* Journal of Educational learning for talented students.

Labaree, D. F. (2011), *Consuming the Public School*. Educational theory, 61 : 381-394

Langford, P. (1989). *The process of learning.* In P. Langford (Ed.), Educational Psychology: An Australian perceptive (pp. 43-64). Melbourne: Longman Cheshire

Laureate Education Inc. (2008). *Cognitive learning theories.* (Video webcast). Retrieved August 23, 2013from http://www.courseurl.com

Le, T. T. (2010). Infusing Cooperative Learning into An EFL Classroom. *English Language Teaching,* 3(2), 64-77

Lee, M. L. and Schule, C. (2010). *Demographic.* In N. Salkind (ED.), Encyclopedia of research design. (pp. 347-348). Thousand Oaks CA: SAGE Publication, Inc doi: http://dx.doi.ord/10.4135/971412961288.n108

Lescano, .A. (1995). *The remedial English project.* English Teaching Forum, 33(4). Retrieved 20 January 2009 from *http://eca.state.gov/forum/vols/vol33/no4/p40.htm*

Littleton, K., Wood, C., & Chera, P. (2006). Interactions with talking books: Phonological awareness affects boys" use of talking books. *Journal computerized Assisted Learning, 22:382-390.* London: Kluwer Academic Publishers

Lucker, G., Rosenfield, D., Sikes, J., and Aronson, E. (1976). Effects of competitive and individualistic goal structure on achievement: A Meta Analysis. *Psychological Bulletin*, *89*, 47-62.

Lynch, Sharon J. (2000*). Equity and Science Education Reform*. Mahwah, NJ: Lawrence

Machemer, P., & Crawford, P. (2007). Students perceptions of active learning in a large cross disciplinary classroom. *Active learning in Higher Education, 8, 9-10*

Maesor, L. & Woods, P. (1984). *Changing Schools: Pupils Perspectives on Transfer.* Comprehensive. Milton Keynes: Open University Press

Mahaboobjan, A. (2010). *Research methodology in physical Education.* Delhi.kalpaz Publication

Mahmood, S. (2006). *Evaluating the mathematics performance of developmental mathematics students when computed assisted instruction is combined with traditional strategies.* Ed. D. dissertation, Texas South University, Texas. Retrieved August 2, 2012, from Dissertation & Thesis: Full Text. (Publication No. AAT 3251891). Manuscript submitted for publication.

Marbach-Ad, G., Seal.O & Sokolove, P. (2001). Students attitudes and recommendations on active learning. *Journal of College Science Teaching, 30,* 434-438

Martin, C., Dianne, R., Heller, R., & Mahmoud, E.(1991). American and Soviet Children‟s‟ Attitudes towards Computers. *Journal of Educational Computing Research, 8(2*), 155-185

Mascolol, F., & Fisher, K. W. (2005). *Constructivism and Social Constructivism. Retrieved February 8, 2012 from* http://www.ucdoer.ie/index.php/Education_Theory/Constructivism_and_Social_Constructivism.

Matthews, M. (1991). *Cooperative learning: What does it mean for gifted students?* Milton Keynes: Open University Press

Mayes, J. T. (1993). Commentary: *impact of the cognitive theory on the practice of courseware authoring,* Journal of Computer-assisted Learning.

Mazur, E. (1997). *Peer instruction: A user' manual.* Upper Saddle River, NJ: Prentice-Hall

McDermott, L. C. (1993). Guest comment: How we teach and how studentgs learn-a mismatch? American Journal of Physics, 61, 295-298.

McDermott, L. C., & Shaffer, P. S. (1992) *"Research as a guide for curriculum development: An example from introductory electricity.* American Journal of Physics. 60, 994-1003"

McLeod, S. A. (2010). *Zone of proximal Development-Scaffolding-Simply Psychology.* Retrieved September 12, 2013 from http://www.simplypsychology.org/Zone-of-proximal-Development.html

McPartland, J. M., & Slavin, R. E. (1990). *Policy Perspectives: Increasing achievement.* Milton Keynes: Open University Press

Mengduo, Q., & Xiaoling, J. (2010). Jigsaw strategy as a cooperative learning technique: focusing on the language learners. *Chinese journal of applied linguistics, 33*(4), 113-125.

Mervasch, Z. R. (1991). *Learning mathematics in different mastery environments. meta-analysis.* Psychological Bulletin, 89, 47-62.

Miller et al. 1993; Nichols & Miller (1994) Milton Keynes: *Cooperative learning*: Open University Press.

Millis, B. J. (2002). Fulfilling the promise of the "seven principles" through cooperative learning: Action agenda for the University classroom. *Journal on Excellence in College Teaching,* 2, 139-144.

Mills, B., McKittrick, B., Mulhall, P., & Fetteris, S. (1999). *Cooperative Learning that works.* Physical Education, 34, 11-16

Mischo, C., & Rheinberg, F. (1995). Educational goals and teachers‟ preference for individual reference norms in evaluating academic achievement. *Journal of Educational psychology,* 9, 139-151.

Moll, A. (2002). Clarifying constructivism in a context of curriculum change. *Journal of Education, 27, 5-32*.

Moust, J. H. C., Van Berkel, H. J. M., & Schmidt, H. G. (2005). Signs of erosion: Reflections on three decades of problem-based learning at Maastricht University. *Higher Education,* 50, 665-683.

Mouton, J. (1996). *Understanding social research.* Pretoria; J. L. van Schaik

Mulryan, C. M. (1994). Perceptions of intermediate students' cooperative small-group work in mathematics. *The Journal of Educational Research, 87*, 280-291.

Myers, R.E. and Fouts, J.T. (1992). A cluster analysis of high school science classroom environments and attitude towards science. *Journal of Research in Science Teaching*, 29, 929- 937.

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

Navarette, C., Cohen, E. G., De Avila, E., Benton, J., Lotan, R., & Parchment, C. (1985). *Evaluating the mathematics performance of developmental mathematics students when computed assisted instruction is combined with traditional strategies.* Ed. D. dissertation, Texas South University, Texas. Retrieved August 2, 2012, from Dissertation & Thesis: Full Text. (Publication No. AAT 3251891). Manuscript submitted for publication.

Nhu-Le, T. (1999). A Case Study of Cooperative Learning in Inorganic Chemistry Tutorials at the Vietnam National University-Ho Chi Minh City (*Master dissertation,* University of Simon Fraser, Canada). [Online] Available: http://www.ir.lib.sfu.ca/bitstream/1892/8731/1/b19483041.pdf (March, 19, 2010)

Nix, R. (1999). *A critical evaluation of science-related virtual fields trips available on the World Wide Web in partial fulfillment of the requirements in SMEC*-708 Curtin University of Technology Western Australia.

Novak, J. D., & Canas, A.J.(2008). The Theory Underlying Concept Maps and How to Construct Them, *Technical Report IHMC CmapTools 2006-01 Rev 01*-2008, Florida Institute for Human and Machine Cognition.

Nwagbo, C.R. (2002). *Levels of scientific Literacy of secondary school students: implication for sustainable development.* 43rd Annual proceeding of STAN, 73-77 NY: The Math Solutions Publications.

