UNIVERSITY OF EDUCATION, WINNEBA

EFFECTS OF JIGSAW COOPERATIVE LEARNING STRATEGY ON CHEMISTRY STUDENTS' UNDERSTANDING OF RATE OF CHEMICAL REACTION

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MAY, 2023

DECLARATION

Student's Declaration

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

Signature……

Date……

Supervisor's Declaration

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of thesis/dissertation/project as laid down by the University of Education, Winneba.

Name: DR. EMMANUEL K. OPPONG

Signature……

Date……

DEDICATION

To my late mother Janet Sakyi, all lecturers of the Chemistry Education Department, University of Education, Winneba, the staff of Bompeh Senior High Technical School. The staff of Adiembra Senior High Technical School.

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Every work requires the toil, time and devotion of others. Words are not enough to express my gratitude to all those assigned to me by God to help conduct successfully this work.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATION

ANCO:	Analysis of Covariance
ANCOVA:	Analysis of Variance
B.E.C.E:	Basic Education Certificate Examination
C.I.	Confidence Interval
CL:	Cooperative Learning
EFL:	English as a Foreign Language
GDP:	Gross Domestic Product
GES:	Ghana Education Service
JCLS:	jigsaw cooperative learning strategy
JSS:	Junior High School
MAT:	mathematics achievement test
SHS:	Senior High School
SLPAT:	Science Laboratory Physic Achievement Test
SPSS:	Statistical Package for Social Sciences
STAD:	Students Teams Achievement Divisions
ToP:	theory of performance
W.A.E.C:	West African Examination Council

ABSTRACT

This research was to examine the effects of jigsaw cooperative learning strategy on chemistry students' understanding of rate of reaction in the Bompeh Senior High Technical School and Adiembra Senior High School in the Western region of Ghana. An experimental design was used. Data was collected using a 'pen and pencil' test and questionnaire. A total of 84 students were sampled; 42 from each school using a simple random sampling technique. The experimental group was taught using the jigsaw cooperative learning method and the control group was taught using the traditional lecture method. The data was analysed using a chi square statistical analysis tool. The pre-test and post-test administered to the experimental group showed that, there is a significant change in the students' understanding of rate of reaction when the intervention (jigsaw cooperative learning method) was used to teach the experimental group. Findings demonstrate that, the jigsaw cooperative learning technique brings about better understanding of the concept of rate of reaction rather than the traditional method. Jigsaw cooperative learning was able to help students improve on their interpersonal relationship since they were able to interact among themselves to find solution to problems. It was recommended that teachers should employ the jigsaw cooperative learning strategy in the teaching and learning of concepts in chemistry.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter presents the general introduction of the study. Material in this chapter is presented under thematic areas namely; background of the study, problem statement, purpose of the study, objectives of the study, significance of the study, limitations, delimitations, definition of operational terms and organisation of the study.

1.1 Background of the Study

Recent literature presents outcomes in favour of the effectiveness of jigsaw cooperative learning strategy (JCLS) compared to the traditional chalk and talk method (Shao, Guo & Mok, 2021). However, such outcomes are too general creating a gap in the local contexts (Gilavand, 2015). This gap has caused many teachers in the local contexts of the classroom to be unclear about JCLