UNIVERSITY OF EDUCATION, WINNEBA

THE EFFECT OF STUDENT TEAMS ACHIEVEMENT DIVISIONS (STAD) COOPERATIVE LEARNING ON SENIOR HIGH SCHOOL STUDENTS' PERFORMANCE IN THE MOLE CONCEPT

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DECLARATION

Students' Declaration

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

SIGNATURE:.....................................

DATE:...

Supervisor's Declaration

I, PROF. JOHN K. EMINAH hereby declare that the preparation and presentation of this thesis was supervised by me in accordance with the guideline on supervision of thesis as laid down by the University of Education, Winneba.

SIGNATURE:..

DATE:...

DEDICATION

To the Amighty God who has been the source of my strength throughout this work.

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ABSTRACT

This research was designed to investigate the effect of Student Teams Achievement Divisions (STAD) cooperative learning on students' performance in the mole concept among selected senior high schools. The objectives of the study were to determine: the ideas students have on the mole concept, students' performance in the mole concept when taught with STAD cooperative learning, the difference in performance between the male and female students taught with STAD and the perceptions of the students of the use of STAD in the chemistry lessons. The quasi-experimental design was adopted for the study. A simple random sampling and purposive sampling were used to select two senior high schools for the study. A total of 65 students participated in the study.Thirty (30) for the control group who were taught the mole concept with the traditional instructional approach and thirty five (35) for the experimental group who were taught the same concept with the (STAD) cooperative learning approach. The instrument that were used to collect data were pre-test, post-test, questionnaires and interview. The test items were piloted in other schools with similar characteristics as the research group and the reliability quoefficients were found to be suitable for the study. The data collected were mainly analysed using central tendencies, frequency distribution table and t-test. Hypotheses were accepted or rejected at significant level of 0.05. The results of the study revealed that STAD cooperative learning had significant impact and enhanced the academic achievement and performance of students in the mole concept. The results also showed that both the male and female students performed equally in the mole concept when taught with the STAD instructional approach.This means that STAD impacted male and female equally in their study of the mole. It was again revealed by the results of the study that students have high positive perception of STAD cooperative instructional approach and prefer it to the traditional instructional approach. The results of this study would be beneficial to integrated science and chemistry teachers, curriculum planners and developers as well as policy makers in improving the teaching and learning process and achievement in the mole concept.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter deals with the introductory part of the study and it covers background to the study, statement of the problem, purpose of the study, objectives of the study and research questions. It also looked at significance of the study, delimitation, limitations and the organization of the study.

1.1 Background to the study

Understanding of how students learn can help teachers to device effective strategy for teaching (Ali, Anwer & Jaffar, 2015). Therefore, teachers should design learning activities that can better address the individual needs of students. Hence major aim of teaching and learning process to upgrade learner knowledge which is reflected in achievement and retention of what is learnt is achievement in terms of grades, as it is a sole measure of learning in many cases. To achieve this target, teachers use of diverse teaching methods is recommended. These methods are usually adopted to enhance students' learning (Ali, Anwer & Jaffar, 2015).

The methods include scaffolding instruction, problem solving instruction, mind mapping instruction, differentiating instruction etc. Thus, scaffolding is an instructional strategy that is used to move students progressively toward stronger understanding and, ultimately, greater independence in the learning process; while problem-solving strategy is an instructional strategy that is used to make students to be active participant in the teaching learning process where he thinks out solution to problems by himself while he is assisted by the teacher who only guides by giving hints or suggestion as the need arises; in differentiated strategy, different types of grouping are used to foster students' learning according to their pace and understanding; while mind mapping strategy is an instructional strategy that uses diagram to represent words, ideas, tasks or other items linked to and arranged radially around a central key word or idea; it is used to generalized, visualized, classify ideas and as an aid in study, organization, problem solving and decision making (Ali, Anwer & Jaffar, 2015).

In spite of effort of the researchers into the strategies of improving the perennial poor achievement of students in chemistry, chief examiners yearly reports have continued to highlight students' weakness in chemical arithmetic; (i) inability of students to write chemical formulae; (ii) poor mathematical skills; (iii) inability of students to determine mole ratio and (iv) inability of students to balance chemical equations from stoichiometric equations (WAEC Chief Examiner's Report, 2016). Further researches in support of the WAEC Chief Examiner's reports showed that students persistently perform poorly in chemistry owing to poor problem-solving in stoichiometry (Opara, 2013; Udosoro, 2017; Badru, 2014).

The West African Examination Council (WAEC) chief examiner's report (2016 & 2017) indicated that many students were unable to perform some stoichiometric calculations well due to their inability to apply the mole concept. During the researcher's practice as a chemistry teacher in Accra Senior High School for the pasts ten years, it has been observed in assignments, tests and examinations conducted for different batches of students, that they performed poorly in the mole concept.

Researchers have continued to seek better ways of teaching Chemistry in order to maximize meaningful learning; to identify the causal variables for the repeated failure and to identify the learning strategies employed by students (Bello & Oke 2017).

Researchers in the field of education are trying to enhance the learning outcomes of the students by introducing innovative approaches. Among the innovative approach is cooperative learning. Cooperative learning has been well documented in the educational research as a successful pedagogy to improve students' academic achievement. It is a fundamental principle of cooperative learning that group members are linked together in such a way that they cannot succeed unless everyone succeed, they will actively assist each other to make sure that the assignment is done and the purpose of the group achieved (Deutsch, 1949). Cooperative learning exists when students work together to accomplish shared learning goals. Cooperative learning is a classroom technique (Agarwal, 2010). It is a learner centered instructional approach that is usually guided by a facilitator. Study of Rienties,Tempelaar, Bossche, Gijselaers and Segers, (2019) opined that studying together is more important to be successful rather than studying alone. Different cooperative learning strategies can be employed to help low ability students to improve achievement, who had difficulties making success in the traditional classroom. Ajaja and Eravwoke (2012) reaffirmed the ability of cooperative learning when used as an instructional strategy to bring about significant improvement in students' achievement in school science subject. More so, the study of Ajaja and Mezieobi (2018) showed that students performed highly using cooperative learning instructional strategy irrespective of ability level. The results of the study also indicated that both the male and female students benefited equally from the cooperative learning strategy.

In cooperative learning, students are given a task and work together to accomplish this task. Each individual has responsibilities and is held accountable for aiding in the completion of the assignment; success therefore is dependent on the work of everyone in the group. In addition to learning from each other, students also learn how to work as part of a team and have others depend on them.

Attitudes and values of learners are formed through social interaction. Most of our attitudes are formed by discussing what we know with others. Continuing in this manner, we exchange our information and knowledge with that of others who have acquired theirs in different ways. This exchange shapes our views and perspective. In students centered instructional approach, using students' ideas means incorporating students' experiences, points of view, feelings and problems in to the lesson by making the student the focus of the learning. Research by Johnson and Johnson (1999) on learning together and alone showed that cooperative learning enhanced more positive attitude towards learners and teachers.

The knowledge of chemistry is necessary for understanding composition, properties and behaviour changes of matter that form the environment. The teaching of chemistry is also aimed at developing scientific concepts, principles and skills in the learners. Chemistry teaching has often focused more on transmission of information than on knowledge construction in small groups. Students hardly want to think for themselves and will rather want to be told the right answers to solution.

Meaningful learning occurs when individuals choose to relate new knowledge to relevant concepts they already know. This calls for commitment on the part of the learner to link new concepts with higher order and more inclusive concepts that are already understood by the learner that can serve to anchor new learning. Meaningful learning can be enhanced based on positive attitudes of the learner. Development of instructional strategies that actively engage learners in the process of knowledge acquisition can help translate new conception into the classroom practice.

The mole concept as one of the topics aimed at equipping students with some cognitive skills poses a massive challenge to students. Shadreck and Enunuwe (2018) recognized the mole concept as one of the most difficult topics to teach and learn within the chemistry curriculum due to its abstract, theoretical nature.

Students who do not fully understand the mole concept experience difficulties in understanding the subsequent topics (Kamarudin, 2014). For instance, stoichiometry which include volumetric calculations and concentration of solutions. There is the need for teachers to use an instructional strategy that helps learners overcome these challenges so as to improve their performance. Findings indicated by Indriyanti (2016), showed that students fail to construct meaningful understandings of the mole concept for the following reasons: inconsistency between the instructional approaches of the textbook and teacher; confusing mole concept vocabulary; students' math anxiety and proportional reasoning ability; learners' cognitive levels; and lack of practice in problem solving .

Active engagement of the learner with the learning environment, focusing on the learner rather than the teacher, and acknowledging and challenging learners’ understanding and intellectual development are useful pedagogical strategies that can facilitate meaningful learning (Ayoade, 2012). A major factor accounting for the persistent poor performance in the mole concept has been largely blamed on students’ misconceptions of the rather abstract concept. These misconceptions are often resistant to instructions and become obstacles to the acquisition of scientific concepts. Misconceptions pertaining to this more abstract concept result from some instructional experience within or outside the classroom, including independent study. In a cooperative learning environment, learners are encouraged to be the center of learning and learn together. Learners will not enjoy learning if it happens in isolation (Bruner & Jerome, 2016). As such, learners improve their critical thinking and intellectual skills by learning from one another (Ibrahim, 2013).

Various forms of cooperative learning have been developed by researchers over the years that can be adapted to suit different philosophies of teachers. These include Students Teams Achievement Division (STAD), Teams-Games-Tournaments (TGT), Jigsaw Procedure etc. Students Teams Achievement Division (STAD) is a cooperative learning technique that has been extensively researched and assessed specifically on academic achievements, attitudes, social interactions and interpersonal relationships (Balfakih, 2003; Bernaus & Gardner, 2008; Slavin 1990; Kagan, 1994; Johnson & Johnson, 1998, 1999; Tarim & Akdeniz, 2008). STAD is one of the simplest forms of all cooperative learning techniques. Research studies showed that STAD as a teaching technique has been applied with great success in various science research projects. For instance, Adesoji and Ibrahim (2009) and Balfakih (2003) in Chemistry, Ho and Boo (2007) in Physics, Pei-wen (2001), Van-Wyk (2010), and Keramati (2010) in Mathematics, reported that STAD cooperative learning is more effective than the traditional instructional strategy. Since the mole concept has been identified as one of the difficult concepts to learn and teach within the chemistry curriculum due to its abstract and theoretical nature, the cooperative learning approach which seek to improve critical thinking skills and greater enjoyment of the learning process was therefore considered as a good instructional strategy that can be of great help to students to overcome this challenge of poor performance in the mole concept.

1.2 Statement of the problem

The United Nations Educational Scientific and Cultural Organization (UNESCO) and the International Union of Pure and Applied Chemistry (IUPAC) have organized numerous international meetings to promote inexpensive experimental-based teaching in chemistry (Bello, 2018). However, mole concept which is one of the topics aimed at equipping students with some cognitive skills and practical skills poses a massive challenge to students. Students who do not fully understand the mole concept experience difficulties in understanding related concept. For instance, students who do not fully understand the mole concept find it difficult to understand topics like stoichiometry which include volumetric calculations and concentration of solutions.

Secondary school teachers usually prefer teaching with the traditional techniques. Instead of concept learning, most teachers rather use problem solving approaches in their instruction. They are of the view that the chemistry syllabus is loaded and for the students to be able to do well in their West African Secondary School Certificate Examination (WASSCE), such instructional approaches are appropriate. This phenomenon of focusing on teaching students to solve problem for examination is perceived as a real barrier to conceptual learning.

Through the researcher's own experience, observation and dialogue with some colleague teachers and students (in Accra Senior High School where the researcher teaches) and other neighbouring schools, she found evidence of students' difficulty with the mole and associate concepts. This has been one of the contributing factors to the poor performance of students in tests and examinations especially in the mole concept. Cooperative learning techniques have been shown to enhance students' learning and social relations relative to a whole class method of teaching (Adeyemi, 2002) and also increased retention of new learning, improved critical thinking skills, greater enjoyment of the learning process, and preparation for engaging in successful teamwork in later life. For this reason the STAD, a cooperative learning strategy was utilized in this study to determine whether or not it would result in improved performance in the mole concept.

1.3 Purpose of the study

This study sought to investigate the effect of Student Teams Achievement Divisions (STAD) cooperative learning on Senior High School students' performance in the mole concept.

1.4 Objectives of the study

The objectives of the study were to:

1. assess ideas students possessed on the mole concept.
2. assess the performance of students in the control and experimental group after treatment.
3. determine mean difference in performance between the male and female experimental group students after the treatment.
4. assess perceptions of the experimental group students of the use of Student Teams-Achievement Divisions cooperative learning approach for the chemistry lessons.

1.5 Research Questions

The following research questions were addressed in the study:

1. What ideas do the students possess on the mole concept?
2. To what extent is the mean performance of an experimental group students in the mole concept greater than that of a control group after treatment?

3. What is the mean difference in performance between the male and female experimental group students after the treatment?
4. What are the perceptions of the experimental group students of the use of STAD cooperative learning for the chemistry lessons?

1.6 Null Hypotheses

Null hypothesis ($H_{0\ 1}$):

There is no significant difference between the mean scores of students who were taught by STAD cooperative learning and those who were taught by the traditional teaching approach.

Null hypothesis ($H_{0\ 2}$)

There is no significant difference between the mean scores of males and females students who were taught by the STAD cooperative learning.

1.7 Significance of the study

This study was significant because it provides empirical evidence on the effect of STAD cooperative learning on students' performance in the mole concept. It also provides insight into students' pereceptions and motivation towards the use of STAD cooperative instructional approach in learning chemistry as well as the benefit of peer-cooperation in their academic achievements. This outcome is believed would be beneficial to students, teachers and policy makers of education as a whole.

1.8 Delimitations of the study

This study was confined to only two senior high schools in the Korley-Klortey Municipal of the Greater Accra Region. It was also delimited to the concept of mole in chemistry and only STAD cooperative learning and traditional teaching strategy were discussed in this study.

1.9 Limitations of the study

This research had some limitations. Test anxiety on the part of the students could possibly affect their scores on the pre-test and post-test. Also, limited resources regarding time and finances did not allow the researcher to carry out the study in many senior high schools. Finally, the information collected using the questionnaire might not be totally valid as the use of questionnaire did not offer the opportunity to collect additional information through probing and prompting questions because the respondents were to respond to only the items on the questionnaire.

1.10 Definition of Terms

Cooperative learning: It is a teaching strategy that places students in small groups, offering students the opportunity to complete a task together to increase their own and each other's learning.

Students Team Achievement Division: It is a cooperative learning strategy in which small groups of learners with different levels of ability work together to accomplish a shared learning goal.

Traditional instructional method: The traditional instructional method also called the conventional method of teaching as used in this study refers to the method of teaching that promote the supremacy of the teacher. The teacher followed the drill and rote method of memorizing. In this method, children learn through repetition and memorization.

Students: A person who is enrolled in school and studying chemistry at the time of the study.

Mole concept: The mole as a concept is the amount of substance that contains as many elementary particles as there atoms in 12 g of carbon-12

1.11 Abbreviation and Acronyms

STAD	Student Teams Achievement Divisions
SHS	Senior High School
WAEC	West African Examination Council
WASSCE	West African Secondary School Certificate Examination
UNESCO	United Nations Educational, Scientific and Cultural Organization
IUPAC	International Union of Pure and Applied Chemistry
P T	Performance Test
SPSS	Statistical Package for Social Scientist
CL	Cooperative Learning
ZPD	Zone of Proximal Development

1.12 Organization of the Study Report

The report of the study was organized into five chapters. The first chapter which is the introduction of the study covered the background to the study, statement of the problem, purpose of the study, research questions, the significance of the study, delimitation of the study, limitations of the study and definitions of terms.

The second chapter delved in to the review of related literature to the study. It begins with the chapter overview and then a review of related literature under various strands. Chapter three consists of research methodology. It is divided into the overview, the design of the study, population and sampling procedure, instrumentation, validity of the instruments, the reliability of the instruments, data collection procedure and data analysis. Chapter four contains results and discussions of the study. Chapter five covers the summary of findings, conclusion, recommendations, and suggestions for further study. References and appendices were also added.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 Overview

This chapter discussed the review of related literature on cooperative learning, history of cooperative learning, categories of cooperative learning and benefit of cooperative learning. Differences between cooperative learning group and traditional learning group were also discussed. Again, modern methods of cooperative learning, component of STAD cooperative learning, its merit and demerit were also reviewed. Theoretical framework, empirical and conceptual frame work were also covered. Finally, the mole concept, difficulties students have in learning the mole concept and the use of STAD cooperative learning strategy in enhancing students' understanding of the mole concept were also covered.