Oakes, J., & Lipton, M. (1990). *Tracking and ability grouping: A structural barrier to artistic students at each grade level.* Washington, DC: Information Services, Office of Educational Research and Improvement.

Ojo, O.M. (1989). *The differential effectiveness of cooperative, competitive and individualistic goal structures on students' performance in chemistry*. Ph.D thesis, Dept. of teacher education, University of Ibadan, Ibadan.

Okebukonla, P.A.O. (1984). *Effects of cooperative, competitive and individualistic laboratory interaction patterns on students' performance in biology.* Ph.D Thesis, Dept of Teacher Education, University of Ibadan, Ibadan.

Oni, S. (2012). *Revitalizing Nigerian Education in Digital Age.* Trafford Publishing, p.75.

Oppenheim, A.N. (1992). *Questionnaire Design, Interviewing and Attitude Measurement.* London: Printer Publisher Limited.

Orey, M. (Ed.) (2001). Emerging perspective on learning, teaching, and technology. Retrieved September 10, 2013, from http://projects.coe.uga.edu/eplt/

Orlich, H., Harder. J, Callahan, R., & Gibson, W. (1998). Teaching strategies: *A guide to better instruction*. New York: Houghton Mifflin Company

Ormrod, J. E. (1995). *Human learning.* Englewood Cliffs, New York: Merrill.

Osborne J., Simon S., and 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.F. (2001). *Science Education for Contemporary society. Problems, issues and dilemmas*. In O. Dejang, E.R. Science Berg, A. Alblas (eds). *Teaching for scientific literacy.* Utrerh the master land.

Osborne, J. and Collins, S. (2001).Pupils‟ views of the role and value of the science curriculum: a focus-group study. *International Journal of Science Education*.

Page-Bucci, H. (February, 2003). *The value of Likert scales in measuring attitudes of online learners*. Available online: http://www.hkadesibns.co.uk/websites/msc/reme/likert.htm (accessed: 13-07-2005).

Paivio, A. (1971). *Imagery and verbal processes*. New York: Holt, Rinehart, and Winston.

Paris, S. G. (1988*). Models and metaphors of learning strategies.* In C.E. Weinstein, E. T. Goetz & P. A. Alexander (Ed.), *Learning and study strategies: Issues in assessment, instruction, and evaluation* (pp. 299-321). San Diego; Academic Press

Peterson, P., Janicki, T., & Swing, S. (1981). *Preparing the Higher Education Sector Development Project - Developing New Model Universities (NMUs) in Vietnam*. Ha Noi: Ministry of Education and Training.

Phipps, M., Phipps, C., Kask, S., & Higgens, S. (2001). University students‟ perceptions of cooperative learning: Implications for administrators and instructors. *The Journal of Experiential Education, 24, 14-21*

Piaget, J. & Inhelder, B. (1973). *Memory and intelligence.* NY: Basic Books

Piaget, J. (1954). *Play, dreams and imitation in childhood.* London: Heineman

Piburn, M.D. and Baker, D.R. (1993). If I were the teacher – Qualitative study of attitude towards science. *Science Education*, 77, 393-406.

Pintrich, P. R., Smith, D., Garcia, T., & McKeachie, W. (1993). Reliability and Predictive Validity in Psychometrics. *Educational and Psychological Measurement*, 53.801

Pitler, H., Hubbell, E., Kuhn M. & Malenoski, K.(2007). *Using Technology with Classroom instruction that works:* Alexandria, VA: ASCD

Poepping, W. and Mella, I, (2001). *Ubenim chemistry*. *Der Mathematics and nature, senshaftliache unterricht, 54, 417-419.*

Poepping, W. and Mella, I, (2001). *Ubenim chemistry. Der Mathematics and nature, senshaftliache unterricht, 54, 417-419.q*

Potthast, M.J. (1999). Outcomes of using Small-Group Cooperative Learning Experiences in Introductory Statistics Courses. *College Student Journal*, 33 (1), 34-42

Quaittoo, W. A., (1996). *The Ultimate Chemistry*. Kov‟s Series; fourth edition

Reid, J. Forrestal, P., & Cook, J. (1989). *Small Group Learning in the Classroom.* Portsmouth, NH: Heineman

Reiss, M.J. (2000). *Understanding science lessons: Five years of science teaching*. Malden. MA. Blackwell Publishing

Rennie, H. N. (1990). *Computer Toys…Computer Confidence for Women, 1990, Title IX at 25 Report Card on Gender Equity, Executive Summary*. New York: American Association of University Women.

Robinson, A. (1990*). Cooperation or exploitation? The argument against cooperative learning.* Phoenix, AZ: ACM Press

Robson C (2002). *Real world research: a resource for social scientists and practitioner researchers*. Second Edition. Malden. MA. Blackwell Publishing.

Rogers, K. B. (1991). *The relationship of grouping practices to the education.* Boston: Fordanna Academic Publisher

Sabina, A., & Sabina, R. (2006). *Collaborative learning in an introductory computer science, March 2006*. SIGSCE „4 (pp. 304-309). Phoenix, AZ: ACM Press

Sahin, A. (2010). Effects of Jigsaw III technique on achievement in written expression. *Asia Pacific education review,* 12(3), 427-435. http://dx.doi.org/10.1007/s12564-010-9135-8

Salend, D., and Sonnenschein, P. (1989). *Validating the effectiveness of a cooperative learning.* Boston: Fordanna Academic Publisher

Samuels, Linda (1999). *Girls Can Succeed in Science: Antidotes for Science Phobia in Boys and Girls.* Thousand Oaks, CA: Corwin Press. Tel.: (805) 499-9774

Sanders, Jo (1994). *Lifting the Barriers: 600 Strategies that really work.* Boston: Fordanna Academic Publisher

Sarantakos, R. (1998). *Research methods in Schools.* Boston: Fordanna Academic Publisher

Schreiner, C., and Sjøberg, S. (2004). *Sowing the seeds of ROSE. Background, rationale, questionnaire development and data collection for ROSE (The relevance of science education) - a comparative study of students' views of science and science education.* Acta Didactica.-(4/2004) (ISBN 82-90904-79-7): Dept. of Teacher Education and School Development. University of Oslo, Norway

Schreiner, C., and Sjøberg, S. (2006).Science education and youth‟s identity construction–two incompartible project? In D. Corrigan, Dillon, J. and Gunstone, R. (Eds.), *The re-emergence of values in the science curriculum*: Sense Publications (in progress).

Schunk, D. H. (1996). *Learning theories*. Englewood Cliffs, Prentice-Hall, Inc.

Sharan, S. (1980). *Cooperative learning in small groups.* Boston: Fordanna Academic Publisher

Sharan, S., & Shachar, H. (1988). *Language and learning in the cooperative learning.* Boston: Fordanna Academic Publisher

Sharan, S., & Sharan, Y. (1976). *Small group teaching*. Englewood Cliffs, NJ:

Shaw, S., Grimes, D., & Bulman, J. (2005). *Educating slow learners: Are charter schools the last, best hope for their educational success?* The Charter Schools Resource Journal, 1(1).

