UNIVERSITY OF EDUCATION, WINNEBA

EFFECT OF COOPERATIVE INSTRUCTIONAL APPROACHES ON STUDENTS' PERFORMANCE IN CHEMICAL BONDING AT ASUOM SENIOR HIGH SCHOOL

EUNICE DEI

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(220026536)

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

DECEMBER, 2023

DECLARATION

STUDENT'S DECLARATION

I, **Eunice Dei**, declare that this research work, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for other masters elsewhere.

Signature: ……

Date: ……

SUPERVISOR'S DECLARATION

I, **J. K. Eminah**, hereby declare that the preparation and presentation of this research work was supervised in accordance with the guidelines on supervision of dissertation as laid down by the University of Education, Winneba.

Signature: ……

Date: ……

DEDICATION

This work is dedicated to my dad Mr Hayford Kofi Dei.

ACKNOWLEDGEMENTS

I want to first thank the almighty God for making this possible.

I wish to express my heartfelt appreciation to my supervisor, Prof. J. K. Eminah, a Professor in the Department of Science Education, University of Education, Winneba, for his technical guidance and encouragement throughout this research work.

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ABSTRACT

This study investigated the effect of cooperative instructional approach on the performance of Form One General Science students of Asuom Senior High School in chemical bonding. The study adopted an action research design and utilised the purposive sampling technique to select an intact class of forty (40) students for the research. Data were gathered using tests and questionnaire, and analysed using descriptive and inferential statistics. The findings of the study indicated that students exhibited a notable improvement in academic performance from the pre-intervention test (Mean= 6.18) to the post-intervention test (Mean= 9.84). The t-test analysis revealed a statistically significant difference between the pre-intervention test mean score and the post- intervention test mean score ($p= 0.037$; $p< 0.05$). Also, the findings revealed the effects of the intervention on the mean performance of both male (Mean= 6.81) and female (Mean= 9.67) senior high school (SHS) students in chemical bonding. The t-test analysis of the pre and post-intervention test scores revealed a statistically significant difference between the mean academic performance of the male and female SHS students after being taught with cooperative instructional approach were p-value = 0.028 and its lesser than the alpha value which is 0.05. Moreover, the findings of the study revealed that SHS students have overwhelmingly positive views on the use of cooperative instructional approach in the teaching and learning of chemical bonding. Based on the findings the researcher recommended that teachers should include cooperative instructional approach as in their lessons to increase student's confidence level. Additionally, teachers should engage students in cooperative instructional activities to enable students the exhibit attitudes needed for effective group methods. Teachers should use cooperative instructional approaches to sustain students' interest in lesson activities and ensure their active participation as well.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter gives the introduction to the study. It considers the following: Background to the study, statement of the problem, purpose and objectives of the study, research questions, limitations and delimitation.

1.1 Background to the Study

Cooperative learning in the 1960s was not in the attention of the scholars as the individualistic and competitive learning were the dominating teaching methods. Nowadays, cooperative learning is a crucial method in the educational field not only in the elementary and secondary schools but also in the universities (Johnson & Johnson, 2016).

Cooperative learning refers to the instructional use of small groups where students work with one another in order to master the academic content of a subject. Also, Smith 2004 stated that learning could be cooperative when the students work together to accomplish specific tasks.

Research around the word has highlighted the effectiveness of cooperative learning in promoting deep learning and higher achievement in the classroom, especially science classroom at all levels (Johnson & Johnson, 1989; Johnson et al., 2019)

Several studies have validated the effectiveness of student engagement strategies such as cooperative, collaborative, and active learning, but most of such studies are based on classroom behaviours such as students' participation, attention span, and students' interest towards learning of chemistry rather than on test scores and other forms of classroom achievements (Johnson, Johnson, & Stanne, 2018). These studies generally

measure individual participation and interest as a result of student engagement with peers. Although these studies contribute to pedagogy, they fail to consider the longer-term impact of specific learning strategies on student academic achievement. Researchers have consistently found a relationship between student engagement and positive classroom outcomes such as attention and interest (Ames, 2018; Carini, Kuh, & Klein, 2016; Pascarella & Terenzini, 2015; Skinner & Belmont, 2013). Although fewer studies have addressed specifically academic performance, some have found relationships between student engagement and problem solving, retention, and logic skills (Cooper, Cox, Nammouz, Case, & Stevens, 2018). Others have found that students working closely with a diverse group of peers are more likely to experience gains in the development of need for cognition (Goodman, 2011; Loes, 2019).

A vigorous review of the available literature also revealed that studies often focused on the general impact of senior high school students' experiences on their academic development, and little evidence supported the direct link between cooperative learning and the performance of students in chemistry (Cabrera *et al*., 2017). Chemical bonding in integrated science was taught in a science class at Asuom senior high school, it was observed based on the scores of students to questions that the students could not answer simple questions on this topic. It was difficult for these students to define these rudimentary terms that underscored the whole concept of chemistry. This present study thus sought to assess the effect of cooperative learning approach on the academic performance of senior high school students in chemistry.

1.2 Statement of the Problem

The Ghana Education Service Senior High School Integrated Science Syllabus was meant to equip students with relevant basic scientific knowledge and to produce character-minded learners who can contribute to personal, national and the global

development (CRDD,2010; NaCCA,2020). However, the researcher's personal experience in her school showed that the students performed poorly particularly in chemical bonding.

The WAEC Chief Examiner's Report, in the years 2015 to 2018 showed that students did not perform well in chemistry and this was as a result of lack of understanding of basic concepts including chemical bonding. Since knowledge of chemical bonding and related concepts (ionic and covalent bonding) is important for understanding other integrated science topics, the researcher decided to design an appropriate intervention to enable the students gain conceptual understanding of chemical bonding.

1.3 Purpose of the Study

The purpose of the study is to investigate the impact of cooperative instructional approaches on the students' academic performance in chemical bonding in Asuom Senior High School.

1.4 Objectives of the Study

The objectives of the study were to determine:

1. the ideas the students possessed about chemical bonding as well as the difficulties they face during lessons.
2. the effect of Cooperative Instructional Approaches on the students' performance in chemical bonding.
3. the differential effects of the intervention on the mean performances of the male and female students.
4. the perception of the students of the use of Cooperative Instructional Approaches for lessons on chemical bonding.

1.5 Research Questions

The following research questions were addressed in the study

1. What ideas do the students possess about chemical bonding and what difficulties do they face during lessons on the topic?
2. What is the effect of cooperative instructional approaches on the students' performance in chemical bonding?
3. What is the differential effects of the intervention on the mean performance of the male and female students?
4. What are the students' perceptions of the use of cooperative instructional approaches for lessons on chemical bonding?

1.6 Significance of the Study

- The study may help to enhance the students' conceptual understanding of chemical bonding in Asuom Senior High School.
- Again, the study may be helpful to arouse and maintain students' interest in learning chemistry.
- Last but not the least, the study may help provide suggestions for other researchers to pursue other investigative directions on the problem of this study.

1.7 Limitations of the Study

The study might be affected by the unavoidable absence of some students at critical stages of the implementation, that is the pre-intervention, intervention and post-intervention stages.

1.8 Delimitations of the Study

The study involved only Form One Students' in Asuom Senior High School. The intervention will focus only on chemical bonding. Other integrated science topics were excluded.

1.9 Definition of Terms

Cooperative Instructional Approaches: Cooperative Instructional Approach is a kind of learning situation in which students work as a team collaboratively in a relatively small group while they share ideas and experiences in the processes.

Traditional Instructional Approach: teaching methods characterized by only verbal modal instruction such as teacher-centered.

1.10 Abbreviations

WAEC: West African Examination Council

GES: Ghana Education Service

CRDD: Curriculum Research and Development Division

NaCCA: National Council for Curriculum and Assessment

1.11 Organization of the Research Report

This research report is organized into five chapters. Chapter one comprises of a brief introduction, background to the study, statement of the study, purpose of the study and research questions. The others are design of the study, limitation, delimitation, significance of the study and finally organization of the study. Chapter Two comprises literature review that relates to the study. Chapter Three is methodology of the study. This comprises of research design population and sample selection research instrument pilot-testing, pre-test intervention and post-test and the data analysis plan. Chapter Four comprises with the presentation of results findings discussions whiles chapter five

covers the summary of the findings conclusions recommendations and suggestions for further studies.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

In this chapter, the theoretical perspective as well as the conceptual framework of this study will be discussed. This chapter of the study will also review literature related to the study. The literature will be reviewed extensively under various themes.

2.1 Meaning and Historical background of Cooperative Instructional Approaches

Cooperative learning can be defined as a teaching method that involves students in learning process to understand and learn content of the subject (Slavin 2016). The most common one employed in education is possibly that of Johnson and Johnson (2016) of Minnesota University. They describe that students work in group in cooperative learning strategy, to achieve shared goals, under conditions of positive inter-dependence, individual and group accountability, face-to-face promotion, proper utilization of cooperative skills and group processing. Cooperative learning technique is different from group learning approach. An instructional strategy is recognized as cooperative learning to the degree to which these referred elements are present.

Concept of cooperative learning has been existed in history of ancient time. Teachers have persuaded their pupils to work together on occasional group projects, in group debates or peer tutoring methods since immemorial time (Slavin, 2018). Quintilian had explained the concept of group debates in the early first century, who argued that peer learning would facilitate the pupils (Johnson Johnson & Stanne, 2018). Marcus Fabius Quintilian was famous roman teacher from about 68-88 AD (Pappas, 2003). Pappas, (2003) stated that concept of peer learning was mentioned in the Talmud too (Collection

of ancient writings on Jewish Law, and traditions), which emphasized the peer learning (Chiu, 2000). Two Talmud: The Palestinian Talmud and the Babylonian Talmud have written by Jewish scholars. The importance of group debates between 400 AD and 600 AD was favoured by Johnson, Johnson and Stanne (2019). Political harmony, educational cooperation, religious reforms were highlighted by john Comenius in his works (Pappas, 2003). Johnson, Johnson and Stanne (2019) claimed that Comenius advocated that during group debates practice, students would learn by receiving instruction and providing instruction to others. They stated that Joseph Lancaster and Andrew Bell had started peer learning groups-based schools in 1800 in England respectively.

Evolution of these schools promoted peer learning extensively and the idea of group debates learning was used up across the Atlantic Ocean. In 1806 peer learning groups-based school was initiated based on Lancastrian concepts in New York City. During common school practices peer learning based schools gained support in USA in first quarter of 19th century.

Priority was given to Implementation of group debates learning in class in the last quarter of 19th century. He was competent to manage more than 30000 visitors per year to examine his implementation of peer teaching (Clarke, 2009). Implementation of peer tutoring was also advocated in John Dewy famous project method attributing the Parker efforts.

Johnson, Johnson and Stanne (2019), stated that peer learning techniques dominated by American education system till the ending of the century. Meanwhile Parker was also boosting with devotion the application of peer learning. Turner and Triplett (2007) initiated comparative studies on competitive, individualistic, and peer learning in England and America respectively.

Miller was probably one of the pioneer researchers, who conducted experimental study on peer learning strategies in 1929. Deutsch, (2015) claimed that May and Doob were reviewed literature on cooperative and Competitive learning until 1937.

Cooperative learning has passed through the stages of success and failure in the educational institutes of America. In 1930s competitive learning achieved attention in American education and peer learning failed to keep its interest in educational practices (Pepitone, 2008). Peer learning reclaimed the interest in American education system when community schools were promoted to amalgamate in 1960s.

Peer learning was implemented in the classrooms because researchers and educators were advocating to produce mutual interaction among the learners belonging to various races and to assist the learners of minority group to enhance their educational attainment (Oslen & Kagan, 2012). In America few research studies carried out to promote and evaluate cooperative learning methods in classroom through the end of 20th century (Slavin, 2018). For example, Elliot Aronson and his companions developed jigsaw technique at Texas University Austin. Learning together was developed through efforts of Johnson and Johnson (2016) at Minnesota University America. Slavin (2018) and companions introduced Games-Tournament and STAD techniques at Johns Hopkin University America. Currently useful and effectual cooperative learning approaches are available for instruction of various subjects at various educational levels because of practical implementations by numerous instructors and many years of research. Today instructors have opportunities to select empirical cooperative learning technique to be used efficiently for teaching any subject at different levels. Hence, instructor could use cooperative learning approach to organize classrooms for valuable instruction (Slavin 2018).

2.2 The Nature of Chemical Bonding Concept

Chemical bonding is one of the key concepts in chemistry and one of the most fundamental ones that students learn. In fact, Hornby (2009) reported that bonding is a central concept in the teaching of chemistry. A thorough understanding of it is necessary for understanding of every other topic in chemistry such as carbon compounds, proteins, polymers, acids and bases, chemical energy and thermodynamics. The concepts of chemical bonding and structure, such as covalent bonds, molecules, ions, giant lattices and hydrogen bonds are highly abstract. Due to the abstract nature of bonding, it is considered by teachers-trainee and chemists to be a very complicated concept to understand (Robinson, 2003; Taber, 2001). Chemical bonding is an area in the physical sciences which understanding is developed through diverse models which learners are expected to interpret through the use of different range of symbolic representations and modes (Taber, 2001). Levy, Mamlok-Naaman, Hofstein and Taber (2010) argues that in order to fully understand these concepts, learners of chemical bonding must be familiar with mathematical and physical concepts and laws that are associated with bonding concepts such as orbital, electronegativity, electron repulsion and polarity. Learning about chemical bonding also allows the learner to make predictions and give explanations about physical and chemical properties of all substances.

Sanchez Gomez and Martin (2003) discussed that the most advanced models available to chemist for understanding the structure of matter are those that might be judged as best approximations to 'reality' of the current state of knowledge deriving from quantum chemistry. However, Sanchez Gomez and Martin also suggested that the majority of chemists were quite content to work with models that largely predated developments in quantum chemistry. This is considered to provide support and explain

current knowledge of matter. It means that most chemists are using set of models and modes that are now understood to be limited representational meaning of the structure of matter.

Chemist understand substances as clusters of sub- microscopic particles formed by chemical bonds (Levy, Mamlok-Naaman, Hofstein and Taber (2010). The chemical bonds between these particles are used to explain many of the chemical and physical properties of substances and chemical phenomena (Hurst, 2002; Levy Nahum, Hofstein, Mamlok-Naaman & Bar-Dov, 2004). Since chemical bonding is a central concept in teaching chemistry, a thorough appreciation of its nature and characteristics is necessary for the learners. Chemical bonding is also explained to be what holds atoms together in molecules and crystal. It stated that that it is one of six most important key concepts that should be included in every high school chemistry syllabus.

2.2 Cooperative Learning Theoretical Bases

Learning theories are the origin of the widespread usage of cooperative learning instruction. A review of related literature reveals that cooperative learning was essentially insignificant fifty years ago, but that it is now a common learning strategy at all educational levels (primary, elementary, and secondary schools, colleges, and universities) in most developed and developing countries.

The majority of academics have put out a wide range of theoretical hypotheses to explain the better ranking of cooperative learning (Slavin 2016; Johnson & Johnson, 2016). Social cognitive theories and motivational theories are the two basic categories into which the theories pertaining to the cooperative learning approach are divided. The stories of these two schools of thought come next. Learning theories are the origin of the widespread usage of cooperative learning instruction. A review of related literature reveals that cooperative learning was essentially insignificant fifty years ago, but that it

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2.2.1 Motivational theory

As it serves as the foundation for these cooperative learning theories that enable learners to engage in learning activities, the motivational outlook of cooperative learning focuses primarily on the incentive structures and team goal formation. Deutsch (2015) identifies three types of goal structures:

i. Cooperative goal structures, where each member of the group is required to contribute to the achievement of the goals of the others.
ii. A system of goals that is competitive and requires everyone to try to prevent others from achieving their goals.
iii. Individualistic goal structures, in which no one person's actions have an impact on the achievement of another person's goals.