2.1 Definition of Cooperative Learning

There are many definitions of cooperative learning in early literature. Cooperative learning is an instructional methods in which students work in small, mixed-ability groups to achieve some sort of group goal (Slavin, 1987). Cooperative learning is an instructional strategy that enables small groups of students to work together on a common assignment (Lewis, 2019). The parameters often vary, as students can work collaboratively on a variety of problems, ranging from simple mathematics problems to large assignments such as proposing environmental solutions on a national level. Another definition provided by Teed, McDaris and Roseth (2018) is that cooperation is not having students sit side-by-side at the same table to talk with each other as they do their individual assignments. Cooperation is not assigning a report to a group of students where one student does all the work and the others put their names on the product as well. Cooperation involves much more than being physically near other students, discussing material, helping, or sharing material with other students. There is a crucial difference between simply putting students into groups to learn and in structuring cooperative interdependence among students.

Cooperative learning is a classroom technique (Agarwal, 2010). It is a learner centered instructional approach that is usually guided by a facilitator. This type of leaning is organized in such a way that members of a group have the opportunity of interacting with one another with the aim of mastering a particular concept. Gillies (2016) mentioned that, cooperative learning is a pedagogical teaching approach that enhances social interaction and learning among learners across different subject areas. It creates conducive atmosphere for learner to work in group to achieve tasks. Cooperative learning therefore is a teaching strategy that places students in small groups, offering students the opportunity to complete a task together to increase their own and each other's learning. By using this strategy, students can encourage each other to work together on academic tasks as well as help each other with classroom assignments since the essential feature of cooperative learning is that the success of one student helps other students to be successful (Slavin, 2011).

2.2 History of Cooperative Learning

The idea of cooperative learning goes far back in history. According to Johnson, Johnson, and Smith (1991), the concept of peer learning was described as early as the first century by Marcus Fabius Quintilian, who advocated that peer learning could benefit the students. The idea of peer learning was also described in the Talmud, which explicitly stated the importance of having a learning partner to facilitate learning (Chiu, 2000). Comenius argued that students would learn by teaching and being taught by other students (Johnson, Johnson, & Smith, 1991). In the late 18th century, Joseph Lancaster and Andrew Bell opened schools in England that used peer learning groups extensively (Johnson, Johnson, & Smith, 1991). The development of these schools appeared to have marked a milestone for peer learning because, not long afterwards, the idea of peer learning was brought across the Atlantic Ocean when a Lancastrian school was established in New York City in 1806. In the 1970s, several research groups in the United States began independently to develop and examine cooperative learning methods in classroom settings (Slavin, 1991b). These groups included Elliot Aronson and his associates (University of Texas at Austin) who developed the Jigsaw method, David Johnson and Roger Johnson (Cooperative Learning Center at the University of Minnesota) who developed Learning Together, as well as David DeVries, Keith Edwards and Robert Slavin (Center for Social Organization of School at the 23 Johns Hopkins University) who developed Teams-Games-Tournament and Student Teams Achievement Divisions.

It is worth noting that, before 1970, almost all the reported studies on cooperative learning had been college-based. Beginning in the earlier 1970s, nonetheless, the positive effects of cooperative learning attracted K-12 educators' attention. The tide turned. Studies at elementary and secondary levels became robust while those at college level became limited. It was not until after the 1990s cooperative learning at college level began to regain attention from researchers and educators (Johnson, Johnson, & Smith, 1998).

Cooperative learning strategy requires students cooperation and interdependence in its task, goal and reward structure. It requires students to be actively engaged in discussions, debates, tutoring and team work. Students must coordinate their efforts to complete given task. Cooperative learning aims at developing the cognitive and social skills of the learner. Cooperative learning model was developed to achieve at least three instructional goals; academic achievement, tolerance and acceptance of diversity and social skills development. Cooperative learning lessons are characterized by the following features: Students work in teams to master learning goals, Teams are made up of high, low and average achieving students, and whenever possible, teams include a racial, cultural, and gender mixed. Reward systems are oriented to the group.

2.3 Differences between cooperative learning and collaborative learning

The term cooperative learning and collaborative learning are used interchangeably by the public and some educational practitioners. (Adams, 2000, Walling, 2007). According to oxford dictionary and Thesaurus, cooperation means to toil together for a common end and collaboration means to work in partnership. The two definitions are alike, however, cooperative learning and collaborative learning are different in many ways. Collaborative learning stresses student self- governance over structure while cooperative learning components like mutual interaction and individual responsibility situate the learners to participate actively in group activities and lesson competition among teammates.

Fundamental elements of cooperative learning ensure that every group member makes contributions. Collaborative learning does not emphasize these elements because students have powers to take decisions by themselves. To ensure mutual interaction and accountability, instructor keeps under observation learners' deportment in cooperative learning group; however collaborative teacher does not take much look at that. Cooperative and collaborative learning can be differentiated based on group formation.

Cooperative group is organized, systematized and commonly requires prior instructor's groundwork and collaborative group commonly rested on the learners' concerns.

2.4 Elements of cooperative learning

According to Johnson et. al (1998) five elements are required in cooperative learning. These are explained as follows:

1. Positive interdependence; team members perceive that they are dependent on other members of the group to complete the group's goal, task or assignment.
2. Individual accountability; the quality and quantity of each member's contribution to learning is assessed and provided to the group and the individual. Each student, as well as the group is responsible for learning the assigned task.
3. Face-face promotive interaction; team members promote each other's productivity by helping, sharing and encouraging efforts to produce and learn. Group members explain, discuss and teach what they learn to team-mates.
4. Interpersonal/social and small group skills; team members purposefully learn social skills necessary to function effectively as a learning community. These team skills relate directly to job-performance skills, such as instructorship, decision-making, trust building, communication and conflict-management.
5. Group processing; group members reflect on their progress as a learning team and define strategies for improvement. Instructors also monitor the performance of the group and provide feedback to the group.

2.5 Categories of Cooperative Learning

Three main categories of cooperative learning exist Chen & Lin (2020), Gillies, Ashman & Terwel (2007). These are formal cooperative learning, informal cooperative learning and cooperative base groups.

2.5.1 Formal cooperative learning

This is a category of cooperative learning where learners work together for a class period for several weeks in order to achieve set goals and specific tasks. It enhances active participation of learners in academic work. The work can be seen in the form of searching for information, organizing, explaining, interpreting and summarizing or searching on a given subject matter. Formal cooperative goals can also be seen in the form of report writing and conducting of experiments. Members of formal cooperative learning groups discuss how effectively and collaboratively they can work together towards the achievement of the goals of the group and how they can improve in the future. Selection of objectives, determination of group size, assignment of various roles and responsibilities, room arrangement and materials required for successful lessons and decisions are made by the facilitators of formal cooperative learning.

Other responsibilities of facilitator within the ambient of formal cooperative learning include:

1. Explaining task to be performed, clear specification of assignment as well as concept and strategies.
2. The facilitator spelt out criteria and social skills required for success of the group.
3. The facilitator intervenes and aids the groups towards achievement of goals.

4. Data collection, assessing and evaluation of the groups is also done by the teacher during formal cooperative learning.

2.5.2 Informal cooperative learning

It is ad-hock group that last for a whole class period. Informal cooperative learning groups are often organized so that students engage in three- five minutes focused discussions before and after lecture and two-three minute turn to-your partner discussions throughout a lecture. This group is created for the purpose of carrying out short duration. This group can be formed during lectures or demonstration in order to focus learners' attention to what they are currently learning. Informal cooperative learning group help to outline the expectations and scope of the lesson. It ensures that learners are actively involved in a lesson. Informal cooperative group also provides a means for closure to an instructional session (Kopparla & Goldsby, 2019).

2.5.3 Cooperative base group

These are long-term heterogeneous cooperative learning groups with stable membership. Base groups give the support, help, encouragement and assistance each member needs to make academic progress and develop cognitively and socially in healthy ways. These groups are permanent that is lasting from one week to several years and provide the long-term, caring peer relationships necessary to influence members consistently to work hard in school. The use of base groups tends to improve attendance, personalize the work required and the school experience and improve the quality of learning. Positive development is enhanced when base groups are given the responsibility for conducting a year-long service project to improve the school.

The three types of cooperative learning complement and support each other. A typical ninety-minute class session for example begins with a base group meeting of five to ten minutes in which members welcome each other and check each member's homework to ensure it is completed and understood. Secondly, the instructor gives a short lecture with informal cooperative learning to introduce the objectives, schedule the topic of the class session. Thirdly, the instructor uses formal cooperative learning to conduct an instructional activity focused on the topic of the session. Fourthly, near the end of the class, the instructor summarizes (using informal cooperative learning) what has taken place, interesting ideas generated by the formal cooperative groups, and explains how the lesson leads into the assignment for the next class session. Lastly, the class session ends with a base group meeting in which students review what they have learned, what homework has been assigned and what help each member needs to complete the homework (Agarwal, 2010; Kopparla & Goldsby, 2019).

2.6 Benefits of cooperative learning

Cooperative learning as a teaching strategy has been a success story in the transformation of education over the past decade (Adams & Hamm, 1996). Scholars in students learning have shown a growing interest in using cooperative learning technique in the classroom teaching (Van Wyk, 2010). Christensen, Herrison, Hollindale and Wood (2019) believed that cooperative learning enhances achievement and satisfaction of learners. Cooperative learning creates conducive environment for learners to be actively involved in classroom knowledge construction. Cooperative learning can be said to lead to the formation of attitude, values, provision of models of pro-social behaviour, presentation of alternative perspective and viewpoints, building a coherent and integrated identity and promotion of critical thinking, reasoning and problem -solving behaviour. All this result in collaborative skills improvement, better self- esteem and increased achievement (Johnson & Johnson, 1999).

Academic achievements of students have been found to be enhanced by the use of cooperative learning (Johnson & Johnson, 1989, Slavin, 1990, Slavin, 1991). Stevens and Slavin (1995) stated that, the fact that it has been linked to increase in the academic achievement of learners at all ability levels is another reason for its use. Apart from academic benefit, it has been found out to promote self-esteem, interpersonal relationship towards school and peers.

2.7 Differences between cooperative learning and traditional learning group

Kelly (2019) summarizes the differences between cooperative learning groups and traditional education groups in the following points:

- **Interdependence**

  In a traditional classroom group setting, students are not interdependent upon one another. There is no feeling of a positive interaction where the students need to work as a group to produce a quality piece of work. On the other hand, true cooperative learning provides students with incentives to work as a team to succeed together.

- **Accountability**

  A traditional learning group does not provide the structure for individual accountability. This is often a huge downfall and upsetting to those students who work the hardest in the group. Since all students are graded the same, less motivated students will allow the motivated ones to do the majority of the work. On the other hand, a cooperative learning group provides for individual accountability through rubrics, teacher observation, and peer evaluations.

- **Leadership**

  Typically, one student will be appointed the group leader in a traditional group setting. On the other hand, in cooperative learning, students share leadership roles so that all have ownership of the project.

- **Responsibility**

  Because traditional groups are treated homogeneously, students will typically look out for and be responsible for only themselves. There is no real shared responsibility. On the other hand, cooperative learning groups require students to share responsibility for the overall project that is created.

- **Social Skills**

  In a traditional group, social skills are typically assumed and ignored. There is no direct instruction on group dynamics and teamwork. On the other hand, cooperative learning is all about teamwork and this is often directly taught, emphasized, and in the end assessed through the project rubric.

- **Teacher Involvement**

  In a traditional group, a teacher will give an assignment like a shared worksheet, and give students time to finish the activity. "The teacher does not really observe and intervene in group dynamics because this is not the purpose of this type of activity. On the other hand, cooperative learning is all about teamwork and group dynamics. Because of this and the project rubric that is used to assess the students' work, teachers are more directly involved in observing and if necessary, intervening to help ensure effective teamwork within each group.

- **Group Evaluation**

  In a traditional classroom group setting, the students themselves have no reason to assess how well they worked as a group. Typically, the only time the teacher hears about group dynamics and teamwork is when one student feels that they "did all the work." On the other hand, in a cooperative learning group setting, students are expected and typically required to assess their effectiveness in the group setting. Teachers will hand out evaluations for the students to complete where they answer questions about and rate each team member including themselves and discuss any teamwork issues that arose.

2.8 Role of the teacher in cooperative learning

In cooperative learning, the learners are the leaders and the active participants. The teacher is only a coordinator and a facilitator who interferes to correct a fatal error or to offer help when necessary. One of the main objectives of cooperative learning is that learners gain and appreciate group-work skills. Since it cannot be assumed that learners will learn from each other the way to work together nor how to plan and organize the lesson, the active role of the teacher in collaborative learning is highlighted through the various planning and implementation of work/plans. That will organize the appropriate learning environment and collaborative activities to help learners transform and move smoothly from classroom learning, as one group, to learning in specific groups to achieve the lesson or unit objectives - at the same time.

El-Aly (2014) explains the role of the teacher in cooperative learning as follows:

2.8.1 First Phase (Before the lesson)

1. The first phase begins with setting the educational objectives of the lesson. It is essential for the teacher to clearly define the objectives of the lesson procedurally and gradually and determine the behaviour that everyone in the group should be able to performed of the lesson. For the strategy of cooperative learning to be successful the objectives should be clear, authentic and attainable. The objectives can be academic, cognitive, psychological and psychomotor.

2. Determining the size of groups: The basic rule for group members is that the lower the number of members, the better the groups; i.e. Groups of 2-4 members are more positive and active than groups that exceed this number. There is no standard size for cooperative learning groups. The teacher changes the number of group members according to the objectives of the lesson, the nature of desired tasks, the possibilities and resources available, the time allotted for cooperative learning, and the age and experience of the students. However, the researcher thinks that the ideal number can never exceed four or five people maximum.
3. Assigning students to groups: The results of some studies have confirmed that learning in non-heterogeneous groups is better than learning in homogeneous groups. A high-achieving student helps his less-achieving classmate when they have common goals. There are several ways in which students can be assigned to groups, where they can be randomized or deliberately chosen by the teacher noting that students may choose their own groups.
4. Classroom arrangement: The teacher arranges the classroom so that the students of each group are close to each other to exchange material, maintain visual contact with all members, and speak quietly inside the group without disturbing other groups provided that the educational material is not visually reversed for some members of the same group. The groups are sufficiently spaced, so as not to clutter one group over another as the teacher can easily find his way to each group. In this regard, the arrangement of seats, in cooperative learning classroom, takes many forms including:
    a. Cluster arrangement: Students' 4-5 seats and drawers are collected separately.

b. Rotating or moving arrangement: Students' drawers and seats are arranged in the form of wings.

c. Circular arrangement: It is the best way to arrange groups, where the seats are arranged facing each other in a circular way leading to the greatest interaction between group members

5. Assigning roles to group members: For the success of cooperative learning, the teacher assigns a role for each individual in each group. There are conditions that the teacher must take into consideration when assigning roles. These can be summarized as follows:

   a. Describe the tasks of each role.

   b. Explain to students how to carry out their roles.

   c. Follow-up students' performance for all roles to know the level of mastery of each role.

      The teacher's correct use of roles that are thoroughly defined and followed-up will enhance the students' performance and develop their social skills.

   d. Exchange roles of group members from one lesson to another or even during one lesson, so that each student can learn how to carry out each role and acquire the social skills associated with such roles.

6. Preparation of aid materials and tools for the lesson: It is the teacher's task to prepare the materials, tools and means necessary for the lesson such as working papers, tools for conducting scientific competitions, and display devices, illustrations, cue cards and others. The teacher prepares materials according to the task that students will be required to accomplish and distributes them in a

way that allows collaborative work and positive interdependence in achieving educational goals.

7. Defining and explaining the criteria for success: One of the most important roles of the teacher in cooperative learning is to determine the criteria for success on the individual and collective levels. The success criteria must be authentic, flexible and realistic for each individual within the group. At the individual level, 90% is considered excellent, 89% is very good, and 70% - 79% is good so on and so forth. At the group level, the group is deemed to have completed its work if its members together receive at least 85%.
8. Preparation of individual written and oral tests: It is the role of the teacher to prepare short written tests and questions for oral tests conducted randomly on group students. The aim of these tests is to promote individual accountability among students within a group.

2.8.2 Second Phase (During the lesson)

Eldeeb (2006) explains that teacher's tasks during the lesson are to:

1. Explain and clarify the academic tasks: The teacher explains to the students the educational tasks that they have to do, including the objectives of the lesson and the procedures asking them some questions. He may do this in a worksheet consisting of direct and indirect questions, theoretical and practical. He presents it at the beginning of the lesson after explaining the objectives of the content of the paper, or at the end of the lesson as non-descriptive activities. The worksheet must be related to the topic of discussion to be implemented by students as extracurricular work to be discussed in the next lesson.
2. Explain the success benchmarks for the student: Build interdependence and cooperation to achieve the goal: The teacher helps the students believe that they

are in an educational position that requires them to work together and urge them to support each other's learning.

3. Monitor groups to ensure that each individual is doing his work to build individual accountability and ensure that the objectives are met.
4. Intervene and offer help when needed: The following are steps to control the intervention of the teacher in the work of the group:
   a. Inspect the behaviour of students
   b. Assist in the performance of the task
   c. Intervene to teach collaborative skill
5. Collect the necessary data on student performance in groups
6. Request a quick report from students about their course of and progress in work and the difficulties encountered in their roles
7. Build and encourage inter-group collaboration by encouraging the group that has completed its work to assist other groups that have not completed their work in applying the correct procedures without giving answers.
8. Reward all students in the classroom when performing their tasks well. In the end, all members of the class from different groups will be given points of encouragement and rewards, as all students have achieved the pre-determined benchmark of excellence. This encourages cooperation among students.