Sherman LW, Thomas M 1986. Mathematic achievement in cooperative goal-structured high school classrooms. *Journal of educational research*, 70(3): 169-172.

Simpson, R.D, Koballa, T. R. Oliver, J. S. and Crawley, F. E. (1994). Research on the effective dimension of science learning, in Gabel, D. L. (Ed) *Handbook on research in science teaching and learning.* New York US: Macmillian.

Simpson, R.D. & Oliver, J.S. (1990). *A summary of major influences on attitude.* Boston: Fordanna Academic Publisher

Sjøberg, S. (2000b). *Science and Scientists: The SAS-study. Cross-cultural evidence and perspective on pupils interests, experiences and perceptions-background, development and selected results.* Acta Didactica. (1/2000). Department of Teacher Education and School Development. University of Oslo.

Skinner, B. F. (1974). *About behaviourism*. New York: Knopf.

Slavin , R. E. (1987). Developmental and motivational perspectives on cooperative learning: reconciliation. *Child Development*, 58: 1161-1167.

Slavin, R. (1995). *Cooperative learning: Theory, research, and practice*. Massachusetts: Allyn and Bacon.

Slavin, R. E. (1980). *Cooperative learning.* Review of Educational Research, 50, 315-

Slavin, R. E. (1984). *Team assisted individualization: Cooperative learning.* In R. E. Mayer & P. A.

Slavin, R. E. (1986). *Using student team learning* (3rd. Ed.) Baltimore

Slavin, R. E. (1990). *Ability grouping, cooperative learning and the gifted. Journal for science.* Englewood Cliffs: Prentice Hall

Slavin, R. E. (1990). *Cooperative learning: Theory, research and practice*. In R. E. Mayer & P. A.

Slavin, R. E. (1991). *Educational Psychology*. (3rd Ed.). Englewood Cliffs: Prentice Hall

Slavin, R. E. (1991). *Synthesis of research on cooperative learning*. Englewood Cliffs: Prentice Hall

Slavin, R. E. (2011). *Instruction based on cooperative learning.* In R. E. Mayer & P. A. Alexander (Eds.), Handbook of Research on Learning and Instruction (pp. 344-360). New York: Taylor & Francis.

Slavin, R. E. 1990. *Co-operative learning*. New York: Longman.

Slavin, R. E. 1995. *Cooperative Learning. Second Edition.* New York US: Macmillian.

Slavin, R., Leavey, M., & Madden, N. (1984). *Combining cooperative learning.* New York US: Macmillian.

Smerdon, B. A., Burkam, D. T. & Lee, V. E. (1999). Access to constructivist and didactic teaching: who gets it? Where it is practiced? *Teachers College Record, 101,* 5-43.

Smith, C. J. & Lasett, R. (1993*). Effective classroom management: A Teachers guide.* New York: Routledge Taylor Francis Group

Smith, D.L., & McNelis, M. J. (1993). *Distance education: graduate students attitudes and academic performance.* Oslo: Oslo University

Smith, K., Johnson, D.W., & Johnson, R. (1982). *The effects of cooperative learning.* New York US: Macmillian.

Southern, W. T., & Jones, E. D. (Eds.). (1991). *Preparing the higher education sector development project - developing new model universities (NMUs) in Vietnam*. Ha Noi: Ministry of Education and Training.

Sternberg, R. J. (2006). *Cognitive psychology* (fourth edition). Thomson Wadsworth. Pp. 234-36. SBN 0-534-51421-9

Stevens, R., Madden, N., Slavin, R., & Farnish, A. (1987*). Cooperative integrated learning.* New York US: Macmillian.

Stevens, R., Slavin, R., & Farnish, A. (1991). *The effects of cooperative learning and students' comparisons of gifted and regular classes*. Journal for the Education of students. Journal of Social Psychology, 116, 277-283.

Sundberg, M.D., Dini, M.L. & Li, E. (1994). Decreasing course content improves student comprehension of science and attitudes towards science in freshman biology. *Journal of Research in Science Teaching*, 31, 679-693.

Surgenor, P. (2010). *Teaching toolkit. How students learn 1*.UCD. UCD, UCD Teaching & Learning Resources. Dublin.

Tang, H. (2000). "*Using cooperative concept mapping skill to teach ESL reading,"* PASSA, 30, pp. 77-89.

Taylor S. and France J. (1991) misconception of students and teacher in chemical equilibrium. *International Journal of Science Education, 13*(4), 487-494.

Tesser, A. (1993). On the importance of heritability in the psychological Research: The Case of Attitudes. Psychological Review, 100, 129-142.

Thanh-Pham, T. (2010b). Implementing a Student-Centered Learning Approach at Vietnamese Higher Education Institutions: Barriers under Layers of Casual Layered Analysis (CLA). *Journal of futures studies,* 15(1), 21-38

Tittle, C and Hill, R. (1967). Attitude measurement and prediction of behaviour: An evaluation of conditions and measurement techniques. *Sociometry*, Vol. 30.

Tran, V. D., & Lewis, R. (2012a). *Effects of cooperative learning on students at Giang University in Vietnam. International education studies, 5(1), 86-99. http://dx.doi.org/10.5539/ies.v5n1p86*

Tran, V.D., & Lewis, R. (2012b). *The effects of Jigsaw Learning on Students' Attitudes in a Vietnamese Higher Education Classroom. International Journal of Higher Education, 1(2), 1-13. http://dx.doi.org/10.5430/ijhe.v1n2p9*

Tran, V.D., & Lewis, R. (2012c). *The effects of jigsaw learning on students' knowledge retention in Vietnamese higher education, archives des sciences journal, 65(11), 508-530.* Moryadee, W. (2001). *Effects of cooperative learning using student teams-achievement division's technique on self-efficacy and English learning achievement of prathomsuksa five students.* M.Ed. Dissertation, Chulalongkorn University.

Van Amburgh, J., J. Devlin, J. Kirwin, and D. Qualters.(2005). *Active learning inventory tool*. Cambridge, MA: Harvard University press.

Vaughan, W. (2002). Effects of Cooperative Learning on Achievement and Attitude Among Students of Color. *The journal of educational research,* 95(6), 359-364

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, MA: Harvard University press.

Warring, D. Johnson, D. W. Marujama, G. and Johnson R, (1985). *Impact of different types of cooperative on cross – ethnic and cross-sex relationships. journal of educational psychology, 77, 53-58.*

Whicker, K. M., Bol, L., & Nunerery, J. A. (1997). Cooperative learning in the Secondary Mathematics Classroom. *The journal of educational research,* 91(1),

Wiersma W (2000). Research Methods in Education: An Introduction. Needham Heights. M.A. Allyn and Bacon.

Wiersma, W. (2000). *Research method in education: An introduction.* Needham Heights, MA: A. Pearson.

Woolnough, B. (1991). *Practical science.* Open University Press, Milton Keynes.