Cooperative goal frameworks offer the individual a setting in which team members may only achieve their goals if and when each member succeeds (Johnson & Johnson, 2016; Slavin, 2018). Team members are therefore expected to support and encourage their fellow teammates to exert their maximum effort in relation to achieving their own goals. In other words, cooperative groups' rewards criteria were based on participants' overall achievements, and they established an interpersonal incentive structure where members

of the group could grant or withhold assistance in response to each other's efforts to complete assigned tasks (Slavin, 2018).

According to motivational theorists, standard grading and incentive systems create peer norms in regular classrooms that cause students to avoid academic pursuits. However, when students collaborate in groups to accomplish instructional goals under a cooperative goal structure, their learning efforts support their group mates' success (Deutsch 2015). Slavin (2016) investigated how students who worked in cooperative groups improved their social status in the classroom for increasing academic accomplishment, whereas those in traditional classrooms were unable to do so. These differences in the social repercussions of academic performance can be crucial. According to Brook-Over et al. (2014), group members' support in achieving was the main predictor of their success (after adjusting for ability and social status). Cooperative goal structures undoubtedly result in the development of pro-academic norms among treatment group participants, and these norms support learners' academic achievement. According to Locke and Lathan (2010), setting personal goals is influenced by factors such as team goals, role modelling, support, and assessment. Goals govern how people behave. These components align with Salvin's (2016) cooperative learning model. According to goal setting theory, team objectives lead to higher personal goal accountability than goals alone. if individual goals are placed before team goals. Similar to this, the cooperative learning approach contends that setting team goals would boost inspiration for learning and encourage teammates to do the same. According to Slavin (2016), when a cooperative goal structure is implemented, it creates a group contingency where team members' behaviour serves as the foundation for deciding how much each member would receive in rewards. The team members do not need to be capable of actually helping their teammates in order to apply the group contingencies

theory. The outcome is dependent on how each party behaves. The team rewards persuade people to drive goal-oriented behaviour among their team members, therefore it is sufficient to encourage participants to engage in behaviour that helps the team to be rewarded.

2.2.2 Social cognitive theories

According to Slavin (2016), cooperative learning encourages students to work together to achieve common goals and places them in a social environment where they can mature cognitively by utilising the Slavin cooperative learning model. This, in turn, makes learning easier and more standardised.

According to Merriam and Caffarella (2009) and Hansman (2001), social context is necessary for learning. Learning is not something that happens in a vacuum; rather, it can be shaped by the way students connect with one another, the tools they use to interact, the learning objective, and the social context in which the activity takes place. It includes the social context, everyday customs, and methods and tools for learning to take place in the learning environment. Cognitive theories are classified into two major groups:

i. Developmental theories

ii. Cognitive elaboration theories

2.2.2.1 Developmental theories

These ideas are predicated on the idea that cooperative engagement between learners during appropriate tasks improves students' critical thinking abilities (Damon, 2014; Murray, 2012).

Vygotsky is one of the well-known social cognitive theorists who stresses the importance of social context for cognitive development. He contends that social contact is ultimately what drives cognition forward. According to Slavin (2018), a learner's

growth begins in the social environment before moving on to the personal level; internalisation of information is growth that begins with social interaction of learners before it advances into an individual one.

Additionally, Slavin found that social learning processes make learning simpler and more engaging by giving participants the ability to collaborate with others who are in their proximal growth zones. According to him, the zone of proximal development is the difference between the rate of factual growth determined by working alone and the rate of latent growth determined by working together with gifted peers. The concept of the "zone of proximal development" was discussed by Bransford et al. (2013) in connection to the interaction between collaborative learning and social context. They asserted that cooperative learning guaranteed a stable social environment with other talented individuals. Additionally, (Vygotsky Damon, 2014) asserted that cooperative learning strategies enhance participant development because participants of similar ages tend to work in each other's zones of proximal development and were consequently more productive when working in cooperative groups than when working alone.

According to Vygotsky, participating in cooperative activities boosts learning and socialisation while keeping individuals at their zone of proximal development. Students may have the potential to obtain interpretation that are provided to them in a plainer and more intelligible manner than those they were given by individuals of greater mental ability of similar age if they take advantage of the opportunity to work virtually within their level of proximal growth. According to research into linked literature, Piaget represents socialization's benefits in the social context. He affirmed that social context aids in the acquisition of moral values, manners, standards, traditions, and languages. Piaget (Damon, 2014) strongly criticised the traditional educational system, which employs traditional teaching methods, competitive evaluation, and individual

homework assignments. He asserted that the issue might be resolved by working in teams. He contends that collaborative learning enhances students' mental development. Although Duckworth (2014) argued that engaging in practical action is a fundamental element of mental development, he also stressed that for learning to take place effectively, active student participation in the learning process is a requirement.

They suggested that all expansions and advances should be viewed as transitory conflicts and inconsistencies that need to be managed in order to reach the desired degree of equilibrium.

According to Hartman (2009), assimilation and accommodation are part of the process of equilibration. Assimilation is the process through which people use their current thought processes to comprehend the outside world. When people realise that their current beliefs do not fully consider the reality of the outside world, they either adjust them or establish new ones as part of the accommodation process. While traditional teaching methods may not encourage such activities, the cooperative learning approach helps create the conditions for them to occur. The social transmission theory of Vygotsky and Piaget's proximal development zone are congruent with one another, and Piaget urged for the adoption of cooperative learning. He believed that people are only willing to learn new things when they have a framework that makes it easy for them to absorb and comprehend them. Cooperative learning groups typically give participants the chance to help group members go on to the next stage of growth. These findings offer justification for the widespread application of the collaborative learning methodology in educational institutions (Damon, 2014). They claim that social connection among those taking part in educational activities will position students to achieve more. Discussion of the material will expose any cognitive disagreements, poor logical arguments, and profound knowledge.

As a result, in a cooperative learning group, students will benefit from one another's knowledge.

In his 2000 book, Bandura offers a causation model in which the variables of environment, behaviour, and cognition interact and serve as causes of one another. The term "triadic reciprocity" was coined by Bandura to describe this relationship.

The causal link ensures interaction between these three elements in nature. In most cases, a number of components are required to have a clear influence. According to Bandura, triadic design assures that these three components are tightly related to one another. However, he added that each of the three types of factors has varying degrees of impact depending on the person, behaviour, and circumstance.

According to Bandura (2000), learners' thoughts and emotions can be formed, supervised, and refined through modelling and social interaction. Only via modelling can one direct attention, boost motivation, improve performance, and arouse emotions. Verbal modelling stimulates the mind and aids in the development of cognitive skills.

If modelling helps to facilitate problem solving activities without creating the cognitive process, according to Bandura, learners would just witness the output without knowing how the activity has been completed. The development of cognitive abilities as they are used in problem solving techniques requires the verbalization of thought processes. The directed actions of one's own thoughts are made obvious through apparent representation, and both the traits of thought and action are helpful in fostering broader improvements in cognitive abilities. Bandura has backed the value of modelling and determined that it takes time for modelling to have an impact on the development of cognitive abilities.

2.2.2.2 Cognition elaboration theories

The cognitive elaboration approach differs from the developmental outlook, according to a review of related literature. Wittrock (2008) looked into whether an observer would engage in a certain type of cognitive elaboration of the contents if facts and numbers needed to be kept in mind and connected to information already stored in memory. Teaching others how to learn is one of the most beneficial learning methods.

The students that were actively involved in teaching the content to other students learned more through the cooperative learning strategy (Webb, 2008). According to Dansereau (2018), cognitive elaboration helps learners learn more than those who worked alone but less than those who communicated the content to others. According to research, the cooperative learning approach gives students the chance to take on the roles of presenter and observer. They each study a piece of the material at once, and the presenter summarises what they have learned while the observer corrects any errors and fills in any gaps with the content they may have missed. Both participants can then recall the key ideas. The learners switch roles in the following level. Peer learning, according to Devin, Feldman, and Allen (2016), benefits both the tutor and the tutee more. According to Stevens et al. (2017), collaborative learning places students in a position where they may assess, clarify, and elaborate learning processes to one another. As a result, they can more successfully observe and understand the complex cognitive process. One or more cognitive processes are carried out during face-to-face meaningful engagement, which is a key component of cooperative learning (Mackeachie, 2002). A win-win situation is created when one student provides information to another by summarising it in their own terms. The learning of the observers who receive the explanation is increased by the elaboration, and the learning of the observers who supply the explanation is strengthened.

The cooperative integrated reading, writing, and languages arts programme (Stevens et al., 2017) and reciprocal instruction (Palincsar & Brown, 2014) are examples of programmes that make use of the cognitive elaboration potential in a practical way.

2.3 Types of Cooperative Instructional Approaches

Cooperative learning is divided into three types, with a different implementation of each. Johnson and Johnson (2016) described the following three kinds of cooperative learning based on group work duration.

2.3.1 Formal cooperative learning

Cooperative learning approach becomes formal cooperative learning when learners work in small group and complete assigned work to obtain common goals, for at least one schooling period to few weeks (e.g. report writing, group project, carrying out laboratory work). In formal cooperative learning groups instructors must define learning out comes of the learning session, specify the group size, and assign participants to groups. They describe the group task and promotive interaction. They keep under observation and assess students' learning. They promote learners' groups interpersonal skills, and provide process assistance to group members to rate the quality of their groups' functions.

2.3.2 Informal cooperative learning

Cooperative learning approach becomes informal cooperative learning when the learners toil together to obtain common instructional goals within a session of few minutes to one schooling period. Instructors use direct teaching strategy (demonstration, motion picture etc.) in such sort of cooperative learning. Participants probably, concentrate on the learning content, and work in an environment helpful to learning. They decide on expectancies of what could be taken in during a session,

whether students assimilate the learning content cognitively and avail closure to a schooling session.

2.3.3 Cooperative base group

When learners toil together in a mixed ability group, for at least one to several years with long lasting fellowship to obtain common instructional goals, then cooperative group takes the form of cooperative base group. They are destined to back up, assist, motivate, and boost the teammates to promote their learning growth and enhance cognitive and social capabilities of individuals in wholesome ways (Johnson and Johnson, 2016).

2.4 Traditional Learning (TL) verses Cooperative Learning (CL)

The core of cooperative learning is interdependence. Hsiung (2011) conducted a comparison on students' academic performance in both cooperative learning and traditional learning by using Taguchi Quality Indexes. The participants were 42 sophomore mechanical engineering students. The researcher divided the students into two classes, and each class had 21 students. The first group worked together on solving the tasks assigned to them. Whereas the second group worked individually. After using a T-test, the researcher found that the students who work in cooperative learning groups had higher grades compared to those students who worked alone. In addition, cooperation encourages interaction. Individuals within the team encourage each other and facilitate one another’s efforts to learn together and to teach other students who may have difficulty with a subject or topic. On the other hand, traditional centred learning encourages independent learning. Both systems have positive and negative sides. Cooperative learning encourages teamwork, and because it creates an environment in which students not rely entirely on a teacher to give feedback and support, learners are able to identify their own strengths and weaknesses regarding their

own learning. Thus, they depend less on teachers. However, the negative side of CL is that it requires more time and the learners' cooperation to succeed. Because it is based on students' engagement in material alone, and feedback from the teacher, traditional learning encourages individuals to be more self-reliant (Manning & Lucking, 1991). Active learning techniques employ a more hands-on strategy, animation techniques, and jigsaw technique, which make learning more attractive. In addition, techniques such as project-based learning, inquiry-based learning, and problem-based education increase student's acquaintance and conceptual comprehension (Doymus, Karacop, & Simsek, 2010). Lately, between these techniques jigsaw and animation cooperative education have attracted the awareness of school leaders, teachers, and educational researcher. Researchers have stated that one of the differences between cooperative learning and more traditional learning approaches is that of the role of competition to motivate students. They stated that setting competitive goals enable students to compete. Therefore, in an effort to outdo their classmates, students are compelled to work harder. On the other hand, there is no competitive instinct in cooperative learning. Another difference between the TL and CL is that whilst the individual learning enables one to attain personal goals, there is nothing like personal goals in cooperative learning. In cooperative learning, the interdependence is positive; the students help each other to be better in academic performance. The students want to achieve certain academic goals together in cooperative learning. Additionally, in an extensive analysis of research studies that gave a comparison among the three paradigms of learning, namely, individualistic, competitive, and cooperative learning, Peterson and Miller (2004) examined the quality of college students' experiences during CL. The participants in this study were 113 students in four sections of psychology course. The researchers used questionnaire to collect the data. After two weeks, the students responded. The

researchers found that the best paradigm of learning was cooperative learning (CL). The research took place in a college setting whereby the researchers noted the experiences of students learning together and compared it to individualistic and competitive learning. Students who had cooperative learning experiences were more positive towards academic learning than the ones who did not have cooperative learning experiences. Additionally, they were more appreciative of the ideas and opinions of other students than the ones who did not have cooperative learning experiences. Moreover, the students in the cooperative learning group took part in controversial arguments about academic subjects, developed interaction skills, and had more academic expectations than students who learned in individualistic and competitive environments. A variety of Cooperative learning strategies have been in empirical studies throughout the world, demonstrating a positive effect between cooperative learning and academic performance, as well as attitudes towards learning. As an example, Bahar-ÖzvariŞ, Çetin, Turan and Peters (2006) conducted a study in Turkey in which they examined the difference between cooperative learning strategy which is problem-based learning (PBL) and lecture-based learning. There were 150 students who participated in this study and the experimental group consisted of 67 students, while control group was 83 students in a mental health course. The students were divided randomly into control group and experimental group. The researchers used pre and post- intervention tests as well as using T- test to measure the differences between the two groups. Results showed that cooperative learning led to better academic performance (T=0.00) than individualistic learning (T=0, 70). Students functioned well when they cooperated with each other. The researchers observed that cooperation also increased motivation among students towards their learning. The students in the experiment group sought clarification, elaboration and justification from each other. In

addition, it enabled the students to share argument roles, procedural knowledge and conceptual work. The research has also suggested that cooperative learning can be effective in passive learning environments. This kind of learning depends on verbal lectures, the student's role is passive no activities during class time. Nen-Chen, Gladie, and Wu (2005) conducted an empirical study to examine if cooperative learning improves students' outcomes in passive learning environment or not. The sample in this study was 172 students in an intermediate accounting course at Hong Kong University. The students were randomly split into two groups; one group taught by cooperative learning (small group) and the second group taught entirely though lectures. The researcher used ANCOVA to compare the test results for the two groups. The results showed that the p value was 0.01 in favour of the experimental group. In addition, the students who worked as groups outperformed students who were taught by using lecture. Perkins and Saris (2001) also studied a group of students for four weeks. They studied the effects of the method of jigsaw learning and the traditional type of learning on the performance of students. They found that the students who used the jigsaw learning performed better on the exam given at the end of semester than the ones who used the conventional method, showing a 5% increase between pre-test and post-test scores, compared to students who had received lecture style classes alone the reason is that cooperative learning “stimulates cognitive activities that promote knowledge retention and achievement” (Peterson & Miller, 2004, p. 127). Over 500 research studies are available on the cooperative learning. Researchers such as Manning & Lucking (1991), Huang (2011), Brown and Mcllroy (2011), Peterson and Miller (2004) all prove that cooperative learning is the best mode that teachers should employ in the current educational environment.

2.5 Cooperative Learning and Academic Achievement

Research around the word has highlighted the effectiveness of cooperative learning in promoting deep learning and higher achievement in the classroom, especially science classroom at all levels (Johnson & Johnson, 1989; Johnson et al., 2014). Knowing that cooperative learning encourages student involvement and engagement in their own learning, it provides all students with opportunities to make their thoughts visible to others, allows them to talk about their own ideas, and permits them to consider the ideas of others, which enhances their higher order thinking skills (Johnson et al., 2014). In the light of this, effective cooperative learning leads to active learning that enables students to move beyond the text, memorization of basic facts, and consequently promotes learning and practicing higher-level skills. This would lead, apart from academic benefits, to enhance learners' self-esteem, and interpersonal relationship and attitudes toward school and peers.

2.6 Elements of Cooperative Learning

Research has discovered that there are many strategies or elements to elevate the success of cooperative learning. There are five key elements of cooperative learning that should be added in any lesson to improve cooperative learning. These five factors are: positive interdependence, individual accountability, face-to-face interaction, interpersonal and small group skills, and self-evaluation. The first element is positive interdependence. Here, team members need to rely on each other in order to complete the group's task. Positive interdependence includes allocation of roles or tasks that involve students in the learning process and the for division of responsibility such as student note-taker, time-keeper, and results-reporter. Positive interdependence can be achieved when each group member comes to understand and value the need for group cooperation in the attainment of their own personal goals, the other individual group

member's goals, and the goals of the entire group. Positive interdependence may take several forms, including goal interdependence, task or labour interdependence, resource interdependence, role interdependence, or reward interdependence. The result of this interdependence is that students will be more highly motivated to work cooperatively when task success depends on the participation of other group members (Johnson, Johnson, & Smith, 1998;). However, it is the teacher's responsibility to design interdependence into the assignment. For example, resource interdependence exists when individuals each possess specific resources needed for the group as a whole to succeed. Teachers may promote resource interdependence by giving specific resources to different individuals in the group. Moreover, task or sequence interdependence occurs when one group member must first complete his/her task before the next task can be completed. For example, collecting water samples might be assigned to two group members, while research on how to collect samples is done by two other group members (Johnson, Johnson, & Smith, 1998). The second essential element of cooperative learning is individual accountability. This means assessing the quality and quantity of each member's contributions in the group, which makes each student responsible for his role to the group assignment effort. Individual accountability involves holding each student accountable for mastering relevant material. The purpose of a learning situation is to maximize the achievement of each individual student. Individual accountability is promoted by providing opportunities for the performance of individuals to be observed and evaluated by others. For example, individual quizzes or examinations promote individual accountability. Random checking is posing a question or a problem and randomly calling on specific individuals to give an explanation after talking about the question or problem in a group. Another example of individual contributions to a team report, would be if individual members were asked

at random to present a part of the report. Another approach would be to have one student serve as checker on a team. The role of a checker is to ask each member individually whether they understand the design, solution, or explanation that the team has just constructed. The checker may ask for some demonstration of understanding (Johnson, Johnson, & Smith, 1998). Face-to-Face promotive interaction is the third of these elements, whereby team members assist each other and the group by discussing the topic, challenging others' ideas, and arriving at consensus. Face-to face interaction, works in conjunction with positive interdependence. Face-to-face interactions involve individual group members encouraging and facilitating other group members' efforts to complete tasks and achieve in order to have successful group goals. Face-to-face interaction encompasses providing each other with efficient and effective help and assistance and influencing each other's efforts to achieve mutual goals. One example for a teacher to apply this element in the classroom would be to ask students to form individual responses to a multiple-choice question focused on a particular concept and then reach consensus on an answer as a team. Another would be to follow up successful team activities by asking students to reflect on how the team helped individual learning. Furthermore, jigsaw is a cooperative learning structure in which the material to be learned is divided into separate components. Groups of students are assigned responsibility for each component and learn together how to teach that component. Then teams, with one individual responsible for each component, come together to teach each other the entire set of material (Johnson, Johnson, & Smith, 1998). The fourth essential element of cooperative learning is interpersonal and small group skills. The social skills that are necessary for a student to perform competently in a small group are taught directly during a cooperative learning lesson. Simple small group social skills such as staying with one's group, speaking in a low conversational voice, trusting other

group members, and the sharing of leadership responsibilities usually require specific and direct attention from the teacher. Groups cannot work effectively if members do not have and use the needed social skills such as collaborative skills that include decision-making, trust building, communication, and conflict-management (Johnson, Johnson, & Smith, 1998). Finally, the fifth basic element of cooperative learning involves group self-evaluation. Groups need a specific time to discuss how they achieved their goals and to maintain effective working relationships among members. The purpose of this element is to clarify and improve the productiveness of all group members in contributing to the cooperative efforts of achieving the group's goals. Quality teamwork has many aspects that cooperative learning can help develop in a group, including collaboration, cooperation, and group cohesion. Cooperative learning can increase communicative competence, language knowledge and skills, as well as a higher level of enthusiasm and cooperation within the class.

2.7 Cooperative Learning and Student Participation in Lessons

A study was done on two male secondary students attending the Upward Bound pre-college program. Each student worked in small groups with specific roles, and two observers documented the amount of time each student participated during the cooperative learning activities. The results of this study showed that cooperative learning techniques increased student's participation. Research supports the view that when students are working with their peers in cooperative learning situations, they are actively engaged. Students have a greater chance to become involved with each other as well (Peterson & Miller, 2004).

A Grade 6 class and two Grade 9 classes in Northern Chicago, Illinois was taught using cooperative learning approach. Prior to the introduction of cooperative learning techniques, children experienced difficulty participating in class lectures and retaining

instructional materials, as documented through teacher observations and student surveys. Following the implementation of cooperative learning techniques, students exhibited greater involvement in class lectures/discussion, increased retention and a greater transfer of learning. Over the last quarter century, cooperative learning strategies have arrived as a popular option to traditional instruction due to the positive influence on students' esteem and performance.

2.8 Effect of Different Cooperative Learning Strategies on Students' Performance

Tsay and Brady (2010) conducted a case study on twenty-four participants in a communication research course for four months. The academic performance and involvement were the independent variable in this study. The researcher concluded by using surveys, experiments, and content analysis. After students responded in the survey the researchers collected and analysed data, and discussed finding of the involvements. The result showed that students who employed cooperative learning (group working) had good academic achievement. In addition, cooperative learning techniques were effective on students' outcomes in the application of principles, calculation, and gaining of knowledge. Finally, the results yielded that there was a significant relationship between student involvement in cooperative learning and academic performance ($\beta = 0.26$, $p = 0.01$). Like evaluation and judgment, problem analysis, involvement, and identification of concepts are better with cooperative learning. In the same school of thought, Jong and Chi (2006) found that cooperative learning structures such as Tournaments Games Teams (TGT) gave consistent results that were positive. For example, students who participated in the activities showed positive results on their achievements, mutual concerns, race relations, and other related variables. Furthermore, research that Jong and Chi did on Student Teams Achievement Divisions (STAD) supported the fact that cooperative learning had a positive effect on

the academic achievement of individual students. Huang (2011) gave an analysis of 46 studies that researchers conducted for a specific period of time. Among the findings that he examined, there were the positive outcomes that related cooperative learning with academic performance. He found that 63% of all the students showed better outcomes in individual academic performances in Social Sciences for cooperative learning. On the other hand, only 33% did not show any difference between the outcomes of cooperative learning and the other traditional learning methods. The achievements were 89% better with the students who adopted cooperative learning than those using the traditional methods of learning. The results fully supported the fact that cooperative learning had a positive impact on the academic excellence of the students. Also, research shows that in terms of problem-solving skills, cooperative efforts produce the highest quality. The reason, according to Williams, Caroll and Hautau (2005), is that cognitive process functions improve. When students are in groups, there is an exchange of insights and information among the members of the group. They generate a variety of strategies to solve the problem, increase their ability to translate them into equations and develop an exchange of ideas that they share. What it means is that cooperative learning increases the ability of students to understand academic problems in a way that the traditional forms cannot. Researchers that share the same thoughts are Williams and Caroll (2007). They investigated the progress of two students whose initial responses were unwilling to cooperate with each other. In the human development course, the classroom had 22 students. The two participants were not friends prior to the instructions to sit next to each other and cooperate in assignments and other academic related issues. However, as time passed, both students began to enjoy the company of each other in terms of learning. At the end of the study, the findings revealed that both students had academic gains. There is a thrust in research

about peer learning showing that when instructors ask peers to be in groups, it encourages them to have useful academic discussions and dialogues that benefit them. Their arguments also take a good course because they argue about opinions that promote more research among them than if they learn on individual terms. Curscedieu and Pluut (2013) continued to state that many researchers focus on the individual benefits of cooperative learning, rather than on the whole group. Thus, they did a study on a group of 159 students. Their findings suggested that while all the group members benefited; the ones that benefit more than the rest were the group leaders that in most cases were more aggressive than their group members. The consequence of the students seeking clarification, elaboration and justification from each other is good academic performance. Tsay and Brady (2010) stated that cooperative learning could produce an effect called motivational effects. Ning (2013), Tsay and Brady (2010), and Summers and Turner (2011) also stated that there was a very strong correlation between student academic achievement and their motivation. "The motivational capacity is a strong factor in the academic performance of a student" (Summers & Turner, 2011, p. 459). They encourage each other in their small groups and learn (Ning, 2010). There is a growing consensus among educators and researchers that cooperative learning produces a positive effect among student in terms of motivation which increases academic performance. They suggested that the results not only applied to college students, but to all levels of education. The role of teaches is different in the cooperative learning classroom from that of the traditional class. The teacher is the facilitator of learning in a cooperative learning environment. The teacher is there to help in the sharing of the knowledge that every group already has. He or she does not lecture. Collaboration makes sharing and the subsequent absorption of knowledge better than lecturing alone. Students share what they have learnt. In other cases, there are students who continue

with the discussions even after class. Thus, absorption of the knowledge is better than if the teacher lectures and there is no discussion. Many studies continue to show that in contrast to the traditional methods of learning such as competitive and individualistic, cooperative learning leads to better academic performance of students. In a study by Williams, Caroll, and Hautau (2005), the results reveal that many teachers and instructors in different settings such as Turkey, Taiwan, and America now employ cooperative learning in their classrooms. Wu, (2013), and Williams and Carol (2007) all agree that according to their observations, many schools in different settings now employ the use of cooperative learning. Some of them support the premise that cooperative learning is productive with relation to all areas of content. Moreover, some suggest that despite abilities, races, or geographic locations, all students improve their academic performance as a result of employing cooperative learning. Also, the findings suggest that even students who are high achieving and gifted benefit from cooperative learning.

2.9 Methods of Cooperative Learning

Research studies have been traced back to 1970s on use of cooperative learning methods in classroom. Presently, researchers are also investigating the principles and theories to facilitate the use of cooperative learning approaches in educational fields. As a result of these efforts wide range of cooperative learning techniques are accessible for practice in every subject, in all kinds of schools, at all grade levels throughout the world. (Slavin, 2018) divided these methods in the following sections;

2.9.1 Students' team learning methods

These cooperative learning approaches are investigated and refined by experts and researchers of John Hopkins University America. These techniques are entailed in majority studies of cooperative learning approaches.

In cooperative learning methods learners must participate in group work to reinforce their personal learning and promote teammates' learning too. All group's members may obtain instructional objectives, when emphases are made on the use of group goals for ensuring group success in all methods of students' team learning. These methods provide opportunities to learners to avail learning as group.

All learners' group learning techniques emphasize cooperative learning elements like team rewards, individual accountability, and equal chances for attainment of goals. Group can win group awards and other incentives through achievement of above-mentioned measures. Groups probably involve in competition to fulfil the planned measures in a granted week instead of winning scarce group awards. Individual accountability, group rewards and equal chances for success ascertain that all mixed ability group members are equally persuaded to perform their functions effectively, and that the role play of all group mates are highly rated.

Researchers improved and refined five main pupil team learning techniques through research processes. STAD (Students Team Achievement Division), TGT (Teams Games Tournaments) and Jigsaw II are most common cooperative learning techniques and are being used broadly, at all grade levels for all subjects. CIRC (Cooperative Integrated Reading and Composition) and TAI (Team Accelerated Instruction) are exhaustive curricula methods that are developed for application in specific scheme of studies at specific educational levels. Three popular cooperative group techniques are described next.

2.9.1.1 STAD

Students Team Achievement Division was introduced by Slavin (2016). In this method, learners work in mixed ability groups usually having four members of different races and localities. In STAD instructors ensure lesson presentation as usual in classroom,

and learners toil together in groups to reinforce their learning. They discuss and assist with each other in group to ascertain that teammates have learned the material effectively. Instructors give individuals quizzes to students on the learning content at a times of competition among groups. Group score is added by individuals' scores. An individual gains points if student quiz score exceeds his /her base score and that points are accumulated to the group points (Slavin, 2018). STAD has been considered appropriate for a variety of subjects and grade levels. Teacher presentation, group reinforcement activities, and test are basic elements of STAD cycle, usually requires maximum four schooling periods.

2.9.1.2 TGT (Teams Games Tournaments)

TGT was the first of the cooperative methods developed by D. Devries and his colleagues at John Hopkin University and like STAD makes use of instructor presentation, distribution of work sheet, team work, individual quizzes and group reward. However, weekly tournaments are held among the teams in place of quizzes. In the tournaments, individuals add points to their group scores through playing academic games with other groups' participants. They participate in "tournament tables" of three-person games with members of other groups having parallel previous academic achievements. High performing representative of the group earns reward for whole team. Although, tournament table composition changes weekly and groups are held responsible to study together for six weeks.

2.9.1.3 Jigsaw II

That cooperative learning technique has been made by Slavin through modification of pre-existing Jigsaw technique of Aronson et al (2011). In this cooperative learning technique, like STAD and TGT, learners work in mixed ability groups of four members. Text material is distributed among group members and a portion of a topic is assigned

to each one individual in group for learning. Then they learn the assigned material and team members with similar portion of topic form expert groups. They reinforce their learning in expert groups and go back to present learned material to their original group members. Then they are assessed through quizzes. Portions of instructional material is assigned to group members.

They learn the material, then team members with similar part of the topic e.g. covalent bonding, form expert groups and thoroughly learn the material relevant to covalent bonding. Then "experts" re-joined their parental group to share their learned material with group members. At last, students are assessed through quizzes on the assigned text.

2.9.2 Other cooperative learning methods

2.9.2.1 Circles of learning

Johnson et al. (2016, 2018) developed cooperative learning methods collectively called learning together, at university of Minnesota stressing on cooperative learning elements. In all cooperative learning methods, participants carry out their learning activities in mixed ability groups on assigned material. Each group works on single sheet, and gets recognition and awards based on group outcome. Learning together approach needs to ensure social interaction and group discussion before the practical group working on given assignment.

2.9.2.2 Jigsaw

Jigsaw is cooperative learning approach that facilitates students to work in group and reinforce 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 of their group. Students are assessed through individual quizzes and grades are awarded based on individual quiz outcome. (Aronson et al., 2011; Clarke, 2009).

2.9.2.3 Group investigation

This method, originated by Herbert and later Sharan (2014) 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 on projects jointly in cooperative learning group. In this method cooperative learning groups are based on specific topic of common interest. The topics are selected by teams from a lesson taught to whole class, these topics are classified into individual tasks, relevant activities are put into practice and group reports are prepared. Then students and instructors both evaluate the report presented by each group in the class at a specified period. Six stages of GI implementation are suggested by Sharan (2014). These stages are outlined as under:

- Groups formation and selection of the topic
- Planning of learning task
- Investigation conduction
- Final report preparation
- Final report presentation to entire class
- Achievement evaluation

2.9.2.4 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 and capabilities with others that aim to mature group success. In this method participants collaboratively work on science project in group to discover scientific facts and principles. Implementation of this learning style in bilingual classes showed positive outcomes.