2.8.3 Third phase (After the lesson)

Eldeeb (2006) explains teacher's role in closing the lesson as;

1. The teacher asks groups to exchange papers and worksheets then summarize key points in the lesson. The role of the teacher is to comment on the group discussion when it begins and publicize the answers to the questions to the whole class.

2. Evaluate the groups and learners in the shade of cognitive, psychological and psychomotor objectives.
3. The teacher raises questions about the main ideas of the lesson, along with a brief summary of the basic concepts the learners have learned. The learners are asked to provide examples of the concepts, principles etc.

2.9 Learner's role in cooperative learning

The role of the learner in cooperative learning is radically different from his role in traditional education. The course in cooperative education is characterized by efficiency, activity, positivity and participation. During the group tasks, each student has several common tasks to fulfil such as:

1. Organize, identify and formulate experience
2. Correct information collection from its sources
3. Select appropriate information after organizing it
4. Link previous experiences with new situations
5. Inter-group interaction
6. Practice individual and collective mental investigation
7. Assist other groups after finishing one's task

2.10 Modern Methods of Cooperative Learning

Various forms of cooperative learning have been developed by researchers over the years that can be adopted to suit different philosophies of teachers. Table 1 shows some of the modern methods of cooperative learning adopted from (Johnson, Johnson & Stanne, 2019). Some of these methods were also explained in Table 1.

Table 1: Modern Methods of Cooperative Learning

Researcher-Developer	Date	Method
Johnson & Johnson	Mid 1960s	Learning Together
DeVries & Edwards	Early 1970s	Teams-Games-Tournaments (TGT)
Sharan & Sharan	Mid 1970s	Group Investigation
Johnson & Johnson	Mid 1970s	Constructive Controversy
Aronson & Associates	Late 1970s	Jigsaw Procedure
Slavin & Associates	Late 1970s	Student Teams Achievement Divisions (STAD)
Cohen	Early 1980s	Complex Instruction
Slavin & Associates	Early 1980s	Team Assisted Instruction (TAI)
Kagan	Mid 1980s	Cooperative Learning Structures
Stevens, Slavin, & Associates	Late 1980s	Cooperative Integrated Reading & Composition (CIRC)

2.10.1 Learning Together Technique

With this technique, certain roles are given to students and they are appointed into heterogeneous groups. Students strive to achieve the common group objectives in different roles in these groups; that is students complete the part of the work he is assigned.

2.10.2 Teams- Games- Tournaments

This is a cooperative learning model developed by DeVeris and Edwards (Jianhua & Akahori, 2001). This method involves learners contending as teams representatives against members of other team in playing academic accomplishment through academic quizzes and tournament Haryono et.al (2021). Usman, Saud and Achmad (2018) stated that with Teams- Games- Tournaments, students after the learning in their various groups, each member will be met with other members who have the same ability in a match. The game played is scored and the score is added to the earlier score of the team. This model has cooperative and competition within and between groups respectively.

2.10.3 Jigsaw

Jigsaw is a cooperative learning that facilitates students to work in group and reinforced their learning material in class room. In this method, students must become an expert of portion of a topic. Then they must present their learned content to members in the group. Students are assessed through individual quizzes and grades are awarded based on individual quiz outcome. (Aronson et al, 2012; Clarke, 2009).

2.10.4 Group Investigation

This method originated by Herbert and later Sharan improved it through research studies. Group investigation is a common cooperative instructional approach that provides opportunities to learners to take part in group work effectively. They must plan, investigate, discuss and work jointly in cooperative learning group. In this method, cooperation learning groups are based on specific topic or common interest. The topics are selected by teams from a lesson taught to a whole class. These topics are classified into individual tasks, relevant activities are put into place and group reports are prepared. Then students and instructors both evaluate the report presented by each group in the class at a specific period. Six stages of Group Investigation exist (Sharan 2014). These stages are:

1. Groups formation and selection of topic
2. Planning of learning task
3. Investigation conduction
4. Final report preparation
5. Final report presentation to entire class
6. Achievement evaluation

2.10.5 Complex Instruction

This is an instructional approach in which students carry out group learning activities using cooperative inquiry- based projects particularly in mathematics and science classes. Students have different abilities and capabilities and complex instruction requires different roles and skills. Group members share their skills that aim to facilitate group success. In this method, participants collaboratively work on project in groups to discover scientific facts and principles. Implementation of this learning style in bilingual classes showed positive outcomes.

2.10.6 Cooperative Integrated Reading and Composition

This is a planned scheme which may be employed to promote basic comprehension skills at elementary school (Madden et. al, 2016). With this cooperative learning strategy, learners form pairs and cooperatively practice on reading, sum up narratives and re-enforce vocabulary in their respective groups. They also participate in group learning activities to grasp central concepts and develop other comprehension skills. Learners' motivation is ensured through the use of cooperative reward structure so that they are effectively involve in pairs and work on these learning strategies and would be rewarded based on the whole team performance.

2.10.7 Students- Teams Achievement Division (STAD)

This is a cooperative learning model developed by Robert Slavin in 1978 (Berzener, 2021; Nair & Sanai, 2018). It is a cooperative learning strategy in which small groups of learners with different levels of ability work together to accomplish a shared learning goal (Kim, 2018). Student Teams AChievement Division as a cooperative learning technique has been extensively researched and assessed specifically on academic achievements, attitudes, social interactions and interpersonal relationships Slavin (1983, 1990); Kagan (1994); Johnson et.al (1998); (Johnson & Johnson 1999); Balfakih (2003); Bernaus and Gardner (2008); Tarim and Akdeniz (2008). STAD is one of the simplest and most extensively researched forms of all cooperative learning techniques and it could be an effective instrument to begin with for teachers who are new to the cooperative learning technique (Slavin 1990; Becker & Watts 1998). STAD as a teaching technique was designed and researched by Johns Hopkins University and is known as "student team learning" (Sharan 1995).

Research studies in the use of STAD as a teaching technique has been applied with great success in various research projects (Vaughan 2014; Jacobs & Small 2003; Van Wyk 2010). The main purpose of STAD is to drastically improve and accelerate learner performance. The modified STAD consists of: subsection teams; individual improvement scores; class presentations/demonstrations. Research studies showed that STAD as a teaching technique has been applied with great success in various science research projects. For instance, Adesoji and Ibrahim (2009) and Balfakih (2003) in Chemistry, Ho and Boo (2007) in physics, Pei-wen (2001), Van-Wyk (2010), and Keramati (2010) in Mathematics, reported that STAD is more effective than individualistic instructional strategy, discussion method and conventional classroom instruction.

The use of STAD include enduring teams (usually lasting for six weeks) and an improvement point scoring system which provides high motivation for students across the range of ability levels. STAD is made up of five interlocking components: class presentation, teams, quizzes, improvement scoring and team recognition.

2.11 Components of STAD

1. Class Presentations. The materials in STAD are initially introduced in a class presentation. This is most often a lecture-discussion conducted by the teacher. Class presentations in STAD differ from usual teaching only in a way that it must be clearly focused on STAD unit. In this way, students realized that they must pay careful attention during the class presentations because doing so will help them do well on the quizzes and their individual scores determine their team scores.
2. Teams are composed of four or five students who represent a cross section of the class in academic performance, sex and ethnicity. The major function of the team is to prepare its members to do well on the quizzes. After the teacher presents the lesson, the team meets to study worksheets produced by the teacher. Most often, the study takes the form of students quizzing one another back and forth to sure that they understand the content or working problems together and correcting any misconceptions if teammate make mistakes. The team is the most important feature of STAD. At every point, emphasis is placed on team members doing their best for the team and on the team doing well to help its members. The team provides the peer support for academic performance that is important for effects on learning and the team provide mutual concern and respect that are important for effects on such outcomes as inter-group relations, self-esteem and acceptance of mainstreamed students.
3. Quizzes. After approximately one period of teacher presentation and one period of team practice, the students take individual quizzes. The quizzes are composed of course content questions that the students must answer. They

are designed to test knowledge gained by students from class presentation and during team practice. Students are not permitted to help one another during quizzes. This makes sure every student is individually responsible for knowing the content presented.

4. Individual Improvement Scoring. In addition to the quiz score, students receive an improvement score each week, indicating how well they are performing compared to their usual level of performance.
5. Team Recognition. Each week team received recognition for the sum of the improvement scores of the team members. Each week the teacher prepares newsletter announcing team scores. The newsletter also recognizes individuals who showed the greatest improvement or got perfect papers and reports emulative team standing. In addition, to or instead of the newsletter, many teachers use bulletin boards, special privileges or small prizes or rewards to emphasize the idea that doing well is important.

2.12 Advantages of STAD

Student Teams Achievement Division (STAD) has several merits. Group has greater information resources than individual do. Group has to employ greater number of creative problem-solving methods. Group gained better understanding of themselves as they interact with each other. Working in a group foster learning and comprehension of idea discussed. STAD enhances interpersonal and communication skills of students. It is also an excellent instructional strategy that enhances learners attitude and understanding of subject matter. STAD offers learners the privilege of learning more effectively from their peers. STAD aids students in overcoming mistakes, learning difficulties and misconceptions. It also helps create interactive learning, fun and motivates students to participate actively in learning. STAD pushes students to encourage and help one another towards mastering of skills taught by instructor.

2.13 Disadvantages of STAD

Despite the numerous merits of STAD there are few setbacks. An individual group member may dominate the discussion. Some group members may rely too much on others to get the job done thereby not participating actively. Group members may pressure others to conform to the majority opinion. STAD is time consuming. It is difficult to achieve curriculum target using STAD.

2.14 Theoretical Framework

One reason why the cooperative learning (CL) is so popular in educational circles is that it has sound scientific bases. Theories of CL on different subjects are somehow different. According to the nature of science and the actual setting of science teaching in general, this section intends to seek the theoretical support for CL from the perspectives of social constructivist, cognitive developmental theory, group dynamic and behavioral theory and science teaching and learning.

2.14.1 Constructivist Learning Theory

The main theory guiding this study is the social constructivist framework of knowledge construction with regards to cooperative learning. The underlying premise of cooperative learning is founded in constructivist epistemology. It utilizes ideas of Vygotsky, Piaget and Kohlberb in that both the individual and social settings active dynamics in the learning process as students attempt to imitate real life learning. Constructivist learning is an active constructive process. Learners are not passive to accept the external information, but active to choose the external information according to the former cognitive structure in order to construct the meaning of the present situation. The process of the construction is two ways. On one hand, learners construct the meaning of present things to trace the given information; on the other hand, the original knowledge is not taken out unchangeable, but it will be constructed according to the variation of the concrete situation. Learners' constructions are pluralistic; that is, each learner's constructions are different from one another (Ellis, 1993). It is not only a revolution in learning psychology, but also a leap of epistemology from behaviorism to constructivism. Behaviorists think that human understanding is determined totally by the property of stimulus. The subject of understanding is passive, just as a mirror reflects an object, while constructivist think that man, as the subject of understanding, does not simply reflect reality. In the process of understanding the individuals make choice and choose methods, and they also give reality special meaning. So, understanding does not come from reality itself, but comes from the interaction between subjects and objects (Ellis, 1993). Constructivism stresses the subject's conscious activity, and does not take learners as passive recipients. It considers teaching as a process in which students construct their knowledge actively. And the construction takes place through interaction with others. In teaching, the teacher, who is no longer the original authority, has become a cooperator who constructs knowledge with the students, and the companions have become constructive cooperators from the original competitors. Based on the constructivist theory, Science cooperative learning takes students as the main body of teaching and the active constructors of knowledge. Students are no longer the passive receivers of outside stimulus or the objects of knowledge inculcation.

The superiority of the constructivist method of teaching to the traditional method could be attributed to the active participation of students in all processes of learning. This develops a positive attitude of students towards chemistry, and consequently results in higher achievement. On the other hand, the receptive, teacher-centred method reserves for students leads to many of them experiencing boredom, decrease in interest and develop a negative attitude towards chemistry, thus resulting in lower achievement. This suggests that the choice of the teaching method can go a long way to influence the attitudes of learners toward a given subject. The instance where a particular subject or topic is conceived difficult, the choice of the teaching method can either bring about a positive attitude or negative attitude of learners toward it.

2.14.2 Developmental Theory

Cognitive development is an outcome of cooperative learning wherein constructivist knowledge development and transformation results from collaborative attempts to discover, comprehend and decipher (Vygotsky, 1978). The social constructivist approach emphasizes that knowledge acquired through interaction with others as well as by individual processes. This assertion ties in with the current study on Student-Teams Achievement Divisions (STAD) cooperative learning where learners study in small heterogeneous teams and then break to do exercises individually. Children's cognitive and social development has grown through companions' interaction and association. Vygotsky (1978, p.26), a famous Russian psychologist, presented "Zone of Proximal Development (ZPD)" in which he stressed the difference between the actual developmental level that enables children to solve the problem alone and the latent developmental level with the guidance of adults or cooperation of a better companion. Making ZPD in teaching, he said, it is not only necessary in the teacher's teaching, but also necessary in the cooperation with better companions. Vygotsky believed that "what the learner is able to do in collaboration today, he will be able to do independently tomorrow" (1978, p.47). Enlightened by Vygotsky's ZPD, later scholars discussed the cognitive function of the companions' association from two aspects. One is that the companions teach each other. That is, students with better abilities work as teachers. The other is that the companions cooperate with each other. That is, the students communicate with each other equally and cooperate with each other (Cheyne & Tarulli, 2005).

Similarly, Piaget, a Swiss developmental psychologist, thought that social experience and knowledge, language, value, rules, morality and sign system can be acquired through the interaction with others (Piaget, 1964). Many supporters of Piaget appeal to schools to use more cooperative activities. They think that students' interaction for the learning task can improve their achievements. And they can learn from each other through interactions. For the discussions in the interaction, there must be cognitive struggles. And because of the cognitive struggles, the insufficient deduction must come into being. At last through cooperation a better understanding will be reached (Piaget, 1950). Bruner, one of the supporters of Piaget, created Discovery Learning and one of its pedagogical aims was to help students to learn how to learn (Bruner, 1960). He stated that teachers should make the best conditions for learning, which is one of the aims of CL. The CL can provide the students with more opportunities for interactions. It can also improve the students' understanding and facilitate their development (Bruner, 1990).

2.14.3 Group Dynamics Theory

A group is a dynamic whole in the sense that the interdependence between the members can change. The nature of a cooperative group is the interdependence of the members that leads to the group becoming "a dynamic whole", in which any member's change will lead to the other members' change; secondly, the nervous inner condition of the members can encourage the group to reach expected purpose (Johnson, Johnson &

Holubec, 1994, p.15). Levin also did experimental research on group aims and individual aims. The result shows that in cooperative groups individuals have strong motives. They can encourage each other and make allowance for each other. The information communication between the individuals can go on fluently. The work efficiency of cooperative groups is obviously higher than that of non-cooperative groups (Johnson, Johnson & Holubec, 1994). In America Johnson D.W and Johnson R.T developed the theory into social interdependence theory. They did research on three kinds of aim structure cooperation, competition and individual. And they drew the conclusion that group cooperative structure should become the main organizing form in class; only this structure can work towards the efficiency that promote students' interaction and improve the teaching efficiency of the whole class. From the viewpoint of group interaction, the core theory of the CL can be expressed simply in the following way. When all the people get together to work for the same purpose, they must depend on each other. The interdependence on each other provides interaction for individuals and make them, (1) encourage each other, willing to do whatever promotes the group success; (2) help each other, trying to make the group successful; (3) love each other because all people like others to help them to fulfill the purpose. Hence cooperation has increased the connections of the group members to most extend (Wang, 2001).