APPENDICES

APPENDIX A

University of Education, Winneba

Science Education Department

Data Collecting Instrument

Verification checklist

PERSONA DATA STAGE

Sex of student Age:

Male---- female---- Form

Verification checklist for Students Team Achievement Division (STAD) learning technique used by the teacher in Classroom

ENGAGEMENT STAGE

Does the teacher set the stage by providing the class with cooperative learning?

INDICATOR (tick)

- Grouping of students

  YES__ NO__

Does the teacher make the learners to be aware of how much input they have to make for the learning task?

INDICATOR (tick)

- Provision of defined parameter

  YES__ NO__
- Provision of number of points expected in a task

  YES__ NO__

EXPLORATION STAGE

Does the teacher design activities to bring a sense of ownership to the learners?

INDICATOR (tick)

- Presentation of well defined task

  YES__ NO__
- Provision of adequate and appropriate TLMs

  YES__ NO__
- Are the students confident of the provided information?

  YES__ NO__

Does the teacher encourage learners to be group interdependence (to help ensure that every learner pursues goals that are individually beneficial with the group common goal)?

INDICATOR (tick)

- Individual contribute to group

  YES__ NO__
- Analysis of individual contribution

  YES__ NO__
- Acceptance of divergent view from the group

  YES__ NO__

TRANSFORMATION STAGE

Does the teacher give learners the opportunity to reshape their information gathered by organizing, clarifying, elaborating or synthesizing learning concept?

INDICATORS (tick)

- Explanation of findings further

  YES__ NO__
- Do learners share and compare ideas? (positive feedback among the students and between the teacher and students)

  YES__ NO__

Does the teacher allow discussion and contributions from all group members to avoid few of them dominating?

INDICATOR (tick)

- Teacher goes round during period

  YES__ NO__
- Teacher direct discussion within groups

  YES__ NO__

PRESENTATION STAGE

Does the teacher give learners the opportunity to present their findings in a way that every member of the group contributes?

INDICTOR (tick)

- Presentation of facts in turns

  YES__ NO__

- Students explain other students‟ points

  YES__ NO__

Is the presentation individually and cooperatively?

INDICATOR (tick)

- Random selection of students to give reports

  YES__ NO__

- Even distribution of task and or questions

  YES__ NO__

REFLECTION STAGE

Does learners to:

- Analyze what they have learnt

  YES__ NO__

- Identify strength and weakness in the learning process?
- YES__ NO__
- Does the teacher offer constructive idea on how the learning can be improved?
- YES__ NO__
- Does teacher goes around the group as they work?
- YES__ NO__
- Is the reflection process done individually and cooperatively?
- YES__ NO__
- Are the learners given the opportunity to assess their overall performance?
- YES__ NO__

APPENDIX B

University of Education, Winneba

Science Education Department

Data Collecting Instrument

Interview on Students perception towards STAD

PERSONA DATA STAGE

Sex of student Age:

Male---- female---- Form

I. Do you have meaningful work with your peers in your group at the end of your task?

II. Can you explain the STAD technique in your own understanding for me?

III. Do you prefer this STAD technique to the Traditional teaching method?

IV. Why do you prefer this STAD technique to the usual Traditional method?

V. If you were a today, which of the teaching technique will you use and tell me why?

VI. Do think this strategy is only good for SHS level or can also be used for other levels?

VII. Can this method help make you a good at your profession?

VIII. Beside the class room, where you think that this strategy be used?

IX. Can this strategy be used for other subject besides science?

X. Can this method get rid of shyness from a person?

XI. What do you think is the reason for your improved performance in the exam?

APPENDIX C

University of Education, Winneba

Science Education Department

Data Collecting Instrument

Students' attitude towards STAD

PERSONA DATA STAGE

Sex of student Age:

Male---- female---- Form

Use this scale to answer (describe your thoughts) the questions:

1. Strongly Disagree___2.Disagree___ 3.Average___ 4.Agree____ 5. Strongly Agree_____

COGNITIVE STAGE

XII. Do you have meaningful work at the end of your task?

1. Strongly Disagree___2.Disagree___ 3.Average___ 4.Agree____ 5. Strongly Agree_____

XIII. Do you clearly express your own thoughts when using STAD?

1. Strongly Disagree___2.Disagree___ 3.Average___ 4.Agree____ 5. Strongly Agree_____

XIV. Do you have clarity in learning your lesson in this STAD strategy?

1. Strongly Disagree___2.Disagree___ 3.Average___ 4.Agree____ 5. Strongly Agree_____

XV. Does this approach enable you to participate in sharing information, making decisions, and solving problems?

1. Strongly Disagree___2.Disagree___ 3.Average___ 4.Agree____ 5. Strongly Agree_____

V. Does this approach help everyone reach their goal equally?

1. Strongly Disagree___2.Disagree___ 3.Average___ 4.Agree____ 5. Strongly Agree_____

PRESENTATION STAGE

VI. Do you have confidence as a student in answering your questions?

1. Strongly Disagree___2.Disagree___ 3.Average___ 4.Agree____ 5. Strongly Agree_____

VII. Does this learning helps in a way to make decision for your career? Do you find yourself speaking out your thought (verbal participation) without intimidation or shyness?

1. Strongly Disagree___2.Disagree___ 3.Average___ 4.Agree____ 5. Strongly Agree_____

VIII. Does the lesson become more interesting with this approach?

1. Strongly Disagree___2.Disagree___ 3.Average___ 4.Agree____ 5. Strongly Agree_____

IX. Do you feel actively involved in all activities through this approach?

1. Strongly Disagree___2.Disagree___ 3.Average___ 4.Agree____ 5. Strongly Agree_____

X. Do you feel intellectually challenged through this approach?

1. Strongly Disagree___2.Disagree___ 3.Average___ 4.Agree____ 5. Strongly Agree_____

XI. If you were to make a recommendation, which will you recommend that STAD be used for teaching?

1. Strongly Disagree___2.Disagree___ 3.Average___ 4.Agree____ 5. Strongly Agree_____

INTUITION STAGE

XII. Does this approach train you to be a good leader and a good follower?

1. Strongly Disagree___2.Disagree___ 3.Average___ 4.Agree____

5. Strongly Agree_____

XIII. Are you flexible to make your thoughts known to your friends in the group?

1. Strongly Disagree___2.Disagree___ 3.Average___ 4.Agree____

5. Strongly Agree_____

XIV. Can you make conclusion per discussion that will go in line with what your teacher wants?

1. Strongly Disagree___2.Disagree___ 3.Average___ 4.Agree____

5. Strongly Agree_____

XV. Can you interpret information from graph all by yourself?

1. Strongly Disagree___2.Disagree___ 3.Average___ 4.Agree____

5. Strongly Agree_____

APPENDIX D

DATUS INTERNATIONAL SENIOR HIGH SCHOOL

FORM I

ELECTIVE CHEMISTRY PRE-TEST---Stoichiometry I

NAME…… **SEX…….**

DATE…….SCORE…….

SECTION A: MULTIPLE CHOICE QUESTIONS: 15 MINS: 40 marks

DIRECTION: CHOOSE BY CIRCLING THE LETTER WITH THE MOST CORRECT ANSWER.