Details are ready to be used, in English and other international languages. Hence multilingual learners may toil jointly in cooperative learning groups (Slavin, 2016).

2.9.2.5 Team accelerated instruction

This method has introduced to be used for teaching mathematics to elementary classes or senior students reluctant of algebra course. In this method students can utilize both cooperative and individualistic efforts to achieve instructional objectives. They need to assist group mates and assess each other's work, so that they can learn instructional material. Students encourage and support their group members to participate successively in group work, because they have strong desire of their teams' success. TAI emphasizes individual accountability and each one in the group is to learn instructional material. Individual final tests are given to students and they are not allowed to support others during the final test. All students are placed according to their prior knowledge, so that they may avail similar chances of their success (Slavin, 2016).

2.9.2.6 Cooperative integrated reading and composition

Madden et al. (2016) stated that CIRC is planned scheme which may employ to promote basic comprehension skills at elementary level schooling. In CIRC learners make pairs and cooperatively do practice on reading, sum up narratives to group members, write response to narratives, and re-enforce vocabulary in their respective groups. They also participate in group learning activities to grasp central concept and develop other comprehension skills. Learners' motivation is ensured through use of cooperative reward structure so that they effectively, involve in pairs' work on these learning strategies and would get certificates or awards on basis of whole team members' performance.

2.9.2.7 Structured dyadic methods

It is an organized instructional method that facilitates students' working in pairs on teaching, to one another. They work as tutor and tutee to understand course of action or grasp important points of assigned material. Students may increase their learning through effective implementation of this method (Dansereau, 2018). It is a simple and comprehensive study program of peer tutoring. In this method instructors ask questions from their learners. If they answer accurately, the learners obtain points. If not, instructors tell correct answers and learner must note it and do learning practice several times. Instructors and learners change their roles after each ten minutes. Pairs obtaining maximums points are appreciated on daily basis in class. (Green Wood, Deluadri & Hall, 2019).

2.9.3 Informal learning methods

Baloche (2008) described important informal cooperative learning methods as follows:

2.9.3.1 Spontaneous group discussion

It is structured cooperative learning technique which adds to in a way that improves group learning and conventional teaching and may be lasting for a few minutes to one class session. Team work makes it easier to discuss with students in a session of presentation that what is meant by something, why something is functioning or what's the solution of certain problem (Slavin, 2016).

2.9.3.2 Number heads together

Kagan (2004), claimed that number had allotted to each one in the group. Students knew that instructor might be asked only one group member to represent the group. The instructor presents questions to students in class and asks them to work together on finding the answers. That way they would receive a point, no matter which number was called. It is basically a variant of group discussion and twist is that teacher randomly

selects one student to answer. That twist insures individual accountability and participation of all the students in group activities.

2.9.3.3 Team product

In Team Product method, participants work together in groups on team product like essay writing, picture drawing, and worksheet completion. They ensure a presentation to the class, create better administration, share information to find out possible solution to a group conflict and interpret a poem. Instructor ascertains individual accountability by giving individual roles or responsibility to group members (Slavin, 2016).

2.9.3.4 Think-pair share

This is simple and useful cooperative learning method in which students work in small groups of four members and involve in thinking about questions presented by instructor. Then they are called in front of the class to answer the questions. In this method, four measures are involved.

i. Instructor poses a question in class and students carefully pay attention to it.
ii. Students have a time to ponder of question and write their answers.
iii. Students analyse and talk about their responses in pairs.
iv. Instructor asks some students to share their opinions and views with whole class.

Science teachers and students have hypothetical construct about effectiveness of that approach in classroom. Hence it would be more beneficial in science class and laboratory work. (Lyman, 2011).

2.9.3.5 Round table

This is simple and effective cooperative learning strategy that facilitates students' working together in small groups to study more subject matter, increase courage and determination, and develop their writing skills. In the round table strategy, three

measures are ensured to it. i. Question having multiple choice answers is presented by instructor in the class. ii. In every team, opening member enlists one option on a paper and gives a chance to the next teammate in clock wise direction. iii. Appreciation certificate is awarded to the team with maximum true options. Science teachers may be employed round table cooperative learning approach effectively in the science class and laboratory work.

2.9.3.6 Round robin brain storming/rally robin

It is simple and interesting cooperative learning method in which students work in mixed ability groups of approximately four members including one record keeper. The instructor raises a question of multiple answers and students must reflect on the best option in a specified time. Then students in each group, discuss the answers with their mates in round-robin way. All the responses of teammates are recorded by record keeper. The learner next to the record keeper presents his response and record keeper puts in writing it. After that every member of group gives an answer in clock wise order till time is over. It is slightly different rearrangement of round tables. The shifting is that in this technique, the record keeper is responsible for maintaining the records of each member in group.

2.9.3.7 Cooperative review

It is an effective cooperative learning technique that facilitates learner groups to prepare review questions before the tests. They must enquire the other groups through imploring questions by taking turns. Group gains points based on question asking activities. Initiative taking group gains a point if it gives an accurate response. After that another group may contribute relevant facts to the response and can gain a point (Slavin, 2016).

2.9.3.8 Laboratories and projects

Students toil together in group to work on assigned projects in said method more effectively. Project work may be distributed amongst group members. Instructor has to ensure that every participant needs to accomplish assigned portion of project work. Instructor assesses the project report, presented by student at the end of academic session. A group leader is necessary for projects, but instructor should emphasize that leaner's job is to ascertain collaborative participation of each group member in project work and do not allow free rider to occur. Group members would not be ready to participate completely if they do not realize personal liability for the team out-come (Slavin, 2018).

2.10 Benefits of Cooperative Learning

Cooperative learning has a massive positive impact on students and their working environment. It enhances productivity and improves student knowledge.

Below are the benefits of cooperative learning:

2.10.1 Academic benefits

Cooperative learning strategies have a positive effect on improving the achievement of students and their interpersonal relationships. In 67 studies of the achievement effects of cooperative learning 61% found significantly greater achievement in cooperative learning group than the traditionally taught control groups. Positive effects were found in all major subjects; all grade levels; in urban, rural, and suburban schools; and for high, average, and low achievers. In brief, cooperative learning has been found to be a successful teaching strategy at all levels, from pre-school to postsecondary. A study on two male secondary students attending the Upward Bound pre-college program. Each student worked in small groups with specific roles, and two observers documented the amount of time each student participated during the cooperative learning activities. The

results of this study showed that cooperative learning techniques increased student's participation. Cooperative learning has been researched and implemented in classrooms around the world since the 1970s. Research has proven that this instructional strategy can be effective in encouraging student relations and motivating student academic involvement in school. Research also indicates that cooperative learning has positive effects on academic achievement, especially for students with learning disabilities. It is important, however, to note that cooperative learning does not mean simply putting students in a group. When cooperative learning is carefully structured, students exhibit an increase in academically engaged time and elementary students remain on task. The findings from numerous research studies on cooperative learning show improvement in academic achievement, behaviour and attendance, motivation, and school and classmate's satisfaction. Also, 87% of the studies that used the cooperative learning strategy observed positive effects on learning achievement (AL-Badawi, 2008). In addition, cooperative learning enhances higher academic achievement. In cooperative learning, a group is composed of low achieving students who work harder when grouped higher achieving students. In this way there is hardly any cause of failure for low achieving students. Compared with traditional learning methodologies, cooperative learning is an active instructional strategy that fosters higher academic achievement. Moreover, cooperative learning enhances learning outcomes. The interaction between the weaker students and better achievers results in improved and efficient learning.

2.10.2 Interpersonal benefits

In addition to the academic benefits of cooperative learning there are interpersonal benefits to the students. When students work interdependently, it can increase their feelings of support for one another, and develop their self-esteem. Similarly, cooperative work affects students' development of autonomy, sense of purpose, and

building and maintaining of mature interpersonal relationships. Cooperative learning leads to the personal development of students by promoting self-confidence, and a positive attitude amongst them, while working collectively in a group in order to solve a given task. Engaging students in the learning process increases involvement and allows students to understand how subject material relates to life experiences. If lessons are viewed as relating to the experiences of students in the classroom, and thus a valid application to real life expectations, student motivation will increase.

2.10.3 Social benefits

In cooperative learning students with different learning skills, cultural background, attitudes and personalities interact with each other which ultimately results in the development of social skills like sharing, cooperation, integrity, leadership, decision making and division of labour. There are a number of studies examining the positive effects of cooperative learning. There were 12 out of 14 studies on cooperative learning and inter-group relations that showed that cooperative learning had a positive effect on building positive social relationships. Cooperative learning inculcates the skills of cooperation, leadership, team work and division of labour among the students which makes them efficient for the jobs in the companies which have emphasis on the social skills and favour the combined effort of knowledge and manpower. Despite the ample evidence supporting the use of cooperative learning, there are some drawbacks and fears of using this strategy in the classroom. These reasons present a persuasive disincentive to adopt cooperative approaches.

2.11 Studies Related to Cooperative Learning

Enormous research studies have been carried out to determine the effects of cooperative learning approach verses conventional method regarding the variables of academic achievement, social relations, and psychological norms. Most of studies

results advocated the validity of cooperative learning approach on the above-mentioned variables. A concise description of the studies on the effectiveness of cooperative learning has been discussed as under: Slavin (2018) and Johnson & Johnson (2016) conducted two significant and fundamental meta-analyses on the literature of cooperative learning respectively. They concluded that cooperative strategies had indicated more positive impact on learners' attainment than traditional methodology.

They assessed the impact of cooperative learning on learners' attainment. In these two studies they applied vote counting and effect size as measuring parameters to provide empirical support to their studies. Vote counting refers to reckon the extent of inclusive treatment effect of cooperative learning based on the calculation of studies proportion. Findings of both analyses indicated positive effect, no effect, and negative effect of treatment on achievements (Hedges & Olkin, 2015; Jackson, 2010).

According to Gravetter and Wallnau (2004), effect size refers to compute the mean difference between the treatment and control groups. Johnson and Johnson (2016) and Slavin (2018) used Cohen's criteria for limitations of effect size measures. Cohen (2013), proposed that study which have an effect size as 0.20 has average effect, the study which have an effect size as 0.80 or has greater significant effect. Gall, Borg, and Gall (2003), proposed that study which have an effect size as 0.33 has significant effect. Notable research synthesis was carried out by Johnson and Johnson (2016). Totally, 539 studies were analysed by them and covered 93 years research work appeared on research horizon. 367 studies included in the review had been conducted in previous 29 years. 458 studies were experimental in nature, incorporating variety of subjects at various educational levels. 528 studies were organized in American countries with 178 studies at elementary level, 113 at secondary level, 216 at college level and only 27 on

adults. The mean effect sizes were located between .52 and .89 and whole mean was .73, indicating that cooperative learning was found to be more fruitful methodology than traditional way of teaching. The vote counting also favoured supremacy of cooperative learning, with 323 numbers of studies showed positive effects, 172 showed no effects, and 43 showed negative effects. Slavin (2018) also carried out important research review to search out the effects of cooperative learning verses conventional learning. The results of that review indicated that cooperative learning was more effective approach than traditional learning. This research review employed various techniques of cooperative learning and lasted for (20 hours) or more duration. Total ninety qualified, major studies were analysed by Slavin in his review. Slavin (2018), concluded on the basis of studies analysed that cooperative group work had showed more fruitful performance than traditional teaching. In the meta-analyses firstly, he classified ninety qualified studies in nine categories based on cooperative learning techniques. After that he computed mean effect size for each technique to find out the effectiveness of cooperative learning. Table 3 reflects the classification of effect sizes based on cooperative techniques. This research review also presented the effectiveness of different cooperative learning elements, regarding learners' attainment through comparison of vote counting and mean effect sizes outcomes.

Most studies, which qualified for Slavin's research review (2018), had been carried out in American educational setting at all educational levels. However, very few studies were also conducted in European, and African countries. Nevertheless, the effectiveness of Johnson and Johnson's (2016) synthesis, was more significant than Slavin's synthesis based on Cohen's measures of effect sizes. The results of both reviews favoured the effectiveness of cooperative learning approach on the variable of learners' attainment. Forty-six studies were analysed by Qin et al. (2017) to explore the

effect of cooperative strategies on learners' attainment at all the schooling levels. They found that results of cooperative learners were far better than competitive learners belonging to treatment and control groups respectively. The cooperative group average performance was 71 percent more effective than competitive learning outcomes. An experimental study was carried out by Bayraktar (2001) to determine the effect of cooperative learning approach on students' attainments in health and physical education at university level. The results of study showed that performance of treatment group was significantly, satisfactory than control group in sports activities session on the variables academic attainment, learning attitude and personal skills practices. In Singapore an empirical study was carried out by Christine, Maureen and Rosalind (2002) to determine the effect of cooperative learning on learners' performance in social studies regarding diverse contexts.

This study results showed that low and average achievers of treatment group were performed better and benefited more of cooperative learning approach than learners of control group. Yamarik (2007) conducted a research study to find out the effect of cooperative group work on learners' attainment in the subject of economics. The result indicated that cooperative learners obtained better test scores than traditional learners. Rocio (2011) carried out a study on use of cooperative learning in professional institutions and found that cooperative learning promoted instructional procedure of technical education. As cooperative learning creates a situation in which learners can participate actively in cooperative group activities to reinforce their learning. Hence it might be used effectively, as an alternative method in the field of engineering education. Arbab (2003) designed an empirical study to search out the effectiveness of cooperative group work versus the conventional approach at the secondary level on the variable of students' test scores of general sciences. Learners were classified into treatment and

control groups using pre-test scores. Fifteen days of treatment was given to the experimental group by employing a cooperative learning strategy. Based on the findings, she explored that the mean score of the treatment group was significantly greater than control group. Parveen (2010) carried out an experimental study aimed at, examining the effect of cooperative learning verses traditional approach on variable of students' tests scores, in social studies at elementary level. They stated that they had not found any significant relationship between cooperative learning and conventional method of teaching. Al- Badawi (2008) conducted a study aimed at, was to find out comparative effectiveness of cooperative learning strategy Jigsaw II on variables of learners' performance in the form of reading, tests scores and motivation in English as foreign language (EFL).

The experimental group was given Jigsaw II treatment for two months duration. The findings of the study indicated that he had not found any significant relationship between cooperative strategy "Jigsaw II" and conventional method of teaching. The effect of GI (Group Investigation) and STAD (Student team achievement division) by giving treatment of GI and STAD cooperative learning techniques to both experimental groups on learners' performance in the form of reading and attainment of EFL students. The control group was taught by employing traditional method. After treatment, data were collected by using a post-test as data collecting instrument. Collected data were analysed through statistical parameters like One-way ANOVA and post hoc Schefft test. He concluded that the STAD technique showed the most significant positive outcomes than GI and Conventional methods. Iqbal (2004) investigated the impact of STAD on students' mathematics achievement scores. The experimental group was given treatment for seventy-five days duration by employing the cooperative learning "STAD" technique. Conventional methodology was employed to teach the students in

the control group. The result he of the study indicated that cooperative learners of treatment group had obtained larger academic scores than students of the control group. He furtherly, stated that low-achieving students had benefited more thigh-achieving Vin students from cooperative learning.

Kosar, (2003) evaluated the effectiveness of cooperative learning technique verses conventional learning on higher elementary students' test scores in social studies. Previous annual examination scores in the subject of social studies were used to classify the sample of forty students into treatment and control groups. The experimental group was treated through cooperative learning activities for fifteen days duration. Post-test was used to determine the academic achievements of both groups after treatment, aimed at, comparing their outcomes. The findings of the study indicated that cooperative learners in the treatment group showed better performance in terms of test scores than the control group's learners. Gaith (2003; 2004) evaluated the comparative effectiveness of different cooperative learning techniques on EFL students. In these studies, serious attention was given to all the scientific research measures to ascertain the validity of research processes. They examined the impact of cooperative learning techniques like Jigsaw II, learning together, and (STAD) on the variables of achievements, reading comprehension, motivation, and attitude toward group work. Questionnaires and investigator arranged tests were used to collect relevant data.

They found that in certain studies cooperative learners had shown significantly more positive outcomes than traditional learners, while in other studies, they performed similarly as compared to their counterparts in traditional teaching groups. Gaith, (2003) planned an empirical study to seek out the effect of learning together technique in EFL on secondary school students. He argued that learners of learning together technique

achieved higher test scores than learners in traditional class teaching. Gaith (2004) conducted a study to examine the effect of the Jigsaw II technique on the reading comprehension of students in the EFL at college level. The findings of the study indicated that the learners in Jigsaw II learning outscored their counterparts in traditional classroom room teaching.

Furtherly, they reported that cooperative learning had situated the students to receive more academic and social assistance from their group members and instructors. Gaith (2003) conducted studies to examine the effect of cooperative learning on the variables of school alienation, class cohesion, and grading fairness. The findings of the studies indicated that cooperative learning strategy had decreased school alienation and promoted class cohesion and grading fairness respectively. Gaith (2003) argued that low-achieving students benefited more than high-achieving students from cooperative learning activities in terms of social and academic assistance. Seller, (2005) conducted a study to explore the effect of cooperative learning techniques on EFL students' anxiety, motivation, and attitude towards group work. He concluded that the cooperative learning technique seemed to increase motivation, promote the attitude towards group work and decrease anxiety.

2.12 Challenges Associated with Cooperative Learning

Slavin (2016) lists the following risks associated with cooperative learning methods:

i. Free Rider: When learning activities are poorly planned, the free rider effect, one of the risks associated with cooperative learning, may take place. When using cooperative learning strategies, it's possible to create a situation known as the "free rider effect," in which a small group of teammates perform the majority of the learning assignments while the other peers choose not to take part. The

free rider effect happens when team members are required to fulfill a single task (write a single report or work on a single project, for example).

ii. Diffusion of Responsibility: This challenge to cooperative learning might create an environment in which knowledgeable team members may choose to ignore students who are thought to be less talented group members. When students are given challenging science problems to answer in groups, the talented individuals' active engagement will develop and mature while the contributions of the other, less capable members may be overlooked.

iii. Learning a part of the task specialty: In cooperative learning techniques (like Jigsaw and Group Investigation), the team's task is broken up into pieces, and each group member is given the responsibility to work on a particular element of the task. Therefore, there is a chance that students could develop expertise and master just the portion of the assignment that was allotted to them.

iv. Teacher's loss of control. Conventional learning is a teacher-centered approach that facilitates an environment where instructors play a dominant role in the teaching-learning process and educate their pupils. It is assumed that students are helpful and sensible in the traditional classroom. Instructors believe that they may retain their primary position in traditional classrooms. While cooperative learning is a student-centered technique and teachers may not keep their central position in class. In the cooperative learning approach instructor observes, monitors, and guides the students. Hence instructor must keep in sight and supervise group work, in place of prominently delivering the lesson (Garfied, 2013). Therefore, many instructors are reluctant to employ cooperative learning techniques in class as they believe that they can be deprived of their pivotal position in class.

v. Time requirement: Vaughan, (2010) stated that administration and parents impose pressure on instructors to complete coursework well on time, and they force teachers to continue with traditional methods of instruction. However, coursework would not be completed in cooperative learning situations as group task without requiring additional time. So, instructors probably hesitate to use cooperative learning in schools.

vi. Resistance to change: Senior high schools frequently use the traditional mode of instruction. Teachers and administrators do not wish to change the widely used traditional teaching methods. To transition to a cooperative learning system, enough time is required. It is also challenging to change ingrained behaviors and states of affairs. The rest of the content is not subject to the same reservations held by school administration and subject matter specialists regarding advances in task specialization.

According to Slavin (2016), if students are held individually responsible for their learning, as in student group-learning methodologies, this problem can be solved. Based on the aggregate of the test results of the group's members, incentives are given to the group. In order to ensure that everyone in the group has understood the subject, student team learning strategies may forbid any member from taking advantage of the situation. It is difficult for a group to ignore any of its members when working on a job.

2.13The Conceptual Framework

The conceptual framework of the study is shown dramatically in Figure 1.

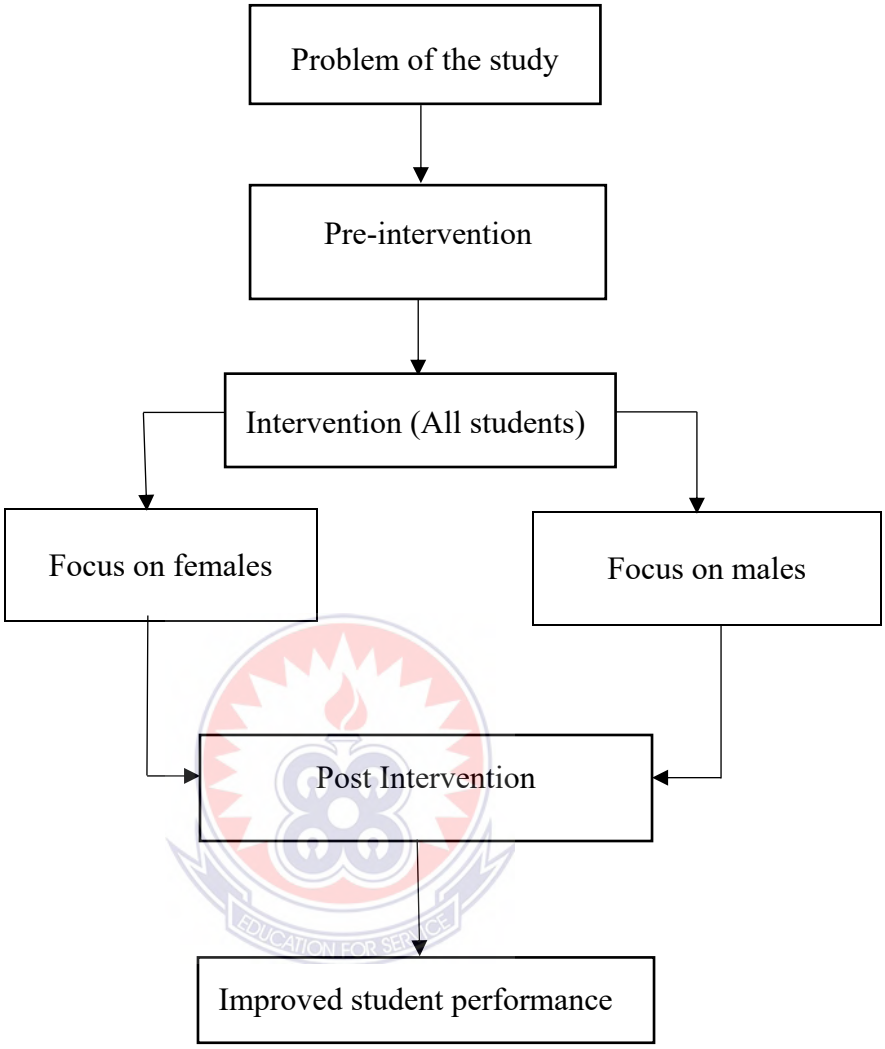

Figure 1: Diagrammatic representation of the conceptual framework of the study

2.14 Empirical Framework

Researchers have carried out different studies to examine the effectiveness of the cooperative learning approach versus conventional learning on students' performance in biology. Effects of Group Investigation and Jigsaw techniques on students' performance in biology in terms of test scores. The findings of the studies indicated that students who received treatment through group investigation achieved high scores in biology than those, who worked in Jigsaw groups. The effect of cooperative learning

was evaluated by Doymus, Karacop, and Simsek 2010 on students' understanding of selected topics in biology. The results of the study indicated that learners in treatment group had achieved higher scores than those, who worked in competitive and individualistic learning settings, as they were involved actively in cooperative group activities and working together.

The effect of the cooperative approach on the learners' performance in terms of test scores and practical skills attainment in the biology course of 9th class, was investigated by Okebukula and Ogunniyi (2014), at secondary level schooling in Nigeria. Results of the study indicated that cooperative learners had outscored those learners, who received instruction through conventional methods. The effect of cooperative interaction techniques versus competitive style on higher elementary school students' achievement was evaluated by Okebukula and Ogunniyi (2014) in Nigeria. He reported that cooperative learners outscored the competitive learners. An experimental study was designed by Shachar and Fischer (2004) to seek out the effect of the Group Investigation Technique on higher secondary school students' achievement, motivation, and understanding of an 11th-grade biology course. The findings of the study showed an increase in test scores of low and medium-ability students in treatment groups and motivation comparatively, seem to decrease in cooperative learning groups.

Taran and Acar (2007) estimated the effect of the cooperative learning style by undertaking an empirical study on secondary school students' insight about classification in 9th class biology courses. The results indicated that students, who were taught through a cooperative learning approach outperformed the students learning in conventional situations. Cooperative groups' learners were also active in the learning process and had positive perceptions about their cooperative work experience. Zisk (2008) carried out a study to explore the effects on test scores and self-concept of

students, whose received treatment by employing cooperative techniques in biology course at secondary level. The results indicated positive gains in self-concept and achievements in the student of cooperative group verses conventional classroom students. Hanze and Berger (2007) designed an empirical study to explore impact of Cooperative Learning approach on variables of learners' academic gains and self-esteem at secondary level. The findings of study indicated that cooperative learning technique had enhanced students' examination scores and promoted self-esteem of cooperative group students. Low self-esteem, having students particularly, seemed to be gain more confidence and competency from cooperative treatment.

In a study conducted by Jenkins, Antill, and Vadasy (2003) to explore the impact of cooperative learning on students' outcomes in special education through perception of the science teachers of secondary classes. They argued that cooperative learning had positive impact on students' performance and self-esteem promotion. Tien, Roth and Kampmeier (2002) initiated a comparative study to determine the impact of peer-led team learning on students' performance in terms of tests scores, grades and knowledge retention in biology in a first semester of three years course. The results indicated that learners of peer-led team had performed far better than the learners, whose were taught in traditional setting. Female and minority students particularly, were achieved higher tests scores than their counterparts in conventional group. They reported that workshops' activities were perceived by students in experimental group as an effective learning agent in biology.

Effects of peer-led team learning strategies on students' achievement, and persistence in biology classes were investigated by Wamser (2006) and reported that the students in treatment groups had obtained higher average academic scores as compared to their

peers, whose were taught through conventional method. Hanson and Wolf Skill (2005) planned study to explore impact of cooperative learning (workshop process) technique on individual test scores, self-confidence, attendance, and attitudes about instruction and tutorial session in biology at SUNY-Stony Brook. Students were classified in four members groups to work on cooperative learning activities based on single concept. Students would have to complete these assigned activities in one-hour duration. To ensure individual accountability, quizzes were given on biology material to students on individual bases. Implementation of this cooperative technique showed positive gains in performances of students in terms of final grades, attendance at tutorial sessions, self-confidence, interest in biology and attitudes towards learning as compared to students, who were taught the course through conventional methods in preceding year.

The conclusions of meta-analysis studies indicated positive outcomes of cooperative learning approaches in biology courses at secondary school and college levels. Bowen (2012) carried out an empirical study to explore the effect of cooperative learning setting on learners 'academic performance in biology courses. He reported that learners of cooperative groups achieved the 64th percentile, while students in traditional learning environment achieved 50th percentile.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter focuses on how the study is been designed. It describes the population for the study, and the selected sample size chosen for the study. The data of this study was collected through pre-intervention and intervention activities

3.1 Description of the Research Area

The study was carried out at Asuom Senior High School and involved Form One science student. The school is located at the heart of Asoum in the Eastern region of Ghana. The school offers the following programs: Science, General Arts, Visual Arts, General Agric, Home Economics, and Business courses.

3.2 Design of the Research

A research design, according to Kombo and Delno (2006), is a strategy, outline, or scheme used to come up with solutions to research challenges.

In this study, Action Research was used. Creswell (2008) stated that Action Research is the most commonly applied practical research design in education today. For Cohen and Manion (2000), Action research is a small-scale intervention and a close assessment of the effects of the intervention. Mills (2000) noted that the purpose of choosing Action Research is meant to effect positive educational change. The study involved three main stages, namely, pre-intervention activities, intervention activities, and its implementation and post-intervention activities. The pre-intervention stage was used to identify and gather information about the problem – students' poor performance in chemical bonding. The intervention stage covered the detailed strategies used to improve the performance of students in the concept of chemical bonding. The

implementation stage is the application of intervention strategies, implemented to overcome students' poor performance in the concept of chemical bonding. The intervention strategies mainly involved the use of a cooperative instructional approach to reduce students' poor performance. The post-intervention activity was designed to evaluate the effectiveness of the interventions used. Students' responses and scores in the post-test were analysed and compared to the pre-test scores conducted at the pre-intervention stage.

3.3 Population

According to Best and Kahn (2003), a population is a group of individuals with at least one common goal and characteristics which distinguish that group from other individuals. Punch (2006), defines a population as a target group of people whom a Researcher wants to develop knowledge. According to Neuman (2006), the population is a set of all units that the research covers, or to which it can be generalized. There are two types of population in research and these are; Target population, which refers to the entire group of individuals or objects to which the Researcher is interested in generalising the conclusions. Also, the Accessible population in research is the population the researchers can apply their conclusions. This population is the subset of the target population and it is also known as the study population. It is from the accessible population that the researchers draw their samples.

In this study, the targeted population involves all S.H.S students made up of **206** students while the accessible population consisted of all form 1 General Science Students.

3.4 Sample and Sampling Procedure

According to Fraenkel and Wallen (2000), the sample is any group on which information is obtained for study. The two main types of samples are probability and non-probability samples.

Sampling is the process of selecting units (e.g., people, organizations) from a population of interest so that by studying the sample we may somewhat generalize our results back to the population from which they were chosen (Trochim, 2006). A sample is a smaller group that is drawn from a larger population and studied (Robson, 2002; Punch, 2006). According to Johnson and Christensen (2008), sampling is the process of drawing a model from a population. A probability sample is a type where every member of the population has an equal opportunity to be selected for the sample. The types of probability samples are as follows: simple random, systematic, stratified, and purposive samples.

The sample population for this study was form one General science Student of Asuom Senior High School Forty students (20 males and 20 females) were purposively selected.

In this study, the purposive sampling technique was used because all the members of the school had some difficulty with chemical bonding and were included in the research. Patton (2002) defines a purposive sample as the type in which the Researcher handpicked the students to be included in the sample based on their judgment of their typicality. The purposive sampling technique, also called judgment sampling, was the deliberate choice of a participant due to the qualities the participant possesses. This sample is also considerably less expensive to use and is perfectly adequate since the findings will not be generalized beyond the sample.

3.5 Research Instruments

According to Fraenkel and Wallen (2003), an instrument is any device used to collect data for purposes of research. A research instrument is a device used to collect data to answer the research questions. Data collection is an essential component in conducting research. O'Leary (2004), remarked that "collecting credible data is a tough task, and it is worth remembering that one method of data collection is not inherently better than another." According to Cohen and Morrison (2007), there are four basic research instruments. These are questionnaires, observation, interviews, and test methods.

In this study, both qualitative and quantitative data gathering was used. The instrument used for collecting data for the study for both the pre-intervention and the post-intervention was a combination of a semi-structured questionnaire and an achievement test as well as observation. The use of the achievement test helped to determine the performance of the students in chemical bonding. The performances determined assisted in comparing the student's performance in the pre-intervention test and the post-intervention test.