2.14.4 Behavioural theory

Behaviorism is a learning theory that explains animals and humans behaviour in terms of conditioning without resorting to feelings and thought. To the behaviourist, the environment of an organism is the determinant of its behaviour. The environment becomes the source of stimuli to which the organism responds. Supporters of behaviourism don't describe behaviour by referring to mental process (Akpan & Kennedy, 2020). Behaviourist see instruction as knowledge transmission from teacher to learner and for that matter not considered the role of the mind during the instructional process (Stoilescu, 2016). Behavioural learning theory suggest that students will commit to participation in both individual and team efforts if they are rewarded for that participation and likely not to commit if no rewards are evident. Therefore, individual and team rewards should be evident in cooperative learning environment wherein rewards for participation in team productivity is purposeful. Based on the various theories incorporated into the study, the composite theoretical framework adopted from (Johnson, Johnson & Smith, 1998) is shown in Figure 1

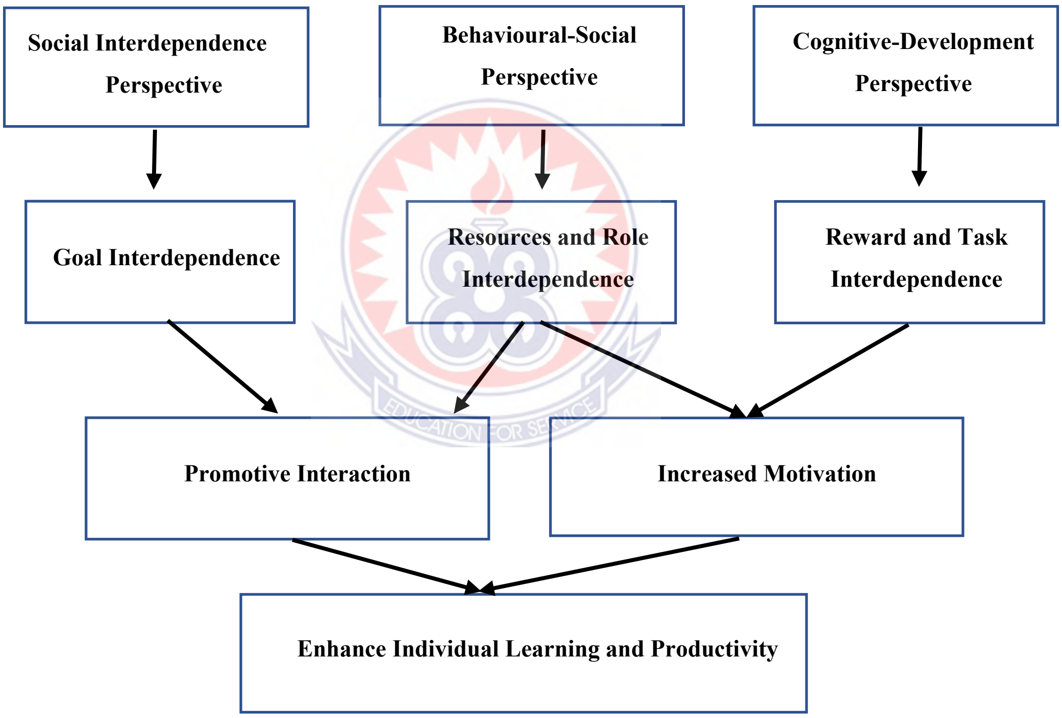

Figure 1: Theoretical Framework for Cooperative Learning: Johnson, D. W., Johnson R. T., and Smith, K. A. (1998)

2.15 Conceptual Framework

The STAD learning strategy involves the teacher presenting the lesson after which students break into groups to work on assigned task where each member of the group plays a role. The teacher provides worksheet for the groups. At the end of each lesson, students are assessed individually to see their progress. Groups are awarded based on their performance. In the teaching and learning of chemistry related concepts, the instructional methods play a major role in determining the learning outcomes. In this study, chemistry instructional methods were categorized into two; STAD cooperative learning and Traditional instructional approach. There are a number of factors that may influence the teaching and learning process as well as the outcomes. Some of these factors include students' maturation, gender, intelligence level and students' dispositions. The conceptual framework shows how the independent variables interact with both intervening variables and the dependent variables to bring about the students' outcomes in teaching and learning. The independent variables for this study are STAD cooperative learning and traditional teaching approach whilst the dependent variable are the students' performance and perception. The intervening variables included the teacher's experience and the teacher's training. The summary of the conceptual framework is presented in Figure 2

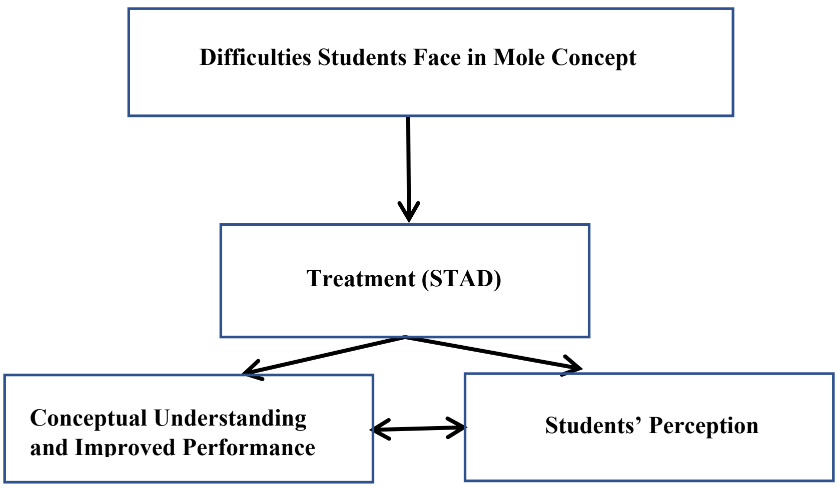

Figure 2: Conceptual Framework

2.16 Empirical Framework

Research studies showed that STAD as a teaching technique has been applied with great success in various science and other field research projects. In the university of South Africa, College of Education, Department of Curriculum and Instruction, (Van Wyk, 2010) carried out a research to find out the effects of STAD cooperative learning on student achievement, attitude and motivation in Economics Education using both paired and unpaired t-test for both control and experimental groups. It was found out that the experimental group perform better than those taught using the traditional teaching approach. Again, it was established that STAD cooperative learning experience is more effective in promoting positive attitudes in students towards Economics Education than direct instruction. Essuman (2004) investigated on "Effects of small- group cooperative learning on the performance in Mathematics of senior secondary school students" Using statistically equivalent control and treatment groups, he found out that the mean score of the experimental group was about three times that of the control group. The t-test value for the mean difference between the mean score on the post-test for the control and experimental groups was -2.57 which was significant at five percent alpha level. The paired sample t-test for the difference between the mean scores on the pre-test and post- test of the control and the experimental group were both statistically significant showing that the experimental group made significant improvement in achievement. Again, analysis of pre-test and post-test among different ability group (low, medium and high) also showed that students of all the ability levels in experimental group achieved a higher mean gain than their counterpart in the control group. Baloche (2008) examined the effect of STAD cooperative learning on English language by giving treatment of STAD cooperative learning to the experimental group and found out that the experimental group performance in English was better than the control group who was taught using the traditional method. Iqba (2014) investigated the impact of STAD on students' mathematics achievement score. The experimental group was given treatment for two months by employing STAD. The conventional method was employed to teach the control group. The results of the study indicated that the academic scores of the experimental group was higher than the control group. Al-Munawwarah (2013) conducted research on "STAD cooperative learning in teaching Reading and Comprehension (A case study in a class of English Grade Students at one public School in Bandung)'' and found out that this technique was effective for second grade students of junior high school in learning reading and comprehension. Again, research studies showed that STAD as a teaching technique has been applied with great success in various science research projects. For instance, Adesoji (2009) and Balfakih (2003) in chemistry, Ho and Boo (2007) in physics, Pei-wen (2001), Van-Wyk (2010), and Keramati (2010) in Mathematics, reported that STAD is more effective than individualistic instructional strategy, discussion method and conventional classroom instruction respectively. Vaughan (2014) examined the effects of cooperative learning on the achievement and attitudes towards mathematics of a group of fifth graders. The students participated for twelve - weeks in cooperative learning in mathematics. The analysis of pre-test and post-test scores revealed positive changes in attitudes and achievement. Other studies had similar findings showing that cooperative learning produces positive effect on mathematics achievement and improves students' attitudes towards mathematics

2.17 Gender Differences in Science Achievement and Perception towards science

Obviously, there is a strong association between gender and academic achievement in science education. The likely influence of gender on students' academic achievement in chemistry when taught using STAD cooperative learning was examined by this study.

Gender has been identified as one of the factors influencing students' achievement in science at senior secondary school level. Balfakih (2003), Adeyemi (2008) Kost, Pollock and Finkelstein (2009) and Oludipe (2012) reported no significant difference between male and female students' performance when taught using cooperative learning strategy. Similarly, Pandian (2004), Yusuf and Afolabi (2010) and Yusuf, Gambari and Olumorin (2012) reported that gender did not have any significant influence on biology achievement using STAD cooperative learning strategy. However, Fajola (2000), Ghaith (2001), Kolawole (2007) in their studies found that male students performed better than female students in the cognitive, affective and psychomotor skill achievements. In contrast, Olson (2002) reported that female students taught mathematics using cooperative learning outperformed their male counterparts. Slavin (1995), for example noted that cooperative learning increases academic achievement of learners at all ability levels. According to Johnson, Johnson and Stanne, (2019), cooperative learning equalize the status and respect for all group members, regardless of gender.

2.18 The Mole Concept

Quantity measurement are made in everyday life; in schools, laboratories, farms, markets, shops kitchen, airports and many other places. These measurements include mass and volume to find out the quantity of matter present in the substances. All substances are made up of atoms, molecules or ions bound together to make up the total matter of the substances (Ameyibor & Wiredu, 2006). Knowledge of quantities is indispensable in all areas of life. For example, in the industrial manufacture of soap, definite amount of reactants such as palm oil and caustic soda (sodium hydroxide) have to be measured to produce a desired quantity and quality of the soap.

In chemistry, quantity of matter can be measured in two different ways;

- Mass quantity;
- Amount of substance (mole) quantity

According to Tro (2011) the mole as a unit is defined as amount of material containing 6.0221421 x 10^{23} (Avogadro's number) particles. In 1900, Max Planck determined the value of Avogadro's constant from his famous law on the blackbody radiation (Planck, 1920). Further research on the mole was made by Albert Einstein, Jean Perrin and many others. Edward Guggenheim finally wrote that, "The mole is the amount of substance containing the same number of particles (which can be atoms, molecules, radicals, ions or electrons) as there atoms in 12 grams of 12C" (Guggenheim, 1961).

Brown-Acquaye (2001) stated that the word mole is derived from the Latin word 'moles' which means a heap of materials. He further explained that the mole is analogous to pair, dozen and pack which represents groups of 2, 12 and 52 items respectively.

Silberberg (2013) defines the mole using the current S1 definition of the mole which is the amount that contains a number of objects equal to the number of atoms in exactly 12g of carbon -12 (which is 6.022 x 10^{23}). The fourteen General conference of national Institute of standard and Technology (NIST) in 1973 established that, the mole is the amount of substance of a system which contain as many entities as there are atoms in 0.0012kilogram of Carbon-12 scale. Techniques such as mass spectrometry, which count atoms very precisely is used to determine this number as 6.02 x 10^{23} (Zumdahl, 2007). The mole is the SI unit of amount of substance and its symbol is mol. For example,1 mole of oxygen gas contains 6.02 x 10^{23} number of entities, has a mass of 0f

32 grams and occupies a volume of 22. 4L. Again, a chemical formula for substances that react in any chemical process, a unit of amount of substance is easy to handle through the measuring of masses of such substances. (Furi, Azcona & Guisasola, 2000). This unit is the mole that contains an Avogadro number, N of particles, whatever the substance and which has a mass (in grams) equal to the atomic or molecular mass of the elementary entity that makes up the substance. (Mills, Cvitas, Homman, Kallay, & Kutsichu, 1993). The precise definition of the mole requires that in every case the elementary entity reference that will serve as the basis for calculation (atoms, molecules, ions) be stated (Furi et. al, 2000). Gilbert et. al, (2015) defined the mole as an amount of material (atoms, ions or molecules) that contain Avogadro's number (L= 6.022×10^{23}) of particles. According to IUPAC (2018) the $6.02214076 \times 10^{23}$ is a fixed numerical value of the Avogadro constant and is called the Avogadro number. Since Avogadro has come out with the number of particles in specified amount i.e. 1mole, it means this constant can be used to determine number of particles contain in any mole. Whether more than or less than one mole of any quantity.1mole of any substance $=6.02 \times 10^{23}$.

Therefore, Number of entities, N in a given amount of substance, n is given by N (number of entities) = n (number of mole) x L (Avogadro's constant) The mole (amount of substance) is the most important of all physical quantities to the chemist (Ameyibor & Wiredu, 2006) .Out of the seven fundamental quantity including time, temperature, mass, luminous intensity etc., the amount of substance (the mole) is the fundamental quantity that relate directly to number of entities (atoms, ions and molecules) in the substance.

2.18.1 Relative atomic mass

Atomic weight are not only fundamental to science. They are also basic to trade and commerce which are directly involved with "amount" of specified substances, (Laeter et. al, 2003) Avogadro's discovery that equal volumes of ideal gases under identical conditions contained equal numbers of atoms or molecules (with relative molecular mass equal to the sum of the atomic weights of all atoms composing a single molecule) led to a simple method of measuring atomic weights from measures of volume and mass of gases of species (Laeter et. al, 2003). A commission set up by IUPAC in 1979 defined relative atomic mass (A_r) of an element from a specific source; "the ratio of the average mass per atom of the element to 1/12 of the mass of an atom of carbon-12 isotope. From the above definition

- Atomic weight can be defined for any sample
- Atomic weights are evaluated for atoms in their electronic and ground states.
- The "average mass per atom" in a specified source is the total mass of the element divided by the total number of atoms of that element

The reference scale is now carbon-12 because it is measured particularly accurately compared to other elements on the periodic table. On this reference scale, carbon-12 was assigned an atomic mass of 12 atomic mass unit (amu) (Asamoah, 2016). Relative atomic mass can be defined as the mass of one atom of an element compared to 1/12 of the mass of one atom of carbon-12 isotope. For instant, if the relative atomic mass of magnesium (Mg) is 24, then it means that one atom of Mg weighs 24 times the mass of 1/12 of the carbon-12 atom. The relative atomic mass has no unit since it compares two atoms. Each atom has a unit of u and therefore they cancel out. On the other hand when considering atomic mass of a particular atom or element it has the unit u.

The use of Ar and u for Cl and Na can be illustrated as follows:

$A_r(Cl) = 35.5$

Atomic mass of (Cl)= 35.5 u

$A_r(Na) = 23$

Atomic mass of Na =23 u

Relative molecular mass (M_r)

Relative molecular mass is defined as the average mass of one molecule compared to 1/12 the mass of 12g of one atom of carbon-12 isotope (Ameyibor & Wiredu, 2006) Relative molecular mass has no unit. For example, $M_r(H_2O)$ is 18. This means the water molecule is 18 times as heavy as 1/12 the mass of one atom of the carbon-12. Similarly, the $M_r(C_6H_{12}O_6) = 180$, which means that the glucose molecule is 180 times as heavy as 1/12 the mass of one atom of ^{12}C atom. The relative masses of molecules and polyatomic ions can be calculated adding up the total number of constituent atoms (Ameyibor & Wiredu, 2006). Given the correct molecular formula and the correct relative masses of the atom, the relative molecular mass can be calculated. For example giving 1) S_8 2) $C_6H_{12}O_6$ 3) H_2SO_4 (S=32; C=12; H=1; O=16), the relative molecular masses can be calculated as follows;

1) $M_r(S_8) = 8 \times 32 = 256$

2) $M_r(C_6H_{12}O_6) = 6 \times 12 + 12 \times 1 + 6 \times 16 = 180$

3) $M_r(H_2SO_4) = 2 \times 1 + 32 + 4 \times 16 = 98$

2.18.2 Molar mass (M)

Molar mass is the mass in grams of one mole of the substance (Zumdahl & Zumdahl, 2012). It has the unit g/mol. As established earlier, there are 6.02×10^{23} entities in one mole of every substance. The molar mass of any substance therefore contains Avogadro constant, $6.02x10^{23}$ entities of the formula unit. The masses of different types of entities differ from substance to substance, hence the masses of one mole of different substances also differ (Ameyibor & Wiredu, 2006). The relative atomic mass, A_r and relative molecular mass, M_r are numerically equal to their molar mass. Molar mass has unit while A_r and M_r have no unit. For example, A_r (Na) =23 while molar mass of Na =23g/ mol; M_r (CH_3COOH) = 60 while molar mass(M) for CH_3COOH = 60g/mol. Using the definition of molar mass, 1 mole of any substance has mass M g while Y mole of any substance has mass Y x M g. Therefore, mass = mole x molar mass; mole = mass / molar mass (Ameyibor & Wiredu, 2006). The amount of any substance can be calculated, given the other quantities. With the amount of substance determined, the number of entities in the mass of the substance can also be calculated.

2.18.3 Molar Volume (V_m)

According to Ebbing and Gammon (2009), Italian chemist Amedeo Avogadro (1776-1856) interpreted the law of combining volumes of gases which is now called Avogadro's law: equal volumes of gases at the same temperature and pressure contain the same number of molecules. Thus, they continue to say that two volumes of hydrogen contain twice the number of molecules as in one volume of oxygen based on the chemical equations for the reaction. This volume expressed for a mole is called molar volume, (V_m) and has the value $22.4dm^3$ (Silberberg, 2012). Furthermore, 1mole of an ideal gas occupies a volume called the standard molar volume of $22.4dm^3$ at standard temperature of 273K and 100kPa pressure. The relationship between any given volume of gas V and amount of substance, n is derived as follows at standard temperature and pressure (stp): 1mole of every gas occupies a volume of $22.4dm^3$ and Y mole of every gas occupies a volume of Y x $22.4dm^3$. Therefore, V (dm^3) = mole (n) x molar volume (V_m), mole(n) = volume(V) / molar volume (V_m). This relation applies to substances in the gaseous state only and does not apply to solids and liquids (Ameyibor & Wiredu, 2006).