1. Amount of particles of a substance is termed as
    a. Mass
    b. Weight
    c. Mole
    d. Molar mass
2. The formula which shows the simplest whole number ratio of the type of atoms or elements in a molecule or compound is
    a. Real number
    b. Structural formula
    c. Empirical formula
    d. Molar formula
3. The mass of 0.05 mole of water, H_2O is
    a. 0.009 g
    b. 15.95 g
    c. 0.9 g
    d. 65.8 g
4. A solution whose concentration is known is termed as
    a. Molar solution
    b. Concentrated solution
    c. Standard solution
    d. A milli-solution
5. The volume occupied by 0.02 moles of a gas at s.t.p. is
    a. 0.24 dm^3
    b. 0.224 dm^3
    c. 0.44 dm^3
    d. 0.112dm^3

SECTION B: Stoichiometry I: 60 marks

ESSAY QUESTIONS: 1 HR

DIRECTION: CAREFULLY ANSWER THE QUESTIONS IN THIS SECTION. SHOW CALCULATION WHERE NEEDED, ERASURE IS NOT ALLOWED.

1. Calculate the amount of ions in 0.6 mole of Calcium chloride?

   $CaCl_2 \longrightarrow Ca^{+2} + 2Cl^{-1}$

2. Find the amount of molecules of NH_3 in 1.5 moles of NH_3.
3. Explain the term as a unit.
4. What is the mass of 0.8 mol of Na_2CO_3? (Na = 23, C = 12, O = 16)
5. An amount of 0.25 g of aspirin, $C_9H_8O_4$, is contained in 100 cm3 of a solution. How many mole and how many molecules of aspirin are in 1.0 dm3 of a solution? (L = 6.02 x 10^{-23} particles mol-1, H = 1, O = 16, C = 12,)

APPENDIX E

DATUS INTERNATIONAL SENIOR HIGH SCHOOL

FORM I

ELECTIVE CHEMISTRY POST-TEST---Stoichiometry I

NAME…… **SEX…….**

DATE…….SCORE…….

SECTION A: MULTIPLE CHOICE QUESTIONS: 15 MINS: 40 marks

DIRECTION: CHOOSE BY CIRCLING THE LETTER WITH THE MOST CORRECT ANSWER.

1. The correct formula for Aluminum tetraoxosulphate VI is
   a. Al_2SO_3
   b. Al_2SO_4
   c. $Al_2(SO4)_3$
   d. $Al_2(SO3)_3$
2. The mass concentration of a solution can be expressed in the following term except
   a. % W/V
   b. %W/W
   c. %V/V
   d. %G/V
3. What is the concentration of a solution whose volume is 10 cm^3 of 2 M NaOH which is diluted to 200 cm^3?
   a. 0.1 M
   b. 0.01 M
   c. 0.2 M
   d. 0. 001 M
4. The amount of solute that is dissolved in 1 Kg of a solvent is termed as
   a. Mole fraction
   b. Molarity
   c. Molality
   d. Solute fraction
5. This unit, g mol-1 represents the
   a. Molarity
   b. Molar mass
   c. Molality
   d. Mole

SECTION B: Stoichiometry I: 60 marks

ESSAY QUESTIONS: 1 HR

DIRECTION: CAREFULLY ANSWER THE QUESTIONS IN THIS SECTION. SHOW CALCULATION WHERE NEEDED, ERASURE IS NOT ALLOWED.

1. Hydrogen peroxide, H_2O_2 can be used as a mouth wash antiseptic. A doctor"s prescription indicates that you should dilute five times from a given before use. Calculate the amount of water in cm^3 that you have to add to 20 cm^3 of the given H_2O_2 solution.
2. Calculate the number of moles of aluminum ion and tetraoxosulphate VI ion in 50 cm^3 of 1.0 M aqueous solution of aluminum tetraoxosulphate VI, $Al_2 (SO4)_3$.
3. 2.0 g of silver trioxonitrate V, $AgNO_3$ is dissolved in 100 g of water. Calculate the mole fraction of the solution. (Ag = 47, O = 16, N = 14)

9.0 g of the hydrated salt, $CuSO_4xH2O$ was dissolved in 500 cm3 of water and its concentration in mol dm^{-3} was experimentally found to be 0.072 M. Calculate:

4. The molar mass of $CuSO_4xH_2O$
5. X, the water of crystallization

APPENDIX F

DATUS INTERNATIONAL SENIOR HIGH SCHOOL

FORM I

ELECTIVE CHEMISTRY PRE-TEST---Stoichiometry II

NAME…… **SEX…….**

DATE…….SCORE…….

SECTION A: MULTIPLE CHOICE QUESTIONS: 30 MINS: 40 marks

DIRECTION: CHOOSE BY CIRCLING THE LETTER WITH THE MOST CORRECT ANSWER.

6. The volume occupied by 0.02 moles of a gas at s.t.p. is
    e. 0.24 dm^3
    f. 0.224 dm^3
    g. 0.44 dm^3
    h. 0.112dm^3
7. The formula which shows the simplest whole number ratio of the type of atoms or elements in a molecule or compound is
    e. Real number
    f. Structural formula
    g. Empirical formula
    h. Molar formula
8. The mass of 0.05 mole of water, H_2O is
    e. 0.009 g
    f. 15.95 g
    g. 0.9 g
    h. 65.8 g
9. A solution whose concentration is known is termed as
    e. Molar solution
    f. Concentrated solution
    g. Standard solution
    h. A milli-solution
10. Point out the specie which is not an ion
    a. SO_4^{-2}
    b. NO_3^{-1}
    c. NH_3
    d. HPO_3^{-2}

SECTION B: Stoichiometry II: 60 marks

ESSAY QUESTIONS: 1 HR

DIRECTION: CAREFULLY ANSWER THE QUESTIONS IN THIS SECTION. SHOW CALCULATION WHERE NEEDED, ERASURE IS NOT ALLOWED.

1. Point out to things that quantitative test detects from the molecular formula of a compound.
2. Deduce the empirical formula of a substance which contains C, H, CL and O as its constituent elements upon analysis. C = 56%, H = 3.9%, Cl = 27%. (C = 12, H = 1, O = 16, Cl = 35.5)
3. Discuss:
   I. Law of conservation of matter
   II. Law of definite proportion
   III. Law of multiple proportion
4. Point out the mole ratio of the various compounds in the reaction:
   $Na_2CO_3 + 2HCl \longrightarrow 2NaCl + CO_2 + H_2O$
5. Calculate the volume occupied by 0.02 moles of a gas at s.t.p.

APPENDIX G

DATUS INTERNATIONAL SENIOR HIGH SCHOOL

FORM I

ELECTIVE CHEMISTRY POST-TEST---Stoichiometry II

NAME…… **SEX…….**

DATE…….SCORE…….

SECTION A: MULTIPLE CHOICE QUESTIONS: 15 MINS: 40 marks

DIRECTION: CHOOSE BY CIRCLING THE LETTER WITH THE MOST CORRECT ANSWER.