3.5.1 Achievement test

The achievement test used for the study was of two types. These were pre-intervention and post-intervention. There were 10 test items each on the pre-intervention (Appendix A) and the post-intervention (Appendix B) instruments used. The test items used for the pre-intervention test were sampled from the set of past examination questions from the WAEC integrated science syllabus on chemical bonding. The pre-intervention items covered the cognitive, affective, and psychomotor domains. The purpose was to reveal the kind of thinking and understanding these students had in learning and teaching Integrated Science at the primary school level. The post-intervention items were similar

to the pre-intervention items and therefore could be said to be of the same difficulty indices. Both tests were administered within 30 minutes.

3.5.2 Questionnaire

A semi-structured questionnaire was developed based on the purpose of the research questions for the students to ascertain their impression about the teaching and learning of chemical bonding after the Cooperative Instructional Approach has been adopted for the intervention. The questionnaire consisted of 13 items and the students were required to tick one of its corresponding responses according to their knowledge and perception and 1 other item required students to provide their responses. The questionnaire was used for the reason that it is easy to collect data and students may not fear being victimized as in an interview. It allowed the students to express whatever ideas they had. It also offered students complete anonymity. The students had enough time to reflect on questions which helped them to give more meaningful answers. Though the questionnaire had all these strengths, it also had some weaknesses. An individual or a group selected should be able to provide information about the problem under study else results or findings would not be valid. In all, there were 12 close-ended items and one open-ended item making a total of 13 items (Appendix C). Generally, the questionnaire sought views from students on the effects of using the Cooperative Instructional Approach on the teaching and learning of Chemical Bonding.

3.5.3 Observation

An observation instrument adapted from the Barbados Workshop Observation instrument was used in the study. The observation schedule was used to determine the students' behaviours during the intervention. This was supplied by my supervisor.

3.6 Validity of the Main Instrument

Fraenkel and Wallen (2003) stated that validity refers to the appropriateness, measurement, correctness, and usefulness of the inferences a Researcher makes. In other words, the validity of an instrument is concerned with the extent to which the instrument measures what it is supposed to measure. Validity simply refers to whether the test measured what it was supposed to measure. Validity is concerned with whether the findings are really about what they appear to be about (Robertson, 2002). According to Cohen, Marion, and Morrison (2003), it is based on the view that a particular instrument measures what it purports. Validity is classified into two. They are internal and external validity by Burns and Grove, (2001).

External validity refers to the extent to which the research results can be generalized beyond the sample used in the study (Burns & Grove, 2001).

Internal validity refers to the extent to how well an experiment is done, especially whether it avoids confounding (more than one possible independent variable acting at the same time) (Burns & Grove, 2001).

In this study, content validity was ensured since the content chosen is in comparison with the syllabus and was effected with the help of my supervisor.

3.7 Reliability of the Main Instrument

Reliability concerns with the extent to which a questionnaire test or any measurable procedure produces the same results on a repeated trail. That is the consistency of score over tie. To ensure the reliability of the instruments, the instruments were tested using test-retest reliability method. The instruments were first administered and re-administered on the same respondents after a week. The reliability of the questionnaire

items was determined by Cronbach's alpha. This was meant to determine the internal consistency of the questionnaire items. The analysis yielded a value of 0.75.

3.8 Pilot Study

The research instruments were pilot-studied personally by the researcher at Asamankese Senior High which was outside the accessible population area. The school was chosen because it has similar characteristics to that of the sampled schools. The instruments were administered to 20 students of the school. The results were analysed to determine the validity of the instruments. Items that needed revision were revised. This was important because it improved the content validity and reliability of the test and improved the formats.

3.9 Data Collection Procedure

An introductory letter was taken from the Head of the Science Department of the University of Education, Winneba to seek permission from the heads of the two schools to use their institutions. The purpose of the study was stated in the letter and cooperation of the school authorities was sought. Permission and support were then sought from the teachers and students to conduct the study. A briefing section on how to respond to the questionnaire was held with the students in their classrooms. The research instruments were administered and collected by me. The purpose was to ensure that no special treatment was given to any of the students, especially during the administration of the achievement tests. All the questionnaires were not retrieved because some of the students gave excuses.

3.9.1 Pre – intervention activities

This stage included two exercises that tested how well students performed and understood the principles of chemical bonding. The first task was to speak with the

class, get to know each student by name, and go over some of the ideas they had on the topic. The initial activities were diagnostic in nature. They were meant to expose the students' difficulties. It also provided the researcher with information about the student's prior understanding of chemical bonding. The second phase involved administering the pre-intervention test on chemical bonding, which was carried out to assess students' performance and their capacity to interpret and comprehend chemical bonding concepts in chemistry. This test served as a foundation for determining whether or not the use of a cooperative instructional approach could improve students' performance.

3.9.2 Preliminary information

After the findings from the pre-intervention activities, an intervention was designed to improve the understanding and hence reduce the students' poor performances of the concept, of chemical bonding.

The five key components of the cooperative learning strategy put forward by Johnson et al. (1994) served as the rigorous guidelines for the entire intervention. It was made sure that the pupils or the different groups conceptualised, pondered on, and practised in accordance with the needs of these five crucial components of the cooperative learning strategy. In other words, each of these components was used to create a successful cooperative learning approach throughout the entire study. The elements used in the study are as follows, along with how they were used:

Positive interdependence: Here, it was made clear to the group that for a task or objective to be completed successfully, each group member depends on the others. In other words, one learner's success was reliant on the other learner's performance.

Promotive face-to-face interaction: The groups were instructed on how to achieve constructive interaction by supporting one another's conclusions, offering feedback, motivating one another, and working towards common goals. Members of the group helped each other out, complimenting, encouraging, and supporting one another to help each other succeed**.**

Individual accountability: Every group member was made to feel responsible for his/ her work during the entire project, it was made sure. By evaluating the level of effort put forth by each participant to ensure the success of their particular groups, this was somewhat accomplished. To do this, each student took an independent test, and students were chosen at random to present the work of their classmates.

Interpersonal and small–group skills (social skills): Students gain social skills through cooperative learning. These abilities enabled them to foster more effective group cooperation. Different skills including communication, trust-building, leadership, and decision-making are also cultivated. There were opportunities for group members to get to know one another, accept and encourage one another, speak clearly, and work out their differences.

Group processing: This evaluation focuses on the groups' performance in completing their duties or goals. This component's main goal was to provide the groups a chance to talk about any concerns or unique requirements they may have. This gave the group the chance to discuss both positive and negative effects of their group activity. There were other chances for the students to evaluate the development of their groups. In order to foster the development of cooperative skills, focus on positive working relationships, and guarantee that members got feedback, the groups used group processing.

Students were observed during the intervention in other to identify their strengths and weaknesses.

3.9.3 Actual intervention activities

The intervention activities covered five weeks and covered the following topics:

1. Nature and formation of covalent bonds.
2. Characteristics of covalent compounds.
3. Nature and formation of ionic bonds.
4. Characteristics of ionic compounds
5. Comparism of bond types.

The implementation of the intervention began with the first lesson through to the last one.

Week 1

Lesson 1: The nature and formation of covalent bonds

Week 2

Lesson 2: Characteristics of covalent compounds

Week 3

Lesson 3: Nature and formation of ionic compounds

Week 4

Lesson 4: Characteristics of ionic compounds

Week 5

Lesson 5: Comparison of bond types

3.9.4 General intervention approach

The students were divided into groups of five and called to appoint a leader. Each group was given an instructional sheet detailing how they were to carry out their activities. Each group was to begin each activity with a brainstorming session on the lesson. The brainstorming session required students in the group to volunteer ideas on the topics of interest to be noted by a recorder or the leader. All ideas are to be recorded. This was to ensure that no single person dominated the group. When all possible views have been recorded, then the group members should consider each point/ suggestion to determine whether or not it was valid. The accepted views of the group is then presented to the class.

After the group presentation, the researcher drew the class attention to areas that required improvement. Each lesson was interspersed with whiteboard illustrations on the formation of covalent and ionic bonds involving atoms of different elements. Members of each group were encouraged to pool their knowledge, resources and skill to accomplish the set tasks.

3.9.5 Post – intervention activities

At the end of the intervention, a test (post-intervention test) was allocated to the students. This test purposely evaluated the performances of the small groups after the four weeks' instruction. It was to help to find out the effect of cooperative instructional approaches on students' performance after the intervention. The post- intervention test was made up of items just in the same line as the pre- intervention test. They were also selected from the set of past questions. The post-intervention test items were fairly selected to cover most of the units in the Integrated Science Syllabus. The duration of the test was 30 minutes. The test was administered and scored. Students were encouraged to do independent work and in order to know their actual results. The two sets of tests were scored and analysed. The students were gathered in their classrooms

where they were briefed on the purpose of the questionnaire. The students were encouraged to respond to the questionnaire truthfully as much as possible. The 16-item questionnaire was then given to the students after the administration of the post-intervention test. The purpose was to determine the attitude of the students towards the teaching and learning of chemical bonding after the intervention.

3.10 Procedure for Data Analysis

According to Ader (2008), data analysis is the process of inspecting, cleaning, transforming, and modelling data to highlight useful intonation, suggesting conclusions, and supporting decision-making. Data obtained from the field is raw and therefore needs to be analysed to give meaning.

The statistical analysis of the tests was carried out first. Descriptive statistics such as means, mean difference, standard deviation, were used to analyses students' scores obtained in the pre and post-intervention tests. These descriptive statistics were used to summarize the general trends in student performance. The purpose of descriptive statistics is not only to describe the data from a study but also to help find patterns within the data described and to inform inferential statistics as well. A study of central tendency indicated the overall performance of students in the groups; different groups and different academic performance levels. Inferential statistics such as student's t-test was used to assess the difference in means obtained by students in pre and post-intervention test at 95% and simple percentages were used. The inferential statistics used in this study were used for answering the quantitative aspect of the research questions as well as testing stated earlier in the first chapter of the study. The data collected from the pre and post-intervention tests were compared and analyzed using t-test

3.11 Ethical Consideration

Permission was sought from the headmaster and stakeholders of the institution where the study was be carried out. Participants of the study were duly informed about the nature of the study and what it sought to achieve.

Respondents were assured of anonymity and confidentiality.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

This chapter presents the results, findings, and discussions of the findings of this study to provide an understanding of the effects of the use of a cooperative instructional approach to instruct students on chemical bonding. The results and discussions were presented based on the research questions that were posed. The guiding research questions of this study were to determine whether the students would perform well in chemical bonding or not when they were taught using a cooperative instructional approach.

4.1 Demographic Data Respondents

This section analyses the various demographic characteristics of the respondents. Supporting tables and figures are provided from the participants, including gender and age.

Table 3:Gender of Respondents

Gender	Frequency (f)	Percentage (%)
Male	20	50
Female	20	50
Total	**40**	**100**

The results (from Table 1) showed that half of participants (50%) were male and half 50% were female. Further to this, the study included respondents of various age group.

Table 4: Age of Respondents

Age Groups	Frequency	Percentage (%)
13-15	6	15
16-20	30	75
20 and over	4	10

The data shows how the responses were distributed across three age groups. The study found that the majority of respondents were aged 16 to 20 years (75%), followed by 15% of respondents aged 13 to 15 years and 10% of respondents aged over 20 years. This suggests that the study sample was primarily composed of adolescents and young adults.

4.2 Presentation of Results by Research Questions

Research question 1: What ideas do the students possess about chemical bonding and what difficulties do they face during lessons on the topic?

This research question sought to identify the ideas students have and the difficulties of the students when exposed to the questions on chemical bonding. Some ideas generated from the response of the participants are as follows;

1. Most students did not know the difference between covalent bonding and ionic bonding.
2. Some students were confused about ionic and electrovalent bonds, in other words they did not know they were the same
3. Some students were confused about hydrogen and oxygen being gases but when 2 atoms of hydrogen and an atom of oxygen combine, they form water which is

a liquid but not gas but when hydrogen atoms combine with nitrogen gas, they form ammonia gas.

Table 3 provides the summary of the students' performance on the pre-intervention test. The findings observed from the study reveal a number of factors that cause students' difficulties in learning chemical bonding.

Table 3: Students performance on chemical bonding pre-intervention test

Mark Range	Item	Option	Frequency	Percentage
1-2	1.	Very weak understanding	20	50%
3-4	2.	Weak understanding	8	20%
5-6	3.	Moderate understanding	2	5%
7-8	4.	Good understanding	6	15%
9-10	5.	Very good understanding	4	10%
Total			**40**	**100%**

Table 3. shows that four students (10%) had very good understanding about chemical bonding while six students (15%) had good understanding about the topic. However, eight students (20%) possessed weak understanding of the topic while twenty students (50%) exhibited very weak understanding of the topic. Also, two students (5%) had average understanding about chemical bonding. So in table 3, it can be concluded that almost all the students (60%) possess weak understanding of chemical bonding.

Additionally, aspects of the topic about which students faced difficulties are shown in Table 4.

Table 4: Most challenging aspects of chemical bonding

Item	Option	Frequency
1.	• Differentiating between ionic and covalent bonds	23
	• Differentiating between molecular formula and structural formulae	6
	• Identifying types of chemical reactions	3
	• Explaining the concept of valence electrons	5
	• Others	4

Table 4 indicates that 23 students faced difficulties in understanding the fundamental differences between ionic and covalent bonds, where ionic bonds involve the transfer of electrons between atoms, whereas covalent bonds involve the sharing of electrons. Also, 6 students struggled with comprehending the arrangement of atoms in a molecule and translating this understanding into chemical formulae. Whereas 3 students found it difficult to identify the type of chemical reaction. Additionally, 5 students faced difficulties in grasping the concept of valence electrons, which are the outermost electrons in an atom and determine its reactivity. Understanding valence electrons is crucial for comprehending electron configurations, bonding, and chemical properties. Four respondents indicated that they faced challenges in aspects not covered by the provided options. Overall, the findings demonstrate that students encountered various challenges in their understanding of chemical bonding. Differentiating between ionic and covalent bonds, understanding molecular structures and formulae, identifying types of chemical reactions, and explaining the concept of valence electrons emerged as the most commonly cited challenging aspects.

Discussion

The findings from Table 3 and Table 4 provide insights into the ideas students possess about chemical bonding and the difficulties they face during lessons on the topic.

Table 3 reveals that majority of the students (60%) demonstrated a weak understanding of chemical bonding. This suggests that students may possess misconceptions or incomplete knowledge about this fundamental topic. These misconceptions can hinder their ability to grasp the nuances of chemical bonding principles and impede their overall comprehension. Similar findings have been reported by Mbage (2014) in a study conducted in the Volta Region. He found that the students only memorised information on chemical bonding but did not really understand what they memorised.

Also, Table 3 further highlights the difficulties students encounter during lessons on chemical bonding. The most frequently chosen challenges include differentiating between ionic and covalent bonds, understanding molecular structures and formulas, identifying types of chemical reactions, and explaining the concept of valence electrons.

The challenge of differentiating between ionic and covalent bonds suggests that students may struggle to grasp the fundamental differences between these two types of chemical bonds. This difficulty could stem from confusion surrounding the concepts of electron transfer and electron sharing. These misconceptions can impede students' understanding of the mechanisms underlying these bonding types (Miller, 2001).

Understanding molecular structures and formulas presents another significant challenge for students. This struggle may arise from the complexity of visualizing and representing the arrangement of atoms within a molecule. Students may encounter difficulty translating their understanding of molecular structures into chemical formulas, hindering their ability to accurately represent and communicate chemical compounds.

Identifying types of chemical reactions emerged as another major challenge. The recognition and categorization of various chemical reactions, such as synthesis, decomposition, combustion, and displacement reactions, require students to apply specific rules and patterns. The difficulties faced by students in this regard may hamper their ability to identify the type of reaction and predict products accurately.