2.18.4 Quantity of solute in solution

A solution is a uniform mixture of two or more substances (Ameyibor &Wiredu, 2006). The solute dissolves in the solvent to give the solution. Usually, the substance which has a smaller volume is considered the solute and the other, making up the larger volume, the solvent. Many solutions exist in nature, for example, sea water. Water is considered a good solvent for many solute. A solution in which the solvent is water is called an aqueous solution. The quantity of solute is very important property of a solution. Generally, the quantity of solute per unit quantity of solution is called concentration. A knowledge of concentration can be very useful in everyday life. For example, human beings estimate the quantity of solute in beverages, sugar, salt and other food solutions by tasting. Some farmers estimate the acid concentration in soils bt tasting it to check whether the soil is suitable for planting crops. However, tasting it is not an accurate and safe method of estimating the concentration of solute in solution. It does not allow the exact quantity of solute in solution to be known. Since different people have different tastes, apart from taste buds being unable to measure exact quantities. For example, many medicine in solution are prepared to specified concentrations of solute in solution to give correct dosages, otherwise they could be poisonous. Solutions in school laboratories have known quantities of solute in them. This knowledge allows each solution to be put to the right use. Different forms of concentration arise due to the measurement of the quantities of solute and solvent in different units. Pure water in the form of distilled water is the main solvent used in the preparations. Concentration can be expressed in four main ways (Ameyibor &Wiredu,

2006). These are; amount of substance concentration, mass concentration, molal concentration and mole fraction.

2.18.5 Amount Concentration

Amount concentration is the shortened term for amount of substance concentration. It is commonly, further shorten to concentration. Amount concentration is the amount of substance dissolve in $1dm^3$ of solution.

2.19 Difficulties students have in learning the mole concept

The findings of numerous studies on the teaching and learning of the mole concept present a gloomy picture of how the mole concept is presented within the education domain. The findings showed that there are various descriptions of the mole concept within the education domain which are inconsistent with the meaning of SI definition of the mole concept as conceptualized within the scientific domain. Teachers and learners face a lot of teaching and learning difficulties of the topic respectively (Furio et al, 2000. It was observed that although it is necessary that teachers and students' conception of the mole should be consistent with the SI definition, this does not imply that the SI definition is the most effective and appropriate instructional presentation of the mole concept. Other scholars have echoed this observation that it is very difficult to teach the mole concept in the form it was constructed by the scientists, especially on the meaning of the 'amount of substance'. There is still a controversy over the meaning of the term 'amount of substance even among scholars and this may be the source of the inconsistencies reported in the literature (Furio, Azcona & Guisasola, 2000). It is not surprising that authors and teachers try various strategies and representations to unpack the meaning of the SI definition just to make the concept comprehensible to learners. It is against this backdrop that there are so many descriptions of the mole within the education domain. Many studies showed that students have trouble understanding the concept of the mole, concentration, molar mass, the mass of material, chemical equations and the limiting reagent (Frazer & Servant, 1987). Gabel and Sherwood (2005) mentioned that the abstract nature of the mole concept makes it difficult for students to relate to the concept. Students have problem in understanding and using the mole concept in quantitative chemical problems. The mole concept is a concept which is not easily understood by students.

A case study conducted by Ibrahim et.al (2013) on eighteen (18) students of Chemical Education Degree, reviewing student achievement on mole concept and concept of matter and its effect on problem solving ability stoichiometric, showed that the mole concept and its relationship to the equation, the achievement of conceptual understanding of the respondents was very poor. Dahsah and Coll (2007) reviewed the achievements of 97 students from three secondary schools in Bangkok, Thailand through questionnaires. They found that only 2% of the total respondents were able to understand all of the concepts tested on the chemical formula, chemical equations, the mole, molarity of solution, the limiting reagent, and the mass of reactants. The study which also used questionnaires showed that students experience difficulties in solving problems related to mole concept because they cannot relate the mole to the number of particles, the mass of substance and chemical equations.

According to Idriyanti, (2016), students think that the mole is a certain mass, a certain number of gas particles, and/or a property of molecules. She further stipulated that students referred the mole only to molecules which in actual fact include all entities such as atoms, ions electrons. In a study carried out by. Students misconception about the mole concept developed from their own theories and logic which do not match up with the accurate scientific theories. These misconceptions lead to the difficulties that students encounter in the study of the mole concept. The study of the mole with its relationship to stoichiometry deals with some mathematics calculations and students who have challenges with mathematics are likely to suffer. Some students struggle with the mole concept because they find mathematics very difficult.

The West African Examination Council (WAEC) Chief Examiner's Report (2015, 2017) cited that there was evidence to support students' misconception of dealing with problems related to the mole concept. It also reports that these misconceptions affect terminologies used in their definitions. Despite efforts made by the stakeholders to improve students' performance over the years, more work needs to be done to consolidate the efforts of stakeholders. Based on literature from various researchers on the causes of poor performance of students on the mole concept, it can be concluded that the mode of instruction plays a vital role in enhancing students understanding of the concept.

2.20 Using STAD cooperative learning strategy in enhancing students' understanding of the mole concept

Students' success in chemistry is influenced by a wide variety of factors including high mathematics and intellectual ability. Students with these high mathematical and intellectual abilities stand a greater chance of doing well in the subject than those with low abilities. However, Adjesoji and Ibraheem, (2009) are of the view that students understanding of the content of chemistry could be conceptual or algorithmic and neither of them seems to be responsible entirely for low test achievements. The presence of misconceptions has been well documented among students at all levels of education in numerous areas of the chemistry curriculum. It has been noted that this is it, in the main that due to the abstract nature of the subject. Abstract concepts are difficult for students to comprehend. It is therefore necessary to be aware of students misconceptions so as to develop proper teaching strategies to deal with the misconceptions. Cooperative learning is a suitable strategy that deals with misconceptions and improve students conceptual understanding of abstract concepts. Based on Slavin, (1995) cooperative learning model, when students have the motivation to learn and encourage and help one another, a stage is created for cognitive development. Vygotsky, (1978) argued that cooperation promotes learning because the process enables learners to operate within one another "zone of proximal development." Working with peers is academically beneficial because when learners are closer to one another in their levels of proximal development, they are able to describe things to one another in a simpler way that is easier to be comprehended than being explained by a person with a very different mental stage. Thus, there is the need to stress on active cooperation in the process of knowledge construction.

2.21 Research Gap

Many research have been conducted on the challenges students have with the mole concept yet the researcher found it necessary to conduct this research because most of the research were conducted in different geographical locations using different population and sample sizes as a results of conditions prevailing in such institution may be different.

Secondly, STAD cooperative learning approach has been successfully employed in other chemistry concept such as hybridization, hydrocarbons, acids, bases and salt but not on the mole concept. It is therefore important to investigate its effect on the mole concept which is one of the concept students have difficulties with.

Finally, the research instruments such as questionnaire may have different items and therefore likely to collect different data other than the one collected by other researchers.

2.22 Summary

The main theory guiding this study is the social constructivist framework of knowledge construction with regards to cooperative learning. Constructivist learning is an active constructive process. The superiority of the constructivist method of teaching to the traditional method could be attributed to the active participation of students in all processes of learning. This develops a positive attitude of students towards chemistry, and consequently results in higher achievement. On the other hand, teacher-centred method reserves for students leads to many of them experiencing boredom, decrease in interest and develop a negative attitude towards chemistry, thus resulting in lower achievement. This suggests that the choice of the teaching method can go a long way to influence the attitudes of learners toward a given subject. The instance where a particular subject or topic is conceived difficult, the choice of the teaching method can either bring about a positive attitude or negative attitude of learners toward it.

The fourteen General conference of national Institute of standard and Technology (NIST) in 1973 established that, the mole is the amount of substance of a system which contain as many entities as there are atoms in 0.0012kilogram of Carbon-12 scale. Techniques such as mass spectrometry, which count atoms very precisely is used to determine this number as 6.02×10^{23} (Zumdahl, 2007). The mole is the SI unit of amount of substance and its symbol is mol. In 1900, Max Planck determined the value of Avogadro's constant from his famous law on the blackbody radiation (Planck, 1920). Further research on the mole was made by Albert Einstein, Jean Perrin and many others.

The presence of misconceptions has been well documented among students at all levels of education in numerous areas of the chemistry curriculum. It has been noted that this is it, in the main that due to the abstract nature of the subject. Abstract concepts are difficult for students to comprehend. It is therefore necessary to be aware of students misconceptions so as to develop proper teaching strategies to deal with the misconceptions.

Cooperative learning is a suitable strategy that deals with misconceptions and improve students conceptual understanding of abstract concepts. Based on Slavin, (1995) cooperative learning model, when students have the motivation to learn and encourage and help one another, a stage is created for cognitive development. Vygotsky, (1978) argued that cooperation promotes learning because the process enables learners to operate within one another "Zone of Proximal Development." Working with peers is academically beneficial because when learners are closer to one another in their levels of proximal development, they are able to describe things to one another in a simpler way that is easier to be comprehended than being explained by a person with a very different mental stage. Thus, there is the need to stress on active cooperation in the process of knowledge construction.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter focused on the methodology of the study. It entailed the description of research design, population and sampling procedure. Research instruments, reliability and validity of the instruments were also discussed. Data collection and analysis procedures as well as ethical considerations were also covered.

3.1 Research Design

Research design is a conceptual structure within which research is conducted and it constitute the blue print for the collection, measurement and analysis of data (Garg & Kothari, 2014). This study adopted a quasi-experimental design. This involved pre-test, post-test control group design (Cohen, Manion & Morrison, 2012). In quasi experiment, the researcher does not have the ability to randomly assign the samples and ensure that the sample selected is as homogeneous as desirable thus limiting the selection of research sample to non-randomization process where groups are already organized in to classes (Levy & Ellis, 2011). An intact class from two selected schools were chosen and assigned to experimental and control groups.

A pre-test was conducted for the groups, and treatment for the experimental group.The experimental group received the STAD cooperative learning whiles the control received the traditional teaching approach. A post-test was administered to both groups after treatment. This design was appropriate to the study because it enables comparison of the control and experimental groups. It also provides reasonable control over threat to the internal validity (McMillan & Schumacher, 2010).

3.2 Population

The target population for the study was all senior high school students in the Greater Accra Region who offer chemistry as elective programme. However, the accessible population consisted of only two senior high schools form two chemistry students from the Korle-Klortey municipal of the Greater Accra Region. Form two chemistry students were chosen because at the time of the research they have already treated the mole and also available unlike form one students who have not yet treated the concept and also form three students who were not readily available because of their preparation for WASSCE.

3.3 Sampling Procedure and Sample

Purposive sampling was used to select two secondary schools in the Korle-Klortey municipal in the Greater Accra Region. Teddlie and Yu (2007) define purposive sampling technique as "selecting units (individuals, groups of individuals, institutions, etc) based on specific purposes associated with answering a research study's questions" (p.77). The sample selection was purposive because the research participants were already in intact classes. Also, these schools were selected based the researcher's observation and experience as a tutor in one of the schools for the past ten years and similar experiences shared by teachers from other schools in the municipal. The intact class from each of the two schools were selected and assigned to experimental (STAD Cooperative learning) and control (traditional instructional learning) groups. The list of students in the class of the experimental group were arranged into different strata based on gender (male & female) and achievement level (high, medium, & low) based on their performance in the last promotion examination in chemistry. Sixty five (65) students participated in the study, thirty-five (35) students consisting of twenty- five

(25) males and ten (10) females for the experimental group and thirty (30) students consisting of twenty-four (24) males and six (6) females for the control group.

3.4 Research Instruments

The research instruments that were employed in this study were questionnaires, achievement test and interview. The test consisted of Pre-test and post-test. Achievement Test (AT) called pre-test was used to assess the academic achievement of all participants before the treatment. After the treatment the same Achievement Test was used as post-test test for both groups but the numbering was rearrange to avoid familiarity. The questions were made up of objectives and subjective test items. The WAEC and GES syllabus as a document was taken into consideration so that the pre-test, treatment lessons and post-test would not be conducted outside the scope of the syllabus. Informal interview was used to collect data on students' views on the mole. To assess ideas students possess on the mole, students were asked to verbally expressed their views on the mole. There was also a questionnaire on students perception of the use of STAD learning approach for the chemistry lessons. The questionnaires were administered only to the experimental group.

3.5 Validity of the Main Instrument

To ensure validity of the instrument, the test items were sent to colleague chemistry teachers and to the researcher's supervisor who is an expert in the field of the study for content validity which were piloted to other students of similar characteristics as the research sample. The questionnaires were also given to the supervisor who is an expert in research to assess the items of the instruments for content validity. Feedback received from assessors were used to revise the test items before using them to collect data for the study. Items that failed to measure the variables as intended were modified.

3.6 Reliability of the Main Instrument

To assess the reliability of the instrument before using it for data collection, the research instrument was piloted on respondents outside the research sample with the same characteristics as the research sample. The test items were administered twice to the participants of the pilot study. The time gap was two weeks. The duration of two weeks was thought short enough for learners not to have gained considerable amount of new knowledge at the second administering of the instrument and sufficiently long enough for them not to remember their previous responses (in the first administering of the instrument). The test-retest technique of determining reliability which involves measuring the same object more than once using the same instrument (Field 2019) was employed to test the reliability of the instrument of the study. Data collected from the first and second administering of the instrument were used to compute the reliability of the instrument. A reliability coefficient of 0.80 was obtained using the Kuder Richison (KR-20) which signifies a good reliability of the instrument. According to Bybee (2014), a reliability is a measure of whether a particular instrument or technique applied repeatedly to the same object yields the same results each time.

3.7 Data collection Procedure

Permission was sought from the heads of the institution where the research was carried out. Heads of science departments, chemistry teachers and science students were also contacted and the necessary arrangement for the data collection procedure that would not interfere with the planned school calendar were made. Test items was first and foremost administered to both the experimental and control group as pre-test to ascertain their entry achievement in the concept of mole.

3.7.1 Interview

To assess the ideas students possess on the mole, students were asked to verbally express their views on the mole. Bell (1993) asserts that a major advantage of interview is its adaptability. A skillful interviewer can follow up ideas, probe responses and investigate motives and feelings, which the questionnaire can never do. The interview can provide information that a written response would conceal. Since participants have already treated the mole, the researcher asked them to bring out their ideas on the mole. All participants from both groups were involved in this section but only thirteen responded. Eight from the experimental group and five from the control group. Based on the participants response, probing questions were asked which helped to collect adequate information on students ideas about the mole. The responses from participants were recorded in Appendix B

3.7.2 Treatment (The Experimental Group)

The experimental group was taught the mole using STAD cooperative learning. This treatment lasted for five weeks. Students were assigned to four- member heterogeneous groups consisting of different gender and different academic achievement levels. A four-step cycle was then initiated:(i) teach (ii) team study (iii) test (iv) recognition. In the teaching stage, the objective for each lesson was spelt out to learners and the concept was taught using demonstration-discussion approach. Groups were then given task to complete. Each member in the group was assigned a role to play. Work sheets were provided to the students where they work cooperatively with each other to complete assigned task. Performance of each team on assigned task was recorded. At the end of each lesson, students took a quiz individually to assess their progress. In the recognition stage, each team receives recognition award depending on the average score of each team. For example teams that average 15- 20 improvement point received a Good Team certificate, teams that average 20-24 improvement point received a Great Team certificate and teams that average 25-30 improvement points received Super Team certificate. The study lasted for five weeks.

The worksheets were provided on the key areas of the mole concept. The key concepts centred on how the mole relates to number of particles and the Avogadro's constant, to the mass and molar mass, the volume, molar volume and amount concentration. Each worksheet therefore focused on these interrelated concepts to drive home the understanding of the mole concept by the students. The worksheets were used to guide the participants understand the key terms in the mole concept and how they are applied in solving problems relating to the mole concept. Worksheet one centred on the concept of the number of particles (atoms, molecules, ions), the Avogadro's constant and the mole conversion. Worksheet two focused on mass, molar mass and mole. Worksheet three centred on the concept of volume and molar volume and finally worksheet four was on molar concentration. Participants were to apply the step by step procedure as laid down during the teaching phase. Students were to work cooperatively to ensure that each team member is able to complete the assigned task. According to Johnson et. al (1998) cooperative learning required; positive interdependence and individual accountability. Team members perceive that they are dependent on other members of the group to complete the group's goal, task or assignment. The quality and quantity of each member's contribution to learning is assessed and provided to the group and the individual. Each student, as well as the group is responsible for learning the assigned task. Groups were monitored to ensure that each individual is doing his work to build individual accountability and ensure that the objectives are met. As the team carried out their task, the researcher(teacher) went round to inspect the behavior of students, assist in the performance of the task where they were having difficulties, intervene to teach collaborative skills, collect the necessary data on student performance in groups, request a quick report from students about their course of and progress in work and the difficulties encountered in their roles. Inter-group collaboration was built by encouraging the group that has completed its work to assist other groups that have not completed their work in applying the correct procedures without giving answers.