1. The correct formula for Ethanol is
   a. $H_3C\text{-}CH_2\text{-}CH_3\text{-}OH$
   b. $H_3C\text{-}CH_2\text{-}CH_2\text{-}OH$
   c. $H_3C\text{-}CH_2\text{-}CH_2\text{-}OH_2$
   d. $H_3C\text{-}CH_2\text{-}CH_3\text{-}O$
2. The mass percentage composition of sodium in sodium trioxocarbonate IV, Na_2CO_3
   a. 34.65%
   b. 55.02%
   c. 43.39%
   d. 43.00%
3. The law of definite proportion states that
   a. Pure samples contain the same element in the same proportion
   b. Sample of chemical substances contain element which combine in the same proportion by mass
   c. Pure samples of the same chemical contain the same elements combined in the same proportion of mass
   d. Chemical compounds are pure because they contain the same mass
4. A chemical equation must always be balanced. This statement means that
   a. Total mole of the reactants must equal to that of the product
   b. Reactant and product must be weighed on a beam balance
   c. Pure sample of the same chemical contain the same element combine in the same proportion by mass
   d. Number of each kind of element for the reactants must be equal to that of the products
5. What volume of AF_4 is produced in the reaction: $A_2 + 4F_2 \rightarrow 2AF_4$ when 3 dm^3 of A_2 reacts completely with F_2 at the same temperature and pressure?
   a. 22.4 dm^3
   b. 3 dm^3
   c. 6 dm^3
   d. 21 dm

SECTION B: Stoiciometry II: 60 marks

ESSAY QUESTIONS: 1 HR

DIRECTION: CAREFULLY ANSWER THE QUESTIONS IN THIS SECTION. SHOW CALCULATION WHERE NEEDED, ERASURE IS NOT ALLOWED.

1. A sample of the poisonous compound nicotine, extracted from cigarette smoke was found to contain 74.0 % C, 8.65 % H and 17.3 % N. what is the empirical formula of nicotine? (C = 12, H = 1, N = 14).
2. Find the mass composition of iron, sulfur hydrogen and oxygen in $FeSO_4.7H_2O$ (S=32, O=16, H=1, Fe=56)
3. 20.00cm^3 of 0.1 M HCl is neutralized by 18.0 cm^3 sodium hydroxide solution. Calculate the concentration of the NaOH solution. (Na=23, H=1, C=12, O=16, Cl=35.5)
4. Upon analysis a substance was found to contain 60 g of x, 24 g of oxygen and 3 g of hydrogen with a vapor density of 45 grams. Calculate its empirical and molecular formulae. (x=1, H=1, O=16)
5. Balance the following equations
   a. $Al_2O_3 \longrightarrow Al + H_2O$
   b. $LiClO_3 \longrightarrow LiCl + 3O_2$
   c. $KHCO_3 + H_2CrO_4 \longrightarrow K_2CrO_4 + CO_2 + H_2O$
   d. $Fe + O_2 \longrightarrow Fe_2O_3$
   e. $H_2SO_4 + Al(OH)_3 \longrightarrow Al_2(SO4)_3$

APPENDIX H

DATUS INTERNATIONAL SENIOR HIGH SCHOOL

FORM I

ELECTIVE CHEMISTRY PRE-TEST---Nuclear chemistry

NAME…… **SEX…….**

DATE…….SCORE…….

SECTION A: MULTIPLE CHOICE QUESTIONS: 30 MINS: 40 marks

DIRECTION: CHOOSE BY CIRCLING THE LETTER WITH THE MOST CORRECT ANSWER.

1. Electron capture includes one of the following
   a. Undergoing decay
   b. Electron from the nucleus
   c. Electron cloud surrounding the proton
   d. Electron cloud surrounding the nucleus
2. $^{230}_{90}TH \longrightarrow {}^{4}_{2}H + X$; x will have a mass number of
   a. 2
   b. 226
   c. 234
   d. 232
3. A specie with the same mass as an electron but different in charge is
   a. Electron
   b. Patron
   c. Positron
   d. Electronic
4. Radioactive decay can also be described as
   a. Nucleus transmutations
   b. Alpha particles
   c. Alpha ray
   d. Spontaneous decomposition
5. Atoms of a given element can have different number of neutron and therefore different
   a. Particles
   b. Electrons
   c. Protons
   d. Mass number

SECTION B: Nuclear chemistry: 60 marks

ESSAY QUESTIONS: 1 HR

DIRECTION: CAREFULLY ANSWER THE QUESTIONS IN THIS SECTION. SHOW CALCULATION WHERE NEEDED, ERASURE IS NOT ALLOWED.

1. Write a balance equation for Lead-205 undergoes positron emission
2. Indicated the number of protons, electrons and neutrons in each of the following
   I. Cerium-137
   II. Cadium-113
   III. $^{37}_{17}Cl$
   IV. ^{234}Pu
3. Provide a short for the followings:
   I. Alpha ray
   II. Positron
   III. Gamma
4. Indicate the number of protons and neutrons in each of the followings
   I. Oxygen-17
   II. Cesium-136
   III. ^{115}Ag
5. Discuss with an equation a rem

APPENDIX I

DATUS INTERNATIONAL SENIOR HIGH SCHOOL

FORM I

ELECTIVE CHEMISTRY POST-TEST---Nuclear chemistry

NAME…… **SEX…….**

DATE…….SCORE…….

SECTION A: MULTIPLE CHOICE QUESTIONS: 30 MINS:40 m arks

DIRECTION: CHOOSE BY CIRCLING THE LETTER WITH THE MOST CORRECT ANSWER.

1. A specie with characteristics rate of decay is termed as:
   a. Dead specie
   b. Radioisotopes
   c. Radioactive reaction
   d. Nucleus
2. The fusing of light nuclei is termed as:
   a. Reaction
   b. Radioactivity of biological specie
   c. Iron
   d. Fusion
3. A chain reaction is a
   a. Resulting reaction
   b. Half reaction
   c. Whole reaction
   d. Clear reaction
4. $^{233}_{90}Th \longrightarrow {}^{233}_{90}Pa + {}^{x}_{-1}e$, the value of x is
   a. 10
   b. -1
   c. 0
   d. 1
5. $^{238}_{92}U + {}^{1}_{0}n \longrightarrow {}^{239}_{x}U \longrightarrow {}^{239}_{93}Np + {}^{0}_{-1}e$, find the value of x
   a. 99
   b. 93
   c. 92
   d. 90

SECTION B: Nuclear chemistry: 60 marks

ESSAY QUESTIONS: 1 HR

DIRECTION: CAREFULLY ANSWER THE QUESTIONS IN THIS SECTION. SHOW CALCULATION WHERE NEEDED, ERASURE IS NOT ALLOWED.

1. Define the following terms
   I. Rem
   II. Curie
   III. Breeder reactor
   IV. Critical mass
   V. Moderator
2. Complete the balance reaction:
   a. $^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{160}_{62}Sm + {}^{72}_{30}Zn + \text{-----} + {}^{1}_{0}n$
   b. $^{239}_{94}P + {}^{1}_{0}n \longrightarrow {}^{144}_{58}Ce + \text{------} + 2\,{}^{1}_{0}n$
3. Write a balanced equation for
   a. $^{59}_{26}Fe(\alpha, \beta)^{63}_{29}Cu$
   b. $^{18}_{8}O(n, \beta)^{19}_{9}Fe$
4. Compare and contrast gamma ray and beta ray
5. The half-life of ^{239}Pu is 24,000 years. What fraction of the ^{239}Pu present in nuclear wastes generated today will be present in the year 3,000?