Additionally, students expressed difficulties in understanding the concept of valence electrons. Valence electrons play a vital role in determining an atom's reactivity and are crucial for understanding concepts such as electron configurations, bonding, and chemical properties. Difficulties in comprehending the concept of valence electrons can hinder students' ability to explain bonding patterns and predict chemical behaviour accurately. The difficulties the students faced might be related to their preferred learning styles (Pruitt, 2005). It is possible that the cooperative instructional approach did not adequately cater for the learners' instructional needs.

Furthermore, 18 respondents identified challenges not covered by the provided options, indicating the presence of additional complexities not captured by the predefined categories. Exploring these challenges in detail could provide further insights into the specific difficulties students encounter during lessons on chemical bonding.

In conclusion, the findings suggest that students possess varying ideas about chemical bonding, with a majority demonstrating a weak understanding. The identified challenges, including differentiating between ionic and covalent bonds, understanding molecular structures and formulas, identifying types of chemical reactions, and explaining the concept of valence electrons, shed light on the specific difficulties students face during lessons on the topic. Addressing these challenges by employing targeted instructional strategies can help improve students' understanding and promote meaningful learning experiences in the field of chemical bonding.

Research question 2: What is the effect of cooperative instructional approach on the students' performance in chemical bonding?

This research question sought to explore the impact of cooperative instructional approaches to the performance of students in chemical bonding. To assess the effect of cooperative instruction on the students' performance in chemical bonding, the students were taken through five lessons of one hour duration each. After completion of the intervention activities, a post-intervention test was administered

This post-intervention test aimed to offer a comprehensive overview of students' performance in chemical bonding. The results of the post-intervention test are summarized in Table 3.

Table 5: Frequency distribution of the achievement test scores of students

Score	1-2	3-4	5-6	7-8	9-10
Pre-Intervention test	18(45%)	14(35%)	6(15%)	2(5%)	0(0%)
Post-intervention test	0(0%)	2(5%)	12(30%)	11(27.5%)	15(37.5%)

From Table 5, for the pre-intervention test, as many as 32 (80%) students scored below 5 with the remaining 8(20%) students scoring from 5 to 10. In the post-intervention test,

there was improvement in performance as 38(95%) students scored from 5 and above. The means, standard deviations and t-test of students in the pre-intervention test and post-intervention test are presented in Table 6.

Table 6: The means and standard deviations of pre-intervention test and post-intervention test

Test	N	Mean Score	Standard deviations	p-value
Pre-intervention test	40	6.18	0.98	
Post-intervention test	40	9.84	1.55	0.037*

Discussion

Looking at Table 6, the results shows that 95% of the students performed better in the post- intervention test after participating in the cooperative instructional activities. This indicates a positive impact on the students' comprehension and suggests that the instructional approaches were effective in enhancing their performance. Also, Table 5 provides further insight into the effect of the Cooperative Instructional Approaches on students' performance.

Furthermore, results from the present pre-intervention test and post-intervention test, indicates the changes in performance before and after the intervention. There was an increase in the number of students scoring above 5 (from 8 to 38) between the pre-intervention test and post-intervention test. These findings indicate that there is an improved performance after the intervention.

Table 6 provides statistical analysis comparing the means of the pre-intervention test and post-intervention test. In the table, the p-value (0.037) is less than the alpha-value (0.05) and it suggests that the difference between the mean scores of the pre-

intervention and post- intervention test was statistically significant. However, with a significance level of $p < 0.05$ where $p = 0.037$, we can say there was a significant difference in means scores between the pre and post-intervention test.

These results collectively demonstrate that the Cooperative Instructional Approaches positively influenced students' performance in chemical bonding. The significant improvement reported by a majority of participants, as well as the higher scores and the statistical analysis, support the effectiveness of the instructional approaches in enhancing students' performance. The data presented highlights the benefits of using cooperative instructional strategies in teaching chemical bonding, as they result in improved performance and understanding among students.

In conclusion, the findings from the provided tables indicate that the Cooperative Instructional Approaches had a positive effect on students' performance in chemical bonding. The majority of participants experienced changes in their understanding and reported significant improvement in their performance. These findings emphasize the importance of implementing cooperative instructional strategies to enhance learning outcomes in chemical bonding. Similarly Anati (2021) found that group activities had a positive effect on students' cognitive achievement. In a study conducted in Oti Boateng Senior High School, Anati (2021) found group activities among students greatly improved their performance in naming inorganic compounds.

Research question 3: What are the differential effects of the intervention on the mean performance of the male and female students?

Table 7: The differential effects of the intervention on the mean performance of the male and female students

The analyzed data is shown in Table 7

Sex	Number of Participants	Mean Score	Standard deviations	p-value
Male	20	6.81	1.08	
Female	20	9.67	1.53	0.028*

Significant= $p < 0.05$

From Table 7, the p-value (0.028) is less than the alpha- value (0.05), therefore we reject the null hypothesis. This implies that the female performed significantly better than their male counterparts as was noted by Eminah, (2007).

Discussion

The mean scores indicate the average performance of the male and female students in the posttest. According to the data, the female group had a higher mean score of 9.67, while the male group had a lower mean score of 6.81. This suggests that, on average, the female students outperformed the male students in relation to the measured outcomes of the intervention.

The standard deviations provide information about the variability of scores within each group. The standard deviation for the male group is 1.53, while for the female group it is 1.08. These values indicate the spread of scores around the mean. The data suggests that the scores within the male group have a slightly greater spread compared to the female group. Thus, the male students' scores may exhibit slightly more variability.

Furthermore, the p-value of 0.028* suggests that the difference between the mean scores of the female and male was statistically significant. With a significance level of $p < 0.05$, it can be concluded that the observed difference in mean scores between the male and female groups is statistically significant.

In summary, the data indicates that the intervention had a differential effect on the mean performance of male and female students. The findings in this study contradicts that of Gyamfi (2023) who conducted a study that involved selected SHS students in Anglo Senior High School. In a study involving 30 SHS chemistry students, Gyamfi (2023) found that on the whole, the males performed significantly better than their female counterparts. On the other hand, the findings reported for the current research question have been exemplified by those of Agadzi (2020) in a study conducted in Breman Asikuma SHS. Agadzi (2020) found that the female SHS chemistry students performed better than their male counterparts in the post-intervention test he administered after the intervention.

Research question 4: What are the students' perceptions of the use of cooperative instructional approaches for lessons on chemical bonding

To answer the above research question, a five-point Likert scale items with 5 options was used. It ranged from 'Strongly Agree, Agree, not sure, Disagree to Strongly Disagree'. This survey format allowed the respondents to express their degrees of agreement with various statements, providing a detailed insight into their perspectives on the use of Cooperative Instructional Approaches in Chemical Bonding. In the discussion, the first two response categories Strongly Agree (SA) and Agree (A) were merged into a single category 'Agree' to make the discussion easy. In the attempt to provide a broad view of the students 'responses to the questionnaire, the Profile Analysis procedure was used to indicate the proportion of students who either agreed or disagreed with each item. This could not have been possible had the Aggregate Analysis procedure been used.

Table 8: Perception of students on the use of cooperative instructional approaches

	Statement	SA F%	A F%	N F%	D F%	SD F%
1.	Cooperative Instructional Approach enhance my understanding of chemical bonding	26(65)	10(25)	3(7.5)	1(2.5)	0(0.0)
2.	Cooperative Instructional Approach makes me feel comfortable in class	30(75)	7(17.5)	3(7.5)	0(0.0)	0(0.0)
3.	Cooperative Instructional Approach influence my confidence in solving questions on chemical bonding	19(47.5)	10(25.0)	6(15.0)	3(7.5)	2(5.0)
4.	I found Cooperative Instructional Approach to be helpful in understanding chemical bonding	35(87.5)	5(12.5)	0(0.0)	0(0.5)	0(0.0)
5.	I would not recommend Cooperative Instructional Approach to other students studying chemical bonding	0(0.00)	0(0.00)	2(5.0)	5(12.5)	33(82.5)
6.	Cooperative Instructional Approach forces me to share ideas	16(40.0)	9(22.5)	10(25.5)	5(12.5)	0(0.0)
7.	I am always angry during lessons on chemical bonding when Cooperative Instructional Approach is used	15(37.5)	11(27.5)	5(12.5)	3(7.5)	6(15.5)
8.	Cooperative Instructional Approach makes me feel bored during lessons on chemical bonding	5(12.5)	4(10.0)	2(5.0)	17(42.5)	12(30.0)
9.	I learn better when ideas are shared on chemical bonding using Cooperative Instructional Approach	30(75.0)	10(25.0)	0(0.0)	0(0.0)	0(0.0)
10.	Cooperative Instructional Approach retarded my understanding of chemical bonding	0(0.00)	0(0.00)	3(7.5)	12(0.0)	25(62.5)

The data analysis highly portrays a positive reception of cooperative instructional approaches among students in understanding of chemical bonding. Based on the responses of 40 participants 90% indicated the expression of agreement (65% Strongly Agree and 25% Agree) and that Cooperative Instructional Approach improved their understanding of chemical bonding.

The next item (2) was to find out whether the students were comfortable during the lessons, 92.5% of students which consisted of 75% of student strongly agreeing and 17.5% agreeing to this statement that they were comfortable that instructional approach. Seven-point five percent (7.5%) of students were not sure about this item whiles no students disagreed or strongly disagreed to that item. It therefore suggests that the students were more comfortable in learning chemical bonding concept when Cooperative Instructional Approach is used

Also, Cooperative Instructional Approach not only enhanced understanding but also boosted students' confidence in chemical bonding in item 3. With 72.5% of students feeling more assured in their abilities (47.5% Strongly Agree and 25% Agree). While the 27.5% combined students who were no sure (15%), 12.5% disagreeing. Majority of students' confidence were boosted.

Students found Cooperative Instructional Approach in item 4 to be helpful in understanding chemical bonding concepts. It showed that all students agree with a statement "I find cooperative instructional Approaches helpful in understanding chemical bonding concepts". Thus, all 40 students (87.5% Strongly Agree, 12.5% Agree) agreed to the statement.

Moreover, there are 33 students (82.5%) who choose that they strongly disagree, 5 students(12.5%) choose disagree and 2 students(5.0%) where not sure with the item 5.

This means that almost all the students deny or disagree that cooperative Instructional Approaches should not be recommended for teaching chemical bonding.

Again, Cooperative Instructional Approach forces students to share idea. The items 6 shows that 16 students representing 40% strongly agree to item 6, 9 students representing 22.5% agree, 10 students also representing 25.5% were not sure, 5 students (12.5%) disagree whiles no student strongly disagree. This means that most students accepts that Cooperative Instructional Approach forces students to share idea.

Students are always angry during lessons on chemical bonding when Cooperative Instructional Approach is used in item 7 , as evidenced by 15 students representing 37.5% Strongly Agree, 11 students thus 27.5% Agree, 5 students which is 12.5% is not sure, 3 students representing 7.5% Disagree whiles 6 students which stands for 15.5% Strongly Disagree. This responses shows that most students get angry when Cooperative Instructional Approach is use.

Item 8 indicates that Cooperative Instructional Approaches makes students bored during chemical bonding lessons and the results are as follows:
5 students indicating 12.5% Strongly Agree, 4 representing 10.0% Agree, 2 students representing 5% are not sure, 17 students indicating 42.5% Disagree to this item whiles 12 students representing 30% Strongly Disagree. This analysis yields a positive result since 72.5% of students Disagree to this item.

Furthermore, Cooperative Instructional Approaches makes students learn better when ideas are shared as shown by 75% representing 30 students Strongly Agreeing and 25% representing 10 students Agreeing. Therefore 100% students agree to this item giving a positive remarks on students learning better when ideas are shared on the use of Cooperative Instructional Approaches.

Lastly, the results shows that the use of Cooperative Instructional Approaches significantly improves understanding of chemical bonding. Thus, 92.5% (62.5% Strongly disagree, 30% disagree) disagree to the fact that Cooperative Instructional Approaches retard students understanding on chemical bonding whiles 3 students representing 7.5% are not sure. This indicates that the cooperative instructional approaches have made a substantial impact on students' learning outcomes and comprehension of the subject matter.

In summary, the data consistently reflects students' positive perceptions of cooperative instructional approaches for lessons on chemical bonding. Students value the effectiveness of these approaches in facilitating their understanding, engagement, and ability to explain concepts. The findings indicate a consensus among students that cooperative instructional approaches are beneficial, and they endorse the recommendation of these approaches for future teaching. Additionally, the positive impact on students' understanding and interest in chemistry-related fields suggests the potential long-term influence of these instructional approaches.

4.3 Observation

An observation technique was employed by the researcher. It was observed that students came prepared during lessons with complete assignments and most of them understood the materials which they compiled. It was also observed that the confidence of some students who felt left out in class were boosted. They felt more accepted, developed leadership tendencies and even worked on their problem-solving skills.

However, some other observations made also revealed that some groups ended in misunderstanding due to contrasting personalities, which almost disrupted the class. Subsequently, it was also observed that most discussions were made by some specific

students who were known to be vocal and intelligent whiles shy students stayed out of the discussions. The researcher tried to discourage the domineering attitudes of some students by suggesting the use of Brainstorming Sessions before lessons to ensure maximum participation by each student.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter presents a summary of major findings, the conclusions and recommendations of the study. They are related to the objectives of the study.

5.1 Summary of Major Findings

Primary data were solicited from a source in response to the research questions. Respondent consisted form one General science Student of Asuom Senior High School. Several findings were revealed by the study and summarized according to the research objectives as follows.

5.1.1 The ideas the students possessed about chemical bonding as well as the difficulties they face during lessons

The findings indicate that students possessed weak understanding of chemical bonding concepts, with misleading and incomplete knowledge. They face difficulties in differentiating between ionic and covalent bonds, understanding molecular structures and formulas, identifying types of chemical reactions, and explaining the concept of valence electrons. Addressing these challenges through targeted instruction is crucial for enhancing students' understanding and promoting meaningful learning experiences in chemical bonding.

5.1.2 The effect of Cooperative Instructional Approaches on the students' performance in chemical bonding

Cooperative Instructional Approaches had a positive impact on students' comprehension and performance in chemical bonding. The majority of the participants

reported changes in their understanding of chemical bonding, and a significant number of students acknowledged a substantial improvement in their performance.

Moreover, the comparison between the control and experimental groups further confirmed the effectiveness of the Cooperative Instructional Approaches. Both groups showed improved performance after the intervention, but the experimental group displayed a more significant improvement. The statistical analysis also revealed a significant difference in the mean scores between the two groups in the posttest, indicating that the experimental group performed better than the control group**.**

Overall, the results presented in the tables provide evidence that the Cooperative Instructional Approaches are effective in enhancing students' comprehension and performance in chemical bonding. These findings have important implications for educators and emphasize the value of incorporating cooperative instructional strategies in teaching this subject.

5.1.3 The differential effects of the intervention on the mean performances of the male and female science students

The findings indicate that the male students had a lower average score in the post-intervention test compared to the female students. The standard deviations show that scores within the male group had slightly more variability than the female group. The p-value of 0.028* suggests that the observed difference in mean scores between the male and female groups is statistically significant. These findings suggest that the intervention had a differential effect on the performance of male and female students, with the females benefiting more from the intervention.

5.1.4 The perception of the students on the use of cooperative instructional approaches for lessons on chemical bonding

learning outcomes and their increased interest in pursuing chemistry or related fields further reinforces the effectiveness of cooperative instructional approaches in fostering students' engagement and motivation. These findings suggest that incorporating cooperative instructional approaches into chemistry lessons can be a valuable pedagogical strategy for enhancing students' understanding and interest in the subject.