3.7.3 The control group

The control group received the traditional instructional approach. This treatment also lasted for five weeks.

This teaching method was mainly teacher-centred with little involvement of the students. The students in this group were not put into small groups for discussions of problems related to the mole concept. They were not provided with any problem solving guide. The teacher who was also the researcher assumed the position of a lecturer, but not a facilitator in the teaching and learning process. The participants were not provided with worksheets on the mole concept to try their hands on and to make presentations for the teacher and their peers to comment on. The teaching was textbook based and mainly marker board illustrations. The participants were allowed to ask questions and answers were provided without so much attention to individual students. Students learned the concept individually without help from their colleagues.

3.7.4 Post-test

After the treatment, a post-test was conducted for both the experimental group and the control group to assess their performance after the intervention. Post -test scores were used as data to qualify the performance of participants as outcome of the intervention.

3.7.5 Questionnaire

Questionnaire was used to gather data on participant perception of the use of STAD for the chemistry lessons. The questionnaires were developed by the researcher. They took the form of Likert scale. There were fifteen items comprising both positive and negative statements. For example, some of the items were stated as 'STAD cooperative learning improved my understanding of the mole concept' as a positive statement and STAD learning does not enhanced my participation during lessons' as a negative statement. Each item was followed by the response 1. Strongly Agree [ ] 2. Agree [ ] 3. Not Sure [ ] 4. Disagree [ ] 5. Strongly Disagree [ ] where participants were to indicate their level of agreement.

3.8 Data Analysis

The analysis of data was based on research questions and the null hypotheses of the study. The data was grouped under the stated research questions and hypotheses. The data generated from the pre-test, the post-test and the questionnaire were analysed quantitatively while the data generated from the interview schedules were analysed qualitatively. The achievement test in the form of pre-test and post-test were subjected to statistical analysis using the t-test. According to McMillan and Schumacher (1997), a t-test is used to determine whether two means are significantly different at selected probability level. Kibos, Wachanga and Changeiywo (2015) also indicated that a t-test is used when dealing with two means because of its superior power to detect differences between two means. The t-test was used to determine whether there was any significant statistical difference between the mean scores of the students who were taught by STAD and those taught by traditional teaching approach. It was also used to determine if there was significant statistical difference between the achievement of the male and female students taught by STAD. Percentages, mean and standard deviations were used to analyse the questionnaire items. The data was analysed using SPSS version 20.0 and Microsoft Excel (2019).

3.9 Ethical Considerations

Research ethics describes the norms for the conduct of research that distinguish acceptable and non-acceptable research behaviour (Anane & Asamoah-Gyimah, 2018). Ethical rules in a study according to Creswell (2013) contain main areas such as research requirements and individual protection. Researcher in this regard ensured the appropriate permission was sought from the schools and other authorities that were necessary. Research permit request was sent to the institutions ahead of time before the actual data collection. The heads of department, teachers and students of the participating schools were met and the purpose of the study was explained to them. Participants were assured of anonymity and confidentiality. Extra time was given to each participant for clarifications about the study before the study was conducted.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Overview

The results and discussions of the findings of the study are presented in this chapter to provide an understanding of the effect of Student Teams Achievement Divisions (STAD) cooperative learning on Senior High school students' performance in the mole concept. The results and discussions were presented in the order of the research questions and the null hypothesis. The guiding research question of the study was to determine whether Senior High School students will perform better academically in the mole concept or not when taught with the STAD cooperative learning.

4.1 Demographic Information of Respondents

Two demographic variables which are gender and age were investigated for the study. It was realized that majority- 49 (75%) of the respondents were male and 16 (25%) were female. Most respondents- 40 (62%) were16 years old and below whilst the remaining 25 accounting for 38% of the sample also were 17- 19 years of age (Table 2).

Table 2: The Demographic Characteristics of Respondents

Variable		Frequency	Percentage
Gender	Male	49	75%
	Female	16	25%
Total		**65**	**100**
Age	16 years and below	40	62%
	17-19 years	25	38%
Total		**65**	**100**

4.2 Presentation of the Results by Research Questions

The source of data on the mole concept was academic performance in the pre-test and post-test scores for both students taught by the STAD cooperative learning and traditional teaching method. The students t-test analysis of the collected data was performed alongside with the discussion. Interview in a form of open questions were used to seek students' ideas on the mole concept. Questionnaires were also used to find out students' perceptions of the use of STAD cooperative learning in the teaching and learning of the mole concept. All of the data from this study were intended to complement one another in order to provide evidence for the interpretation of the effect of STAD cooperative learning on students' performance in the mole concept.

4.2.1 Research question 1: What ideas do the students possess on the mole concept?

The first research question sought to find out students' ideas on the mole concept. To answer this research question, the researcher had an open interview with the students to seek their views. The students from both the experimental and control groups were asked to bring out their views on the mole concept and some of the difficulties they face in learning the mole concept. The responses from both groups were the same. In their response, participants expressed that the mole concept is difficult to understand on their own and even the units and symbols are confusion because of 'M' for molar mass and again 'M' for unit of mole concentration. They also revealed that it is difficult calculating amount of atoms and ions in given compounds and molecules.

Again, students expressed that the individual molecules, ions and atoms that they are calculating in the substances cannot been seen thereby making it difficult to comprehend and also relating the mole to these particles and the mass of the substance is a problem. Students further more expressed that the mole is just about memorizing formulae which is difficult to memorize. Respondent also brought out that the teacher does not make learning of mole concept interesting. Some further expressions of the students were;

> "To me, calculations in the mole concept are too much and t it will be of great help if teachers do something to reduce it"

> "Some chemistry topics like acid, base and salt, balancing of chemical equations etc. were taught in the basic schools which has helped me to improve my understanding at the secondary school level when they were taught but the mole concept has not been taught in the basic school. This makes it too abstract for me".

> "There are practical activities in concepts like preparation of gases but there are no practical activities in the mole"

> "I have problem in mathematics and because the mole concept is loaded with calculations, I always don't do well in the mole"

> "The mole concept should be taken out of the chemistry syllabus because it has no practical use in everyday life''

The responses from the students revealed clearly that the students had some misconceptions about the mole concept and also had difficulties in learning it. The students viewing the mole concept as having no practical base is a misconception since the knowledge of the mole is greatly applied in quantitative analysis which is so much needed in their test of practicals. Also viewing the mole as concept full of formulae to memorized can be attributed to the instructional approach which this research sought to address. The responses from the participants also pointed to the fact that the mole concept is difficult to learn and this idea is supported by a research conducted by Shadreck and Enunuwe (2018) who recognized the mole concept as one of the most difficult topics to learn within the chemistry curriculum due to its abstract, theoretical nature. Gabel & Sherwood (2005) also mentioned that the abstract nature of the mole concept makes it difficult for students to relate to the concept. Participants were also of the view that the mole concept has no practical activities to enhanced their understanding and also how the mole relate to the particles in substances is difficult to comprehend. It is really true that there are not so much practical activities on the mole that is why the researcher chose the STAD learning approach which is learner centered. In students centered instructional approach, using students' ideas means incorporating students' experiences, points of view, feelings and problems in to the lesson by making the student the focus of the learning. The ideas expressed by the students were greatly considered during the treatment on the experimental group. In the lesson delivery the concepts were presented in a systematic way for students to identify how the mole relate to the number of particles, Avogadro's constant, mass, volume and concentration and not just as list of formulae to memorize. The post-test results and perceptions of students towards STAD have revealed that most of the challenges they expressed were overcome by the instructional approach employed by the researcher.

Students also brought out that they cannot relate the mole to the number of particles and the mass of substance. This is in line with the findings of Noraihan (2008) who said that students experience difficulties in solving problems related to mole concept because they cannot relate the mole to the number of particles, the mass of substance and chemical equations. Students also came out that they have difficulties calculating amount of atoms and ions in given compounds and molecules. This showed that they do not understand the mole as it relates to the various entities such as atoms, ions, molecules etc. in given substances. Students further revealed that they memorize formulae involving calculation on the mole concept without understanding. This idea of only memorizing formulae is as a result of the student not understanding the concept.

Because students do not understand the concept, they only memorize formulae which most at times forget some of these formulae and therefore cannot relate them in answering questions. This is the more reason why the STAD cooperative learning was chosen to help students minimized some of these challenges. Moreover, the results revealed that students find it difficult applying the mole in stoichiometric calculations. This is supported by a research conducted by Kamarudin (2014) who came out with the finding that students who do not fully understand the mole concept find it difficult in understanding stoichiometry which include volumetric calculations. To continue with, students also expressed that the mole concept has no practical application to everyday life. This is a misconception since knowledge of the mole concepts helps students in quantitative analysis in their test of practicals.

Lastly on students ideas on the mole concept, the study results showed that how the teacher present the concept doesn't make it interesting for the learners to develop good attitude towards learning the concept. This means that the lesson delivery plays a crucial role in the difficulties encountered by the students in the learning the mole. To minimize some of these challenges faced by learners to bring about effective learning. Active engagement of the learner with the learning environment, focusing on the learner rather than the teacher, and acknowledging (as well as challenging) learners' understanding intellectual development are useful pedagogical strategies that can facilitate meaningful learning (Ayoade, 2012). This was why the researcher chose STAD cooperative learning strategy which sought to improve conceptual understanding of the learner through interaction with colleagues.

4.2.2 Research question two: To what extent is the mean performance of the experimental group students in the mole concept greater than that of the control group after treatment?

Participants performance in the pre-test before the treatment as shown in the results of Appendix G revealed that the mean and SD for both experimental and control groups are 43.43, 16.486 and 40.070, 15.881 respectively with the t-test showing no significant difference in their performance. Which means that the performance of students from both group were the same.

After the treatment which is the use of STAD in teaching the experimental group the mole concept and traditional method in teaching the control group the same concept, the same performance Test used in the pre-test was administered as post-test. Results (Appendix H Section I) indicated that 63.33% of the students scored between 0-49, 13% scored between 50-54. Also 6.67% each scored between 55-59 and 60-64. 3.33% and 6.67% scored between 65-69 and 70-74 respectively. This revealed that 63% of the control group scored below 50.

From Appendix H Section II, only 28% of the students from the experimental group scored between 0-49. This showed that majority of the students representing 72% scored above 50 as compared to the control where only 37% scored above 50. The results were further analysed to determine the mean and standard deviation. Table 3 revealed that the experimental group had a mean score of 56.000 and SD 17.348 and the control group had a mean of 40.570 and SD 15.915. This indicated that the experimental group had a higher mean score than the control group. To find out if this difference is statistically significant, null hypothesis 1 was tested at alpha = 0.05 level of significance.

Table 3: Mean and Standard Deviation Scores of the Experimental and Control Groups after treatment

Group	Mean	N	Standard Deviation	Standard Error
Experimental	56.00	35	17.348	2.932
Control	40.57	30	15.915	2.906

4.2.3 Null Hypothesis one

Ho_1: There is no significant difference between the mean scores of students who were taught by STAD cooperative learning and those who were taught by the traditional teaching approach. The t-test analysis is shown in Table 4

Table 4: Students t-distribution table showing the difference in achievement scores of the experimental and control groups after treatment

Group	N	Mean	SD	df	t-value	p-value	Mean Difference
Experimental	35	56.000	17.348	63	3.714	0.000	15.433
Control	30	40.570	15.915				

From the t-test analysis as shown in Table 4, $t(63) = 3.714$, $p < 0.05$. There was a significance difference between the post test mean scores of the experimental and control groups ($t(63) = 3.714$; $p < 0.05$) hence the null hypothesis 1 was rejected.

Therefore, the experimental group performed better than the control group after the treatment.

The results of Table 4 indicated that the STAD cooperative learning strategy significantly improved students performance in the mole concept more than the traditional method. The mean score of students taught by the STAD cooperative learning is 56 with SD of 17.35 whilst the mean score of those taught by the traditional method is 40.57 with SD of 15.92 with significant difference in their mean score. This findings agreed with Adesoji and Ibrahim (2009) and Balfakih (2003) who found that students taught Chemistry with STAD performed better than those taught with the traditional teaching method. Ho and Boo (2007) also reported that students who were taught Physics by STAD performed better than those taught by individualistic instructional strategy. Keramati (2010) again reported that STAD is more effective than individualistic instructional strategy, discussion method and conventional classroom instruction in the learning of Mathematics. Essuman (2004) also investigated on "Effects of small- group cooperative learning on the performance in Mathematics of senior secondary school students" using statistically equivalent control and treatment groups, he found out that the mean score of the experimental group was about three times higher than that of the control group.

Van Wyk (2010) also found out the effects of STAD cooperative learning on student achievement, attitude and motivation in Economics Education using both paired and unpaired t-test for both control and experimental groups. It was found out that the experimental group perform better than those taught using the traditional teaching approach.

4.2.4 Research question three: What is the mean difference in performance between the male and female experimental group students after treatment?

This research question sought to find out the difference in performace of male and female students who were taught by the STAD cooperative learning. The post - test results of the male and female experimental group is shown in Table 5.

Table 5: Mean and Standard Deviation Scores of the Experimental Male and Female in the Post-test

Gender	Mean	N	Standard Deviation	Standard Error
Male	58.52	25	17.005	3.401
Female	49.70	10	17.436	5.514

The post-test mean scores for male and female students were 58.52 and 49.70 respectively as shown in Table 5. Similarly, the standard deviations were 17.005 for males and 17.436 for females. The results showed that the mean achievement score for males is higher than that of the females. This implies that the males achieved higher score than the females considering their higher mean achievement score in the post - test. As a result of the observed difference in mean achievement scores, the null hypothesis 2 was tested at alpha = 0.05 significant level using t-test analysis to determine if the observed difference was statistically significant.

4.2.5 Null Hypothesis two: There is no significant difference between the mean scores of males and females experimental group students after treatment (taught by STAD cooperative learning).

The null hypothesis 2 was tested at alpha = 0.05 significant level using t-test analysis to determine if the observed difference in mean was statistically significant. The t-distribution results is shown in Table 6.

Table 6: Students t-distribution table showing the difference in achievement scores of the experimental male and female Students in the post-test

Group test	Mean	t-value	Degree of Freedom	P(2-tailed)	Mean Difference
Male	58.52	1.377	33	0.178	8.820
Female	49.70				

From the null hypothesis two which states that there is no significant difference between the mean scores of male and female students who were taught by the STAD cooperative learning, results from Table 6 revealed t(33) = 1.377 and p-value = 0.178. The p-value (0.178) > than alpha (=0.05) The null hypothesis 2 was therefore accepted. Thus there is no significant difference in the mean performance between the male and female experimental group who were taught by STAD cooperative learning strategy. The male students did not perform better than the female students.

These findings revealed that STAD learning strategy equally enhanced male and female students' achievement in the mole concept. This is in agreement with Yusuf, Gambari and Olumorin (2012) who reported that gender did not have any significant influence on biology achievement using STAD cooperative learning strategy. However, this is in contrast with the finding of Nazre, Sairabanu, and Norasikin, (2010) who found that male students performed better than female students in the cognitive, affective and psychomotor skill achievements using STAD cooperative strategy. Olson (2002) on the other hand reported that female students taught mathematics using cooperative learning outperformed their male counterparts.

4.2.6 Research question four: What are the perceptions of the experimental group students of the use of STAD cooperative learning for the chemistry lessons?

To find out students perceptions of the use of STAD cooperative learning, a questionnaire with fifteen items was developed using a five point likert scale ranging from 1-5 with the following labeling; 1- strongly agree, 2- agree, 3- not sure, 4- disagree 5- strongly disagree was used to collect data on students of the use of STAD teaching strategy. The results of the responses of the students were shown in Table 7.