APPENDIX J

DATUS INTERNATIONAL SENIOR HIGH SCHOOL
FORM II
ELECTIVE CHEMISTRY PRE-TEST----Acids and Bases

NAME…… SEX…….
DATE……SCORE…….

SECTION A: MULTIPLE CHOICE QUESTIONS: 15 MINS: 40 marks
DIRECTION: CHOOSE BY CIRCLING THE LETTER WITH THE MOST CORRECT ANSWER.

1. Which of the following is a solution of PH 4.5?
    a. It reacts with CO^{-2}_3 to release carbon IV oxide
    b. It turns red litmus Paper blue
    c. It is a non-electrolyte
    d. It reacts with acid to form salt and water only
2. The basicity of an acid can be defined as the number of moles of
    a. Hydrogen on present in the acid
    b. Hydrogen ion produced by one mole of the acid
    c. Hydrogen ion in one molar solution of the acid
    d. Hydrogen ion that can neutralize one mole of the base
3. Which of the followings will form an ion upon the acceptance of a hydrogen
    a. OH^{-1}
    b. NH_3
    c. NaO^{-1}
    d. $Be(OH)^{+1}$

SECTION B: ESSAY QUESTIONS: 1 HR: 60 marks

DIRECTION: CAREFULLY ANSWER THE QUESTIONS IN THIS SECTION. SHOW CALCULATION WHERE NEEDED, ERASURE IS NOT ALLOWED.

6. Which chemical specie has the characteristics of a slippery feel?
7. Discuss three characteristics each for an acid and a base.
8. Discuss a conjugate base and a conjugate acid.
9. Name five base and their sources
10. Name five acids and their sources

APPENDIX K

DATUS INTERNATIONAL SENIOR HIGH SCHOOL
FORM II
ELECTIVE CHEMISTRY POST-TEST----Acids and Bases
NAME…… SEX…….
DATE…….SCORE…….

SECTION A: MULTIPLE CHOICE QUESTIONS: 15 MINS: 40 marks
DIRECTION: CHOOSE BY CIRCLING THE LETTER WITH THE MOST CORRECT ANSWER.

4. Which of the following is a solution of PH 14?
    e. It reacts with acid to release sodium
    f. It turns red litmus Paper blue
    g. It is a non-electrolyte
    h. It reacts with acid to form salt and water only
5. The basicity of an acid can be defined as the number of moles of
    e. Hydrogen on present in the acid
    f. Hydrogen ion produced by one mole of the acid
    g. Hydrogen ion in one molar solution of the acid
    h. Hydrogen ion that can neutralize one mole of the base
6. Which of the followings is an acid salt?
    a. $MgCl_2$
    b. Na_2SO_4
    c. $KHCO_3$
    d. $NaNO_3$
7. Buffer solutions are important in agriculture and medicine because
    a. They maintain low PH value
    b. They maintain high PH value
    c. Living things do not need constant PH value
    d. The PH value of living things must be kept fairly constant
8. Acetic acid is a weal acid with the pKa value of 4.70. Calculate the pH of a 0.10 M solution of the acid.
    a. 2.85
    b. 1.00
    c. 4.60
    d. 4.85

SECTION B: ESSAY QUESTIONS: 1 HR: 60 marks

DIRECTION: CAREFULLY ANSWER THE QUESTIONS IN THIS SECTION. SHOW CALCULATION WHERE NEEDED, ERASURE IS NOT ALLOWED.

1. Hydrocyanic acid, HCN, is ionized in water by the reaction:
   $HCN \longrightarrow H^{+1} + CN^{-1}$

   What is the conjugate base of HCN?
2. Calculate the values of H^{+1} and OH^{-1} in a neutral solution at 25^{o} C.
3. Calculate the concentration of H^{+1} in
   a. Solution in which OH^{-1} is 0.010 M
   b. Solution in which OH^{-1} is 2.0×10^{-9} M
4. Calculate the concentration of OH^{-1} in a 0.15 M solution of NH_3. ($kb = 1.8 \times 10^{-5}$)
5. Calculate the pH of a solution of H_2CO_3 whose concentration is 0.0037 M.

]

APPENDIX L

DATUS INTERNATIONAL SENIOR HIGH SCHOOL
FORM II
ELECTIVE CHEMISTRY PRE-TEST----Oxidation-reduction reaction
NAME…… SEX…….
DATE…….SCORE…….

SECTION A: MULTIPLE CHOICE QUESTIONS: 15 MINS: 40 marks
DIRECTION: CHOOSE BY CIRCLING THE LETTER WITH THE MOST CORRECT ANSWER.

9. The gain of electron is
   a. Hydro genesis
   b. Electricity
   c. Oxidation
   d. Reduction
10. The oxidation state of manganese in MnO_4^{-1} is
   a. 2
   b. 5
   c. 7
   d. 4
11. A specie which is oxidized will become more
   a. Atomic
   b. Negative
   c. Positive
   d. Hydrogen
12. A branch of science in which reaction electron is transferred from one substance to another is termed as:
   a. Chemistry
   b. Nuclear chemistry
   c. Electrochemistry
   d. Double replacement reaction
13. A specie which caused a reduction is called
   a. Reducing anode
   b. Reducing agent
   c. oxidizing cathode
   d. Oxidizing agent

SECTION B: Oxidation-reduction reaction

ESSAY QUESTIONS: 1 HR: 60 marks

DIRECTION: CAREFULLY ANSWER THE QUESTIONS IN THIS SECTION. SHOW CALCULATION WHERE NEEDED, ERASURE IS NOT ALLOWED.

1. With a good example, discuss half reaction
2. What is oxidizing agent
3. Analyze the reaction by telling the specie which is oxidized or reduced and state the oxidation state of each specie:
   $Fe + 2HCl \longrightarrow FeCl_2 + H_2$
4. Give the oxidation state of the underlined species:
   a. $\underline{Mn}O_4^{-1}$
   b. $H\underline{Cl}O$
   c. $H_2\underline{S}O_4$
   d. $H\underline{Cr}_2O_7^{-1}$
   e. $\underline{Pb}O_2$
5. Balance the reaction:
   $F_2 + Br_2 \longrightarrow BrF_3$

APPENDIX M

DATUS INTERNATIONAL SENIOR HIGH SCHOOL
FORM II
ELECTIVE CHEMISTRY POST-TEST----Oxidation-reduction reaction
NAME…… SEX…….
DATE……SCORE…….

SECTION A: MULTIPLE CHOICE QUESTIONS: 15 MINS: 40 marks
DIRECTION: CHOOSE BY CIRCLING THE LETTER WITH THE MOST CORRECT ANSWER.