It is important to note that these findings are based on the students' perceptions and self-reports, which may be influenced by various factors such as social desirability bias or individual differences in learning styles. Further research should be conducted to explore the long-term effects of cooperative instructional approaches on students' retention of chemical bonding concepts and their performance in related assessments.

Additionally, investigating the perspectives of teachers and comparing the outcomes of cooperative instructional approaches with traditional instructional methods would provide a comprehensive understanding of the benefits and limitations of cooperative learning in chemistry education. Overall, these findings contribute valuable insights into the positive impact of cooperative instructional approaches on students' perceptions and learning outcomes in the context of chemical bonding lessons.

5.2 Conclusions

The research conducted at ASUOM Senior High School highlights the positive impacts of cooperative instructional approaches for lessons on chemical bonding. The findings demonstrate that cooperative learning strategies enhance students' understanding, engagement, and overall academic performance in this subject area.

Thus, students possess certain ideas about chemical bonding and also face difficulties during lessons. These ideas and difficulties should be taken into consideration while designing instructional approaches for teaching chemical bonding.

Cooperative Instructional Approaches have a significant effect on the students' performance in chemical bonding. Implementing these approaches leads to an improvement in their understanding and application of chemical bonding concepts.

Also, interventions of Cooperative Instructional Approaches have differential effects on the mean performances of male and female science students. It is important to further investigate these differences to identify any potential biases or preferences in the learning styles or needs of male and female students.

The students perceive the use of Cooperative Instructional Approaches for lessons on chemical bonding positively. They find these approaches helpful in enhancing their understanding, engagement, and overall learning experience in this topic.

5.3 Recommendations

All students should be encouraged to participate in cooperative learning activities, as it can improve their comprehension of chemical bonding concepts and facilitate peer interactions, fostering collaborative skills and the development of a deeper understanding. Students should also embrace their role as active learners, seeking out opportunities for cooperative learning outside the classroom as well.

Teachers can benefit from incorporating cooperative instructional approaches into their lesson planning, as it positively affects classroom dynamics and student learning outcomes. Implementing strategies such as group discussions, cooperative projects, and problem-solving tasks can provide students with a meaningful learning experience in chemical bonding, resulting in higher levels of motivation and success. Teachers should

also continuously assess and modify their instructional methods to ensure they align with the needs and learning styles of their students.

Policy makers should consider integrating cooperative instructional approaches into the broader educational system to enhance the overall quality of science education. This approach fosters a positive learning environment, promotes teamwork, and prepares students for future careers in the field of science. Policy makers can support the implementation of cooperative learning strategies by providing professional development opportunities for teachers and allocating resources for the development of collaborative spaces in schools.

Finally, researchers should continue to explore the effectiveness and long-term impacts of cooperative instructional approaches in various educational settings. Further studies can investigate the specific strategies that yield the most significant results, assess the benefits for different student populations, and explore the transferability of these findings to other scientific disciplines. Ongoing research will contribute to the growing body of knowledge and inform instructional practices, ultimately benefiting students and improving the overall educational landscape.

5.4 Suggestions for Future Research

The study investigated the effects of Cooperative Instructional Approach on the students' performance in chemical bonding at Asuom Senior High School. Based on this study the following suggestions are made:

1. The study did not take into account the challenges faced by senior high school science teachers when implementing a cooperative learning strategy to teach chemical bonding. Therefore, it is advised that more study be done in the future

to examine the challenges teachers have while utilising the cooperative instructional approach to teach chemical bonding.

2. A study can be conducted to investigate the efficacy of the cooperative instructional approach at various educational levels and in different science courses.
3. This study focused only on chemical bonding. However, future researchers can also consider topics such as water, acids, bases and salts, structure and reactions of organic compounds, circulatory, nervous, and excretory systems.
4. Thus, it is advised that more study be done in the future to ascertain whether the Cooperative Instructional Approach is beneficial for teaching these additional Integrated Science topics.

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APPENDIX A

PRE-INTERVENTION TEST

Instructions: Select the best answer for each question. Choose the letter corresponding to your chosen answer.

1. Chemical bonding involves the:

   a) Formation of new atoms

   b) Separation of atoms

   c) Interaction between atoms

   d) Conversion of atoms into energy

2. Which type of chemical bond involves the sharing of electrons between atoms?

   a) Ionic bond

   b) Metallic bond

   c) Covalent bond

   d) Hydrogen bond

3. An atom with a positive charge is called a/an:

   a) Cation

   b) Anion

   c) Ion

   d) Isotope

4. Which of the following is an example of an ionic bond?

   a) H20

   b) CO2

   c) NaCl

   d) C6H12O6

Appendix A: Continued

5. Covalent bonds are formed between:

   a) Two metals

   b) A metal and a nonmetal

   c) Two nonmetals

   d) A metal and a metalloid

6. The force that holds atoms together in a solid metal is known as:

   a) Covalent bond

   b) Ionic bond

   c) Metallic bond

   d) Hydrogen bond

7. A molecule with a partially positive end and a partially negative end is called a/an:

   a) Covalent molecule

   b) Ionic molecule

   c) Polar molecule

   d) Nonpolar molecule

8. The chemical formula H2O represents which compound?

   a) Water

   b) Carbon dioxide

   c) Sodium chloride

   d) Glucose

9. How many valence electrons does an atom of chlorine (Cl) have?

   a) 2

   b) 4

   c) 6

   d) 7

Appendix A: Continued

10. Chemical bonding is influenced by:

a) Temperature only

b) Pressure only

c) Both temperature and pressure

d) Neither temperature nor pressure

Note: This test is designed to assess your current knowledge in chemical bonding and will not affect your grades. Take your time and do your best!

Good luck!

APPENDIX B

POST- INTERVENTION TEST

Instructions: Select the best answer for each question. Choose the letter corresponding to your chosen answer.

1. Chemical bonding involves the:

   a) Formation of new atoms

   b) Separation of atoms

   c) Interaction between atoms

   d) Conversion of atoms into energy

2. Which type of chemical bond involves the sharing of electrons between atoms?

   a) Ionic bond

   b) Metallic bond

   c) Covalent bond

   d) Hydrogen bond

3. An atom with a positive charge is called a/an:

   a) Cation

   b) Anion

   c) Ion

   d) Isotope

4. Which of the following is an example of an ionic bond?

   a) H2O

   b) CO2

   c) NaCl

   d) C6H12O6

Appendix B: Continued

5. Covalent bonds are formed between:

   a) Two metals

   b) A metal and a nonmetal

   c) Two nonmetals

   d) A metal and a metalloid

6. The force that holds atoms together in a solid metal is known as:

   a) Covalent bond

   b) Ionic bond

   c) Metallic bond

   d) Hydrogen bond

7. A molecule with a partially positive end and a partially negative end is called a/an:

   a) Covalent molecule

   b) Ionic molecule

   c) Polar molecule

   d) Nonpolar molecule

8. The chemical formula H2O represents which compound?

   a) Water

   b) Carbon dioxide

   c) Sodium chloride

   d) Glucose

9. How many valence electrons does an atom of chlorine (Cl) have?

   a) 2

   b) 4

   c) 6

d) 7

10. Chemical bonding is influenced by:

a) Temperature only

b) Pressure only

c) Both temperature and pressure

d) Neither temperature nor pressure

Note: This test is designed to assess your knowledge after the intervention on chemical bonding. Remember what you have learned and apply it to select the best answer.

Good luck!

APPENDIX C

UNIVERSITY OF EDUCATION, WINNEBA

DEPARTMENT OF SCIENCE EDUCATION

IMPACT OF COOPERATIVE INSTRUCTIONAL APPROACHES ON STUDENTS' PERFORMANCE IN CHEMICAL BONDING AT ASUOM SENIOR HIGH SCHOOL

Questionnaire for Senior High School Students

Introduction

This research is meant for academic purposes only. It will try to find out the impact of cooperative instructional approaches on students' performance in chemical bonding. Kindly provide answers to these questions as honestly and precisely as possible. The responses to these questions will be treated in the strictest confidence.

Section A

Please tick [√] where appropriate or fill in the required information on the spaces provided.

1. Age ……..years
2. Sex/gender
   a. Male [ ]
   b. Female [ ]
3. Form/class……

Section B

Part 1: Determining Students' Ideas and Difficulties in Chemical Bonding

Please tick [√] where appropriate or fill in the required information on the spaces provided.

Appendix C: Continued

1. On a scale of 1 to 5 (1 - No understanding, 5 - Complete understanding), rate your current understanding of chemical bonding concepts.

[ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5

2. Which of the following aspects of chemical bonding do you find most challenging? (Select all that apply)

[ ] Differentiating between ionic and covalent bonds

[ ] Understanding molecular structures and formulas

[ ] Identifying types of chemical reactions

[ ] Explaining the concept of valence electrons

[ ] Others (please specify): _____

Part 2: Evaluating the Perception of Chemical Bonding Applications

3. Did you experience any changes in your understanding of chemical bonding after participating in the Cooperative Instructional Approaches?

[ ] Yes [ ] No

4. On a scale of 1 to 5 (1 - No improvement, 5 - Significant improvement), rate the impact of Cooperative Instructional Approaches on your performance in chemical bonding.

[ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5

Appendix C: Continued

Part 3: Assessing Students' Perception of Cooperative Instructional Approaches

Please tick [√] where appropriate or fill in the required information on the spaces provided.

NO.	Students' Perception of Cooperative Instructional Approaches	Strongly Agree 5	Agree 4	I do not know 3	Disagree 2	Strongly Disagree 1
5	I find Cooperative Instructional Approaches helpful in understanding chemical bonding concepts					
6	I felt highly engaged during the Cooperative Instructional Approaches					
7	I currently feel I have the ability to explain different types of chemical bonds (e.g., ionic, covalent, metallic)					
8	Cooperative Instructional Approaches should be recommended for teaching chemical bonding concepts to other students					
9	The intervention significantly improves my understanding of chemical bonding concepts					
10	I am likely to consider pursuing chemistry or related fields in your future career choices					

THANK YOU

APPENDIX D

LESSON PLAN

Topic: Chemical Bonding

Sub-topic: Ionic and Covalent bonds

Objectives: By the end of the lesson students would be able to

i. Describe the formation of ionic and covalent compounds.

ii. State some properties of ionic and covalent compounds

R.P.K: Students have the idea of sharing because they have been sharing things among themselves.

TLMs: Charts representing diagrams of ionic bonds formation and the first twenty elements. Colored picture of the periodic table

APPENDIX E

ILLUSTRATE THE BOND FORMATION BETWEEN THE FOLLOWING

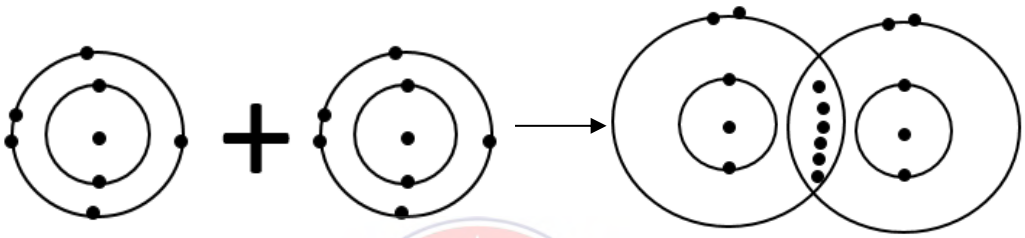
I. N_2

II. H_2O

III. NH_3

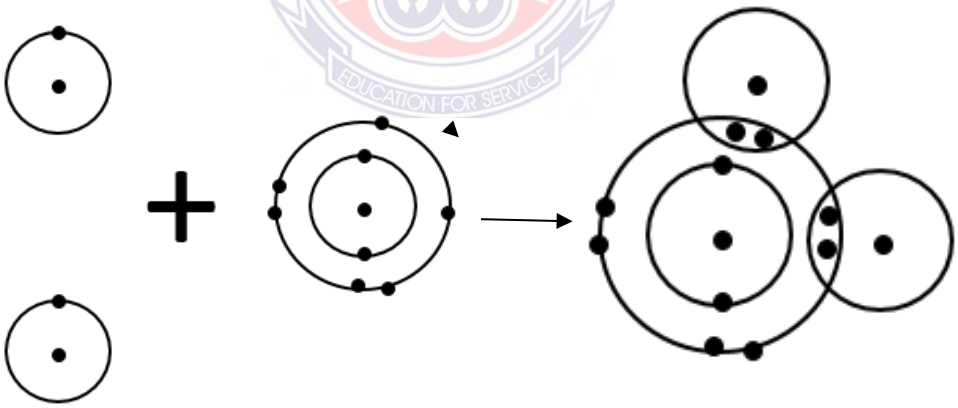
ANS.

I.



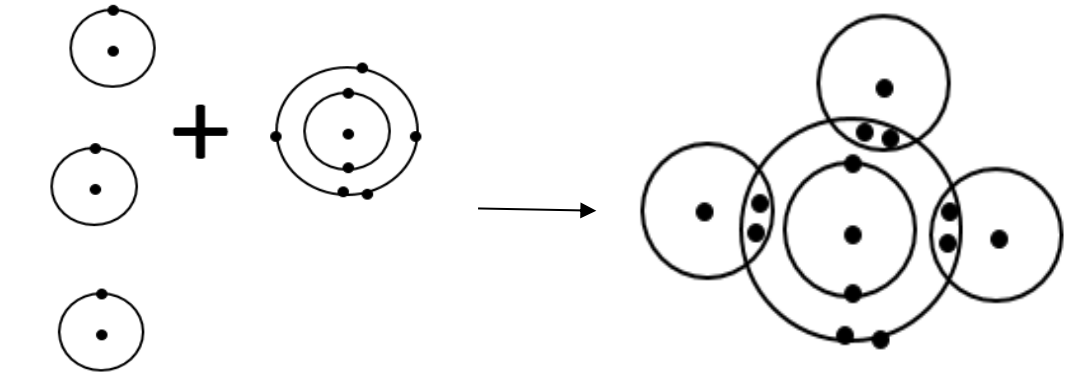
N **N** **N_2**

II.



2 O **H** **H_2O**

Appendix E: Continued



3 H **N** **NH_3**

APPENDIX F

COMPARISON OF BOND TYPES

There are two main types of bonds: electrovalent or ionic and covalent bond. Each type gives characteristic properties to the substances bound by it. A summary of these properties are compared below

Electrovalent/ Ionic Bonds	Covalent Bonds
Soluble in polar solvents, insoluble in organic solvents	insoluble in polar solvents, soluble in organic solvents
Crystals hard and brittle	Crystals soft
Crystals lattice built from ions	Crystal lattice built from molecules
High melting and boiling points	Low melting and boiling points
Bonds are non directional	Bonds are directional
Reactions take place by electron transfer, reactions in solution are practically instantaneous	Reactions take place by molecular collisions, reactions in solutions are slow

APPENDIX G

INTRODUCTORY LETTER

Eunice Dei
University of Education Winneba
Winneba

20th September, 2023

The Headteacher
……..Senior High School
P. O. Box
Kwaebibirem Municipal

Dear Sir

Request for Permission to Conduct Research in Your Institution

I hope this letter finds you in good health and high spirits. I am writing to seek your permission and cooperation for conducting a research study in your esteemed institutions.

I kindly request your permission to allow me access to your institutions, including classrooms, laboratories, and relevant facilities, to conduct observations, and data collection. I assure you that utmost professionalism, confidentiality, and ethical considerations will be maintained throughout the entire research process. The obtained data will be used strictly for research purposes and will be treated with the utmost confidentiality.

Furthermore, I would greatly appreciate the opportunity to collaborate with the teachers, administrative staff, and students of your institutions. Their valuable insights, perspectives, and participation will greatly enrich myS research findings.

Yours Faithfully,
Eunice Dei
University of Education, Winneba