Table 7: Mean, Standard Deviation and Percentages of Students Perceptions towards STAD Cooperative Learning

ITEM	SA	A	NS	D	SD	Mean	Standard Deviation
1. STAD cooperative learning improved my understanding of mole concept	12 (34%)	20(57%)	2(6%)	1(3%)	0(0%)	1.77	0.69
2. The use of STAD reduces forgetfulness in examination	15(43%)	19(54%)	1(3%)	0(0%)	0 (0%)	1.60	0.55
3. I do not always enjoy the lesson when the teacher uses STAD cooperative	0(0%)	0 (0%)	2(6%)	20(57%)	13(37%)	4.31	0.58
4. STAD learning strategy does not motivate me to learn	0(0%)	0 (0%)	2(6%)	15(43%)	18(51%)	4.46	0.61
5. I understand better when the teacher teaches without the STAD cooperative learning	0(0%)	0 (0%)	1(3%)	20(57%)	14(40%)	4.54	0.56
6. STAD learning approach reduces rote learning	20(57%)	15(43%)	0(0%)	0 (0%)	0(0%)	1.43	0.50
7. STAD learning strategy is an effective means of helping students understand difficult concept	19(54%)	14(40%)	2(6%)	0 (0%)	0(0%)	1.51	0.61
8. STAD learning does not help with concept and knowledge acquisition	0 (0%)	0(0%)	2(6%)	13(37%)	20(57%)	4.51	0.51
9. The use of STAD does not assist students to understand difficult	0 (0%)	0(0%)	1(3%)	16(46%)	18(51%)	4.49	0.56

concept							
10. I always enjoy the lesson when our teacher uses STAD	20(57%)	14(40%)	1(3%)	0 (0%)	0(0%)	1.43	0.52
11. STAD cooperative learning enhances my interaction with colleagues	20(57%)	14(40%)	0(0%)	0 (0%)	0(0%)	1.43	0.52
12. STAD learning does not reduce rote learning	0(0%)	0 (0%)	1(3%)	20(57%)	14(40%)	4.37	0.55
13. I learn better when the teacher teaches with STAD cooperative learning.	22(63%)	13(37%)	0(0%)	0 (0%)	0(0%)	1.37	0.49
14. STAD learning reduces stress and recitation during examination	20 (57%)	14(40%)	1(3%)	0(0%)	0(0%)	1.46	0.56
15. STAD does not enhanced my participation during lessons.	0(0%)	0(0%)	0(0%)	9(26%)	26(74%)	4.74	0.44

From Table 7 item 1, students were to respond to whether STAD learning has improved their understanding of the mole concept or not. According to the students response, 34% (12) strongly agreed while 57% (20) agreed. Six percent of the students (6%) (2) were not sure, 3% (1) disagreed and none of the students strongly disagreed. Majority of the students (91%) strongly agreed and agreed with the item. This revealed that most of the students responded positively to the item which indicates that STAD cooperative learning has improved their understanding of the mole concept.

On item 2, the students were asked whether STAD learning reduces forgetfulness in examination or not, and it was observed from Table 7 that ,43% (15) strongly agreed, 54% (19) agreed and 3% (1) was not sure. No student disagreed or strongly disagreed to the item. This showed that most students (97%) strongly agreed and agreed to the item. This showed that majority of the students agreed to the statement that STAD cooperative learning has reduced forgetfulness in examination.

Concerning item 3 students were given a negative statement and Table 7 brought out that none of the students strongly agreed or agreed to the item. Thirty seven percent (37%) (13) strongly disagreed while 57% (20) disagreed and 6% (2) were not sure. This is an indication that a lot of the students were in disagreement to the item which means they rather enjoy the lessons taught with STAD.

In terms of the statement STAD learning strategy does not motivate students to learn, the results shown in Table 7 revealed that 51% (18) strongly disagreed, 43% (15) disagreed and 6% (2) were not sure. None of the students responded to agreed or strongly agreed. Majority of the students 94% (33) disagreed. This means that most of the student disagreed that STAD teaching strategy does not motivate them to learn.

The questionnaire item 5 as shown in Table 7 was a negatively worded statement and the results revealed that none of the respondents strongly agreed or agreed to the statement. Fourty percent (40%) (14) disagreed, 57% (20) strongly disagreed and 3% (1) respondent was not sure. This means that most of the students were strongly against the statement which means that they rather understand better when the teacher teaches with STAD.

Table 7 on item 6 brought out that 57% (20) strongly agreed that STAD teaching strategy reduced rote learning and 43% (15) agreed. No student was unsure of the statement, and none of the student disagreed or strongly disagreed. All the students showed positive response to the item which means that STAD teaching strategy reduced rote learning

Again, from Table 7 on the item STAD is an effective means of helping students in understanding difficult concept, 54% (19) strongly agreed, 40% (14) agreed, 6% (2)

were not sure. There was no response for strongly agree and disagree. The results showed that 94% of the students agreed and strongly agreed. Respondents showed positive perception toward the use of STAD as an effective means of helping learners understand difficult concepts.

Furthermore, negative statement was given to respondents on the item and from Table 7, 37% (13) disagreed, 57% (20) strongly disagree and 6% (2) were not sure. No student agreed or strongly disagreed to the statement. This revealed that most of the students showed negative response to the item which means that they strongly disagreed that STAD learning does not help with concept and knowledge acquisition.

In addition, item 9 from Table 7 was a negative statement and the results indicated that, 46% (16) disagreed, 51% (18) strongly disagree, 3% (1) was not sure. There was no student responding to agree or strongly agree. A total of 97% disagreed to the item meaning majority of the students are of the view that STAD learning help in understanding difficult concept.

Concerning item 10, Students were asked whether they enjoyed the lessons when STAD was used and the results of Table 7 revealed that 57% (20) strongly agreed, 40% (14) agreed and 3% (1) were not sure. Nobody responded to disagree or strongly disagree. These statistics showed almost all the students responded positively that they enjoyed the lessons taught with STAD.

The results of item 11 from Table 7 indicated that 57% (20) strongly agreed and 43% (15) agreed to the item. There was no student responding to disagree or strongly disagree and also there was no student who was not certain of the statement. There was 100% agreement to this item. This suggested that all the students responded positively to the statement which means that STAD cooperative learning enhanced students interaction with their colleagues.

The questionnaire item 12 was negatively worded and the results of Table 7 brought out that 40% (14) strongly disagreed, 57% (20) disagreed and 3% (1) was not sure. No student agreed or strongly agreed to the statement. It therefore suggested that STAD learning reduces rote learning.
According to the students' response as revealed in Table 7 on item 13, 63% (22) strongly agreed to the item, 37% (13) agreed with no student not sure. Also, there was no student disagreeing or strongly disagreeing to the item. This revealed that the students agreed to the item which means that they learn better with STAD instructional approach.

Last but not the least, Table 7 on item 14 indicated that 57% (20) strongly agreed to the item, 40% (14) agreed and 3% (1) was not sure. None of the respondents disagreed or strongly disagreed. This indicated that majority (97%) of the students agreed that STAD learning reduces stress and recitation during examination.

Finally, the response from students concerning the last item as shown in Table 7 indicated that no student agreed or strongly agreed to the statement. Seventy four percent (74%) (26) strongly disagreed and 26% (9) disagreed. This suggested that STAD teaching approach enhanced students participation during lesson. This means that majority of the students responded negatively to the statement.

Taking all the individual items into consideration, it was observed from Table 7 that items 1,2,6, 7, 10, 11, 13 and 14 are positively worded and each of this item mean score is less than 2. Item 1 mean is 1.77 and SD is 0.69, item 2 showed a mean of 1.60 and

SD = 0.55, item 6 recorded mean of 1.43 and SD 0.50. Item 7 mean = 1.51, SD= 0.61. Item 10 mean score is 1.43, SD with SD 0.52. Item 11 mean =1.43, SD = 0.5 while item 13 and 14 mean and SD are 1.37, 0.49, 1.46, 0.56 respectively. The mean and SD revealed that students agreed to the statement which means they showed strong positive perception towards the use of STAD instructional strategy. Also, on the negative worded items which are 3,4,5,8,9,12 and 15 the mean scores were greater than 4. Item 3 mean score is 4.31, SD = 0.58, item 4 mean = 4.46, SD = 0.61, item 5 mean =4.54, SD =0.56. Item 8 revealed a mean of 4.51, SD = 0.51 while item 9 mean =4.49, SD = 0.56. Item 12 mean = 4.37, SD = 0.55 and Item 15 mean = 4.74, SD = 0.44. The means of these items indicated that students disagreed to the statement which means that they rather prefer STAD instructional approach as compared to the traditional teaching method.

The results clearly demonstrated that students showed strong positive perception towards STAD as it came out that their interaction with colleagues and also their participation during lessons improved. According to (Piaget, 1950) students' interaction for the learning task can improve their achievements. And they can learn from each other through interactions. For the discussions in the interaction, there must be cognitive struggles. And because of the cognitive struggles, the insufficient deduction must come into being. At last through cooperation a better understanding will be reached. (Ellis, 1993a) also argued that understanding does not come from reality itself, but comes from the interaction between subjects. Constructivism stresses the subject's conscious activity, and does not take learners as passive recipients. It considers teaching as a process in which students construct their knowledge actively. And the construction takes place through interaction with others. In teaching, the teacher, who is no longer the original authority, has become a cooperator who constructs knowledge with the students, and the companions have become constructive cooperators from the original competitors.

Based on the constructivist theory, science cooperative learning takes students as the main body of teaching and the active constructors of knowledge. Students are no longer the passive receivers of outside stimulus or the object of knowledge inculcation. Students also expressed that they have enjoyed the STAD lessons and appreciated the collaboration and team work, sharing and seeking information from one another and the teacher which as a result has greatly impacted and helped them in developing positive attitude towards learning. This is in support of (Van Wyk, 2010) who established that STAD cooperative learning experience is more effective in promoting positive perception in students towards learning than direct instruction. The perceptions of students towards STAD instructional approach from this study is supported by Shafiee et. al (2022) who reported that students have positive perceptions and experiences related to STAD model of cooperative learning.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter presented the summary of the research findings in relation to the research objectives and conclusions drawn from the research. It also contained recommendation for various stakeholders and also some suggestions proposed for further research.

5.1 Summary of Major Findings

The purpose of the study was to find out the effect of Students Teams Achievement Division (STAD) cooperative learning strategy on students performance in the mole concept. Achievement Test items were administered as pre-test and post-test for both control and experimental group to find out the achievement of the students before and after the study. The objectives of the study were to determine the ideas students possess on the mole concept, the effect of STAD learning on students performance, how STAD learning affect male and female performance and also the perception of the students toward the use of STAD learning strategy.

5.1.1 Ideas Students have on the mole concept

The results from the discussions with both the experimental and the control groups revealed that the mole concept is difficult to learn and also when the teacher teaches. They also revealed that relating the mole to the number of particles and the mass of substance was difficult. Students also came out that they have difficulties calculating amount of atoms and ions in given compounds and molecules. This showed that they do not understand the mole as it relates to the various entities such as atoms, ions, molecules etc. in given substances. Students further revealed that they only memorize formulae involving calculation on the mole concept without understanding. Also, they brought out that it is difficult relating different formulae in solving questions on mole. Because students do not understand the concept, they only memorize formulae which they most at times forget some of these formulae and therefore cannot relate them in answering questions. Moreover, the results revealed that students find it difficult applying the mole in stoichiometric calculations. To continue with, students also brought out that the mole concept has no practical application to everyday life.

5.1.2 Effect of STAD Learning on Students Performance

The analysis of the pre-test results using t-test, showed that there was no significant difference in the mean scores performance between the control and the experimental groups before the treatment. However, the post-test results using the t-test showed that there was a statistically significant difference in achievement between the experimental and control groups. The experimental group mean score was higher than the control group after the treatment. The results of the study indicated that STAD cooperative learning had a positive effect on students' performance. STAD cooperative learning has therefore improved the academic achievement of the students.

5.1.3 Effect of STAD on Male and Female Students Performance

The post-test mean scores for experimental male and female were 58.52 and 49.70 respectively. This revealed that the males have a higher mean score than the female. However, the t-test results showed that there was no significant difference in their mean scores. This means that the male students who studied by STAD learning approach did not perform better than the female who studied by STAD.

5.1.4 Students Perceptions of the Use of STAD Cooperative Learning for the Chemistry Lessons

The effectiveness of the use of STAD instructional approach was confirmed from the response of the students from the questionnaire administered on students' perceptions towards STAD. The students indicated that STAD has significantly improved their understanding of the mole concept, reduce rote learning and forgetfulness during examination as a result of this teaching method placing them at the centre of knowledge acquisition which means that they have expressed positive perception towards the use of STAD. They also indicated that STAD is an effective means of helping them understand the mole concept they perceived as difficult and also improved knowledge acquisition and concept formation. Students again expressed great satisfaction of the use of STAD as it enhanced their interaction with colleagues and great participation during lessons.

5.2 Conclusions

The study aimed at investigating the effect of Student Teams Achievement Divisions cooperative learning on students performance in mole concept on Senior High School. The study brought out that students have poor understanding of the mole but the use of STAD cooperative learning in teaching produced a significant improvement in students' understanding of the mole concept as compared to the traditional instructional approach. Students abilities to interpret and comprehend the concept were hugged when taught with the STAD cooperative learning approach. STAD learning has improved understanding, reduce forgetfulness in examination and also reduce rote learning. Again, results from the study indicated that students enjoyed the interactive lessons with their colleagues and thus were motivated more to participate actively in the lessons therefore preferred STAD cooperative instructional strategy as compared to the traditional method. Finally, it was concluded that the use of STAD cooperative learning strategy is an effective teaching strategy of improving students' academic performance and positive perceptions towards the learning of chemistry.

5.3 Recommendations

From the findings of the study, the following are recommended to understudied schools and teachers and other stakeholders of education;

1. Workshops and seminars should be organized for practicing teachers in the municipal where the research was carried to brief them on the importance of STAD and its use since it is found to enhanced students' academic performance.
2. Science teachers in Ghana should use STAD cooperative teaching strategy to improve their students understanding in difficult concepts like the mole.
3. STAD cooperative has been found to improve students' positive perception towards learning as well as enhancing their active participation in learning and collaborative working skills. Therefore, it should be adopted by basic and senior high schools teachers as one of the basic methods of teaching in schools.

5.4 Suggestions for Further Study

Reflecting on the findings of this study, the following recommendations are made for further study:

1. The difference in perceptions of male and female students on the use of STAD cooperative learning.
2. Further research can be carried out to investigate the effectiveness of STAD in understanding science concepts in different schools so that generalization for Ghana can be provided.

3. The study was limited to mole concept. Thus, it is suggested the study be replicated on other chemistry concept such as chemical equations, redox reactions, bonding and other chemistry concepts.

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APPENDICES

Appendix A

Pre-test

Pre-test for senior high school on the mole concept

The purpose of this exercise is to obtain data for research only. It does not form part of students' continuous assessment for end of semester examination. The main objective is to find out your knowledge or understanding of the mole concept. Thus, do well to approach all questions with open mind without copying from one another. All marks obtained on the test will be treated confidentially since you will not indicate your name on the test paper. The responses you give to the questions will guide science teachers in the school to plan their lessons for effective teaching.

Biodata

Kindly indicate your ID number, sex and your age range in the spaces.

RESPONDENT ID NUMBER……………………………….

1. Sex: Male [ ]   Female [ ]

2.Age: 20 years and above [ ]   17-19 years [ ]   16 years and below [ ]

Circle the correct answer for questions 1-15

Answer all questions

1. How many moles are there in 4.2g of $NaHCO_3$? [Na=23, O=16, C=12, H=1]

   A. 0.05mol

   B. 0.5mol

   C. 0.005mol

   D. 5.0mol

2. A mole of any substance contains……………..

   A. $3.01 x 10^{23}$

B. $1.20x10^{23}$

C. $6.02x10^{23}$

D.9 $01x10^{23}$

3. How many moles of hydrogen atoms are in 49.0g of H_2SO_4 (H=1, O=16, S=32)…………

A. 0.2

B. 0.4

C. 1.0

D. 2.0

4. The number of moles of oxygen atoms in 3 mol of $Al_2(SO4)_3$ is……………..

A. 12

B. 18

C. 24

D. 36

5. If one mole of ammonia contains Y number of particles, then how many particles will 1mol of glucose contain

A. 2Y

B. 0.5Y

C. 3Y

D. Y

6. How many ions are present in 4.0g of molten sodium hydroxide? [L= 6.02×10^{23}, NaOH = 40g/mol]…………………..

A. $6.02x10^{22}$

B. $1.020x10^{23}$

C. $3.14x10^{24}$

D. 6.02×10^{24}

7. 1.0mol of ammonia is 17 g. What will be the mass of 0.3mol of ammonia?

A. 5.10 g

B. 56.67 g

C. 7.43 g

D.68.74 g

8. The number of atoms in one mole of a substance is equal to the

A. Atomic number

B. Avogadro's number

C. Mass number

D. Oxidation number

9. What mass of magnesium contains the same number of particles as there are in 6.00g of ^{12}C? [C=12, Mg= 24]……………..

A. 6.00

B. 12.00

C. 18.00

D. 24.00

10. What is the amount of potassium hydroxide in 250cm^3 of 0.05 mol/dm3 of its solution?…………

A .0.0125mol

B .0.125mol

C.1.2500mol

D.12.500mol

11. The volume occupied by 17g of H_2S at s.t.p is [H=1.0, S=32.0, V_m=22.4 dm^3/ mol]

A. 11.2 dm^3

B. 17.0 dm^3

C. 34.0 dm^3

D. 44.8 dm^3

12. A vessel contained 1.6 moles of oxygen gas. Calculate the number of molecules of the gas. [Avogadro constant = 6.02x1023 mol^{-1}]…………………

A. 3.76 x 10^{23}

B. 9.632 x 10^{23}

C. 19.30 x 10^{23}

D. 12.10 x 10^{23}

13. A large advertising board is to be filled with a mixture of gases, including 8.575g neon. What number of moles of neon is required? [Atomic mass of neon = 20.2g]

A. 0.42

B. 2.02

C. 2.34

D. 8.58

A. Y

14. Determine the number of moles present in 1.5x10^{20} electrons.[[L= 6.02x10^{23}]

A. 5.0 x 10^{-4} moles

B. 2.5 x 10^{-4} moles

C. 1.5 x 10^{-4} moles

D. 1.0 x 10^{-4} moles

15. What is the concentration of a solution containing 1.40g of potassium hydroxide per 250cm^3 [KOH =56g/mol]…………………….

A. 0.025 mol/dm^3

A. 0.050 mol/dm^3

B. 0.100 mol/dm^3

C. 0.224 mol/dm^3

16 a) Define the term mole

b) Calculate the number of

i) oxygen molecules   ii) oxygen atoms

in 0.2mol of oxygen gas (O_2) [L= $6.02x10^{23}$]

c) i)What mass of tetraoxosulphate (VI) acid, H_2SO_4 is contained in 500cm^3 of 0.250mol/dm^3 solution (H =1, S=32, O =16)

ii) What volume will 12g of carbon IV oxide occupy at standard temperature and pressure (s.t.p)? Vm = 22.4 C=12, O=16

17 a) Determine the mole of 5.6g of iron (II) oxide, FeO (Fe = 56, O =16)

b) Define Avogadro's number

c) i) Determine the amount of potassium hydroxide in 250cm^3 of 0.05$moldm^{-3}$ of its solution?   ii) What is molar mass?