1. During the rusting of iron oxygen acts as
   A. Reducing agent
   B. A catalyst
   C. An electron donor
   D. Oxidizing agent
2. Which of the followings are Redox reactions
   I. $2Mg + O_2 \longrightarrow 2MgO$
   II. $2FeCl_2 + Cl_2 \longrightarrow 2FeCl_3$
   III. $4HCl + O_2 \longrightarrow 2Cl_2 + 2H_2O$
   IV. $2PbO + C \longrightarrow 2Pb + CO_2$
   a. II, I
   b. I, II, III, IV
   c. IV, III
   d. I, II, IV
3. Point out the ones that oxidation reactions
   I. $Zn \longrightarrow Zn^{+2}$
   II. $Fe^{+2} \longrightarrow 2FeCl_3$
   III. $2Cl^{-1} \longrightarrow Cl_2$
   IV. $4OH^{-1} \longrightarrow H_2O + O_2$
   a. II, I
   b. I, II, III, IV
   c. III, I
   d. I, II, IV
4. In which of the following redox reaction does oxidation occur?
   I. $Mg^{+2} + 2e^- \longrightarrow Mg$
   II. $Na \longrightarrow Na^{+1} + e^{-1}$
   III. $H_3O^{+1} + OH^{-1} \longrightarrow 2H_2O$
   IV. $CuSO_4 + Zn \longrightarrow ZnSO_4 + Cu$
   a. I and II
   b. II and IV
   c. I, II, III
   d. I, II, III, and IV

5. Which element is reduced in the reaction? $5Fe^{+2} + MnO^{-1}_4 + 8H^{+1} \longrightarrow 5Fe^{+3} + Mn^{+2} + 4H_2O$
   a. Hydrogen
   b. Manganese
   c. Oxygen
   d. Iron

APPENDIX N

DATUS INTERNATIONAL SENIOR HIGH SCHOOL
FORM II
ELECTIVE CHEMISTRY PRE-TEST----Reaction of gases
NAME…… SEX…….
DATE…….SCORE…….

SECTION A: MULTIPLE CHOICE QUESTIONS: 15 MINS: 40 marks
DIRECTION: CHOOSE BY CIRCLING THE LETTER WITH THE MOST CORRECT ANSWER.

14. The molecules of gases are
    a. Transparent and bluish
    b. Cool upon touch
    c. Always rising
    d. Always in random motion
15. Boyles‟ law is concerned with pressure and
    a. Heat
    b. Volume
    c. Temperature
    d. Color
16. Whose hypothesis states equal volumes of gases at the same temperature and pressure contained equal numbers of molecules
    a. Charles
    b. Boyle
    c. Graham
    d. Avogadro
17. At standard temperature, and pressure the volume of a gas is
    a. 20.5 dm^3
    b. 22.4 dm^3
    c. 25.0 dm^3
    d. 4.0 dm^3
18. What will be the pressure of a 1 dm^3 gas at an initial pressure of 760 mmHg and later increased to 1520 mmHg?
    a. 2 dm^3
    b. 0.5 dm^3
    c. 1.5 dm^3
    d. 10 dm^3

SECTION B: Oxidation-reduction reaction

ESSAY QUESTIONS: 1 HR: 60 marks

DIRECTION: CAREFULLY ANSWER THE QUESTIONS IN THIS SECTION. SHOW CALCULATION WHERE NEEDED, ERASURE IS NOT ALLOWED.

1. What pressure, in atm, is exerted by a mixture of 2.00 g of H_2 and 8.00 g of N_2 at 273 K in a 10.0-L
2. If a 0.20-L sample of o_2 at 0^OC and 1.0 atm pressure and a 0.10-L sample of N_2 at 0^oC and 2.0 atm pressures are both placed in a 0.40-L container at 0^oC, what is the total pressure in the container?
3. A large natural-gas storage tank is arranged so that the pressure is maintained at atm. On a cold day in December, when the temperature is – 15^oC (4^oF), the volume of gas in the tank is 28,500 ft^3 . What is the volume of the same quantity of gas on a warm July day when the temperature is 31^oC (88^OF)?
4. The pressure of nitrogen gas in a 12.0-L tank at 27^oC is 2300 1b/$in.^2$.What volume would the gas in this tank have at 1 atm pressure (14.7 1b/$in.^2$) if the temperature remains unchanged?
5. Convert a pressure of 735 mm Hg to kpa.

APPENDIX O

DATUS INTERNATIONAL SENIOR HIGH SCHOOL
FORM II
ELECTIVE CHEMISTRY POST-TEST----Reaction of gases
NAME…… SEX…….
DATE…….SCORE…….

SECTION A: MULTIPLE CHOICE QUESTIONS: 15 MINS: 40 marks
DIRECTION: CHOOSE BY CIRCLING THE LETTER WITH THE MOST CORRECT ANSWER.

1. Convert 0.605 atm to millimeter of mercury mmHg
   a. 400 mmHg
   b. 450 mmHg
   c. 500 mmHg
   d. 490 mmHg
2. A solution which at a given temperature can contain much solute as it can retain the presence of undisclosed solute is known as
   a. Unsaturated solution
   b. Saturated solution
   c. Supersaturated solution
   d. An ideal solution
3. A mixture of ammonium chloride and sodium chloride can be separated by
   a. Evaporation
   b. Recrystillization
   c. Filtration
   d. Decantation
4. A solution which has the ability to dissolve more solute at a particular temperature
   a. Supersaturated solution
   b. Unsaturated solution
   c. Half saturated solution
   d. Whole saturated
5. At the same temperature KNO3 is more soluble than NaCl. A mixture of the two can be separated by
   a. Evaporation
   b. Crystallization
   c. Chromatography
   d. Distillation

SECTION B: Oxidation-reduction reaction

ESSAY QUESTIONS: 1 HR: 60 marks

DIRECTION: CAREFULLY ANSWER THE QUESTIONS IN THIS SECTION. SHOW CALCULATION WHERE NEEDED, ERASURE IS NOT ALLOWED.

1. What pressure, in atm, is exerted by a mixture 2.00 g of H_2 and 8.00 g of N_2 at 273 K in a 10.0 L vessel?
2. What is the density of carbon dioxide gas at 745 mm Hg and 650 C?
3. Discuss Charles‟ law , include a graph
4. If an unknown gas effuses at a rate that is only 0.468 times that of oxygen, O2 at the same temperature, what is the molecular weight of the unknown gas?
5. Calculate the pressure, in Pascal, exerted on the fluid in a hypodermic syringe if the diameter of the plunger is 1.0 cm and a downward force of 3.0 N is applied.

APPENDIX P

Test-Retest Reliability Index

Pearson Product Moment Correlation Formula

$$RXY = \frac{\sum XY - \sum X^{\text{“}} Y^{\text{“}}}{N.SDX.SDY}$$

Nb. RXY = Reliability Index

X = Score of the first test

Y = Scores of the second test

N = Total number of students

SDX = Standard deviation of X series (marks of the first test)

SDY = Standard deviation of Y series (marks of the second test)

$X^{\text{“}}$ = Mean of the X values

$Y^{\text{“}}$ = Mean of the Y values