Appendix B

Ideas Expressed by the Students on the Mole concept

1. The mole concept is difficult to understand on our own
2. The units and symbols are confusion because of ‘M’ for molar mass and again ‘M’ as unit for mole concentration
3. Individual molecules, ions and atoms that are calculated in the substances cannot been seen thereby making it difficult to comprehend and also relating the mole to these particles and the mass of the substance is a problem.
4. The mole is just about memorizing formulae which is difficult to memorize
5. The teacher does not make learning of mole concept interesting since he only makes us copy the note without understanding.
6. Calculations in the mole concept are too much and it will be of great help if teachers do something to reduce it
7. The mole concept was not taught in the basic school and this makes it too abstract.
8. There are practical activities on concepts like preparation of gases, acids, bases and salt but there are no practical activities in the mole.
9. The maths aspect of the mole makes it difficult.
10. The mole concept should be taken out of the chemistry syllabus because it has no practical use in everyday life.

Appendix C

Post-test

The purpose of this exercise is to obtain data for research only. It does not form part of students' continuous assessment for end of semester examination. The main objective is to find out your knowledge or understanding of the mole concept. Thus, do well to approach all questions with open mind without copying from one another. All marks obtained on the test will be treated confidentially since you will not indicate your name on the test paper. The responses you give to the questions will guide science teachers in the school to plan their lessons for effective teaching.

Biodata

Kindly indicate your ID number, sex and your age range in the spaces.

RESPONDENT ID NUMBER……………………………….

1. Sex: Male [ ]   Female [ ]

2. Age: 20 years and above [ ] 17-19 years [ ] 16 years and below [ ]

Circle the correct answer for question 1-15

Answer all questions.

1. How many moles of hydrogen atoms are in 49.0g of H_2SO_4 (H=1, O=16, S=32)…………

   A. 0.2

   B. 0.4

   C. 1.0

   D. 2.0

2. A vessel contained 1.6 moles of oxygen gas. Calculate the number of molecules of the gas.   [Avogadro constant = 6.02×10^{23} mol^{-1}]…………………

   A. 3.76×10^{23}

B. 9.632×10^{23}

C. 19.30×10^{23}

D. 12.10×10^{23}

3. The number of moles of oxygen atoms in 3 mol of $Al_2(SO_4)_3$ is……………..

A. 12

B. 18

C. 24

D. 36

4. The number of atoms in one mole of a substance is equal to the

A. Atomic number

B. Avogadro's number

C. Mass number

D. Oxidation number

5. How many ions are present in 4.0g of molten sodium hydroxide? [L= 6.02×10^{23}, NaOH = 40g/mol]…………………..

A. 6.02×10^{22}

B. 1.020×10^{23}

C. 3.14×10^{24}

D. 6.02×10^{24}

6. What mass of magnesium contains the same number of particles as there are in 6.00g of ^{12}C? [C=12, Mg= 24]……………..

A. 6.00

B. 12.00

C. 18.00

D. 24.00

7. The volume occupied by 17g of H_2S at s.t.p is [H=1.0, S=32.0, V_m=22.4 dm^3/ mol]

A. 11.2 dm^3

B. 17.0 dm^3

C. 34.0 dm^3

D. 44.8 dm^3

8. A mole of any substance contains……………..

A. $3.01x10^{23}$

B. $1.20x10^{23}$

C. $6.02x10^{23}$

D.9 $01x10^{23}$

9. What is the amount of potassium hydroxide in 250cm^3 of 0.05 mol/dm3 of its solution?…………

A .0.0125mol

B .0.125mol

B. 1.2500mol

C. 12.500mol

10. If one mole of ammonia contains Y number of particles, then how many particles will 1mol of glucose contain

A. 2Y

B. 0.5Y

C. 3Y

D. Y

11. Determine the number of moles present in $1.5x10^{20}$ electrons.[[L= $6.02x10^{23}$]

A. 5.0 x 10^{-4} moles

B. 2.5×10^{-4} moles

C. 1.5×10^{-4} moles

D. 1.0×10^{-4} moles

12. What is the concentration of a solution containing 1.40g of potassium hydroxide per 250cm^3 [KOH =56g/mol]……………………

A. 0.025 mol/dm^3

A. 0.050 mol/dm^3

B. 0.100 mol/dm^3

C. 0.224 mol/dm^3

13. How many moles are there in 4.2g of $NaHCO_3$? [Na=23, O=16, C=12, H=1]

A. 0.05mol

B. 0.5mol

C. 0.005mol

D. 5.0mol

14. A large advertising board is to be filled with a mixture of gases, including 8.575g neon. What number of moles of neon is required? [Atomic mass of neon = 20.2g]

A. 0.42

B. 2.02

C. 2.34

D. 8.58

15. 1.0mol of ammonia is 17 g. What will be the mass of 0.3mol of ammonia?

A. 5.10 g

B. 56.67 g

C. 7.43 g

D. 68.74 g

16. a) Define the term mole

b) Calculate the number of

i) oxygen molecules ii) oxygen atoms

in 0.2mol of oxygen gas (O_2) [L= $6.02x10^{23}$]

c) i) What mass of tetraoxosulphate (VI) acid, H_2SO_4 is contained in $500cm^3$ of $0.250mol/dm^3$ solution (H =1, S=32, O =16)

ii) What volume will 12g of carbon IV oxide occupy at standard temperature and pressure (s.t.p)? Vm = 22.4 C=12, O=16

17. a) Determine the mole of 5.6g of iron (II) oxide, FeO (Fe = 56, O =16)

b) Define Avogadro's number

c) i) Determine the amount of potassium hydroxide in $250cm^3$ of $0.05moldm^{-3}$ of its solution? ii) What is molar mass?

Appendix D

This questionnaire has been designed to gather information on students' perceptions towards the use of STAD cooperative learning in the teaching and learning of the mole concept. The information collected will be used solely for academic purposes and such will remain confidential.

Please tick to indicate your level of agreement and disagreement about each of the following statement in the spaces provided

Kindly respond to all questions as accurately as possible.

Tick (√) the box for the appropriate response

RESPONDENT ID NUMBER……………………………….

1. Sex: Male [ ]   Female [ ]

2. Age: 20 years and above [ ]   17-19 years [ ]   16 years and below [ ]

1. STAD cooperative learning improved my understanding of mole concept

1. Strongly Agree [ ] 2. Agree [ ] 3. Not Sure [ ] 4. Disagree [ ] 5. Strongly Disagree [ ]

2. The use of STAD reduces forgetfulness in examination

1. Strongly Agree [ ] 2. Agree [ ] 3. Not Sure [ ] 4. Disagree [ ] 5. Strongly Disagree [ ]

3. I do not always enjoy the lesson when the teacher uses STAD cooperative learning

1. Strongly Agree [ ] 2. Agree [ ] 3. Not Sure [ ] 4. Disagree [ ] 5. Strongly Disagree [ ]

4. STAD learning strategy does not motivate me to learn

1. Strongly Agree [ ] 2. Agree [ ] 3. Not Sure [ ] 4. Disagree [ ] 5. Strongly Disagree [ ]

5. I understand better when the teacher teaches without the STAD cooperative learning

1. Strongly Agree [ ] 2. Agree [ ] 3. Not Sure [ ] 4. Disagree [ ] 5. Strongly Disagree [ ]

6. STAD learning approach reduces rote learning

1. Strongly Agree [ ] 2. Agree [ ] 3. Not Sure [ ] 4. Disagree [ ] 5. Strongly Disagree [ ]

7. STAD learning strategy is an effective means of helping students understand difficult concept

1. Strongly Agree [ ] 2. Agree [ ] 3. Not Sure [ ] 4. Disagree [ ] 5. Strongly Disagree [ ]

8. STAD learning does not help with concept and knowledge acquisition

1. Strongly Agree [ ] 2. Agree [ ] 3. Not Sure [ ] 4. Disagree [ ] 5. Strongly Disagree [ ]

9. The use of STAD does not assist students to understand difficult concept

1. Strongly Agree [ ] 2. Agree [ ] 3. Not Sure [ ] 4. Disagree [ ] 5. Strongly Disagree [ ]

10. I always enjoy the lesson when our teacher uses STAD

1. Strongly Agree [ ] 2. Agree [ ] 3. Not Sure [ ] 4. Disagree [ ] 5. Strongly Disagree [ ]

11. STAD cooperative learning enhances my interaction with colleagues

1. Strongly Agree [ ] 2. Agree [ ] 3. Not Sure [ ] 4. Disagree [ ] 5. Strongly Disagree [ ]

12. STAD learning does not reduce rote learning

1. Strongly Agree [ ] 2. Agree [ ] 3. Not Sure [ ] 4. Disagree [ ] 5. Strongly Disagree [ ]

13. I learn better when the teacher teaches with STAD cooperative learning.

1. Strongly Agree [ ] 2. Agree [ ] 3. Not Sure [ ] 4. Disagree [ ] 5. Strongly Disagree [ ]

14. STAD learning reduces stress and recitation during examination

1. Strongly Agree [ ] 2. Agree [ ] 3. Not Sure [ ] 4. Disagree [ ] 5. Strongly Disagree [ ]

15. STAD learning does not enhanced my participation during lesson

1. Strongly Agree [ ] 2. Agree [ ] 3. Not Sure [ ] 4. Disagree [ ] 5. Strongly Disagree [ ]

Appendix E

PRE- TEST MARKING SCHEME

1. A
2. C
3. C
4. D
5. D
6. A
7. A
8. B
9. D
10. A
11. A
12. B
13. A
14. B
15. B
16. a) Define the term mole

Answer: It is the amount of substance which contains so many elementary particles as there are particles in 12g of carbon-12

b) Calculate the number of

i) oxygen molecules ii) oxygen atoms

in 0.2 mol of oxygen gas (O_2) [L= $6.02x10^{23}$]

Answer: i) 1 mol (O_2) contains $6.02x10^{23}$ oxygen molecules

Therefore 0.2 mol= 0.2/1 x $6.02x10^{23}$ = $1.204x10^{23}$

ii) 1 mole of O_2 molecules contains 2 mol of O atoms, hence total mole of O atoms = 0.2 x 2 = 0.4 mol.

Number of O atoms = 0.4/1 x $6.02x10^{23}$ = $2.408x10^{23}$

c) i)What mass of tetraoxosulphate (VI) acid, H_2SO_4 is contained in 500cm^3 of 0.250mol/dm^3 solution (H =1, S=32, O =16)

Answer: i) molar mass (H2SO4) = 1 x 2 + 32 x 1 +16 x 4) = 98g/mol

Volume of solution = 500cm^3/1000 = 0.5dm^3

1dm^3 of the solution contains 0.250 mol of H_2SO_4

Therefore 0.5 dm^3 = 0.5/1 x 0.25 = 0.125 mol

1mol (H2SO4) = 98g

0.125mol = 0.125/1 x 98 = 12.25 g

ii) What volume will 12g of carbon IV oxide occupy at standard temperature and pressure (s.t.p)? Vm = 22.4 C=12, O=16

Answer: molar mass (CO2) = 12+ 16 x 2 = 44g/mol

44g of CO2 contains 1 mol

Therefore, 12g of CO2 = 12/44 x 1 = 0.272 mol

At s.t.p, 1 mol (CO2) = 22.4dm^3

Hence, 0.272 mol = 0.272/ 1 x 22.4 = 6.0928 dm^3

17a) Determine the mole of 5.6g of iron (II) oxide, FeO (Fe = 56, O =16)

Answer: molar mass (FeO) = 56 x 1+ 16 x 1 = 72g/mol

72g (FeO) = 1mol

Hence 5.6g = 5.6/72 x 1 = 0.0778 mol

b) Define Avodadro's number

Answer: It is the number of entities contained in one mole of a substace.

c) i) Determine the amount of potassium hydroxide in 250cm^3 of 0.05moldm^{-3} of its solution?

Answer: Volume of the solution = 250/1000 = 0.25dm^3

$1dm^3$ of potassium hydroxide solution contains 0.05 mol

Therefore $0.25dm^3$ = 0.25/1 x 0.05 = 0.0125mol

ii) What is molar mass?

Answer: Molar mass is the mass contained in one mole of a substance.

Appendix F

POST-TEST MARKING SCHEME

1. C

2. B

3. D

4. B

5. A

6. D

7. A

8. C

9. A

10. D

11. B

12. B

13. A

14. A

15. A

16 a) Define the term mole

Answer: It is the amount of substance which contains so many elementary particles as there are particles in 12g of carbon-12

b) Calculate the number of

i) oxygen molecules ii) oxygen atoms

in 0.2 mol of oxygen gas (O_2) [L= $6.02x10^{23}$]

Answer: i) 1 mol (O_2) contains $6.02x10^{23}$ oxygen molecules

Therefore 0.2 mol= 0.2/1 x $6.02x10^{23}$ = $1.204x10^{23}$

ii) 1 mole of O_2 molecules contains 2 mol of O atoms, hence total mole of O atoms = 0.2 x 2 = 0.4 mol.

Number of O atoms = 0.4/1 x $6.02x10^{23}$ = $2.408x10^{23}$

c) i)What mass of tetraoxosulphate (VI) acid, H_2SO_4 is contained in 500cm^3 of 0.250mol/dm^3 solution (H =1, S=32, O =16)

Answer: i) molar mass (H2SO4) = 1 x 2 + 32 x 1 +16 x 4) = 98g/mol

Volume of solution = 500cm3/1000 = 0.5dm^3

1dm3 of the solution contains 0.250 mol of H_2SO_4

Therefore 0.5 dm^3 = 0.5/1 x 0.25 = 0.125 mol

1mol (H_2SO_4) = 98g

0.125mol = 0.125/1 x 98 = 12.25 g

ii) What volume will 12g of carbon IV oxide occupy at standard temperature and pressure (s.t.p)? Vm = 22.4 C=12, O=16

Answer: molar mass (CO_2) = 12+ 16 x 2 = 44g/mol

44g of CO_2 contains 1 mol

Therefore, 12g of CO_2 = 12/44 x 1 = 0.272 mol

At s.t.p, 1 mol (CO_2) = 22.4dm^3

Hence, 0.272 mol = 0.272/ 1 x 22.4 = 6.0928 dm^3

17a) Determine the mole of 5.6g of iron (II) oxide, FeO (Fe = 56, O =16)

Answer: molar mass (FeO) = 56 x 1+ 16 x 1 = 72g/mol

72g (FeO) = 1mol

Hence 5.6g = 5.6/72 x 1 = 0.0778 mol

b) Define Avodadro's number

Answer: It is the number of entities contained in one mole of a substace.

c) i) Determine the amount of potassium hydroxide in 250cm^3 of 0.05$moldm^{-3}$ of its solution?

Answer: Volume of the solution = 250/1000 = 0.25dm^3

$1dm^3$ of potassium hydroxide solution contains 0.05 mol

Therefore $0.25dm^3 = 0.25/1 \times 0.05 = 0.0125mol$

ii) What is molar mass?

Answer: Molar mass is the mass contained in one mole of a substance.

Appendix G

Students t-distribution table showing the difference in achievement scores of the experimental and control groups in the pre-test

Groups	N	Mean	SD	df	t-value	p-value
Experimental	35	43.430	16.486	63	0.834	0.408
Control	30	40.070	15.881			

Appendix H

SECTION I

Post-test scores and Frequencies of control Group

Marks	Frequency	Percentage (%)
0-49	19	63.33
50-54	4	13.33
55-59	2	6.67
60-64	2	6.67
65-69	1	3.33
70-74	2	6.67
75-79	0	0
80-100	0	0
Total	30	100

SECTION II

Experimental Group Post-test Scores and Frequencies

Marks	Frequency	Percentage (%)

0-49	10	28.57
50-54	3	8.57
55-59	6	17.14
60-64	4	11.43
65-69	2	5.71
70-74	4	11.43
75-79	3	8.57
80-100	3	8.57
Total	35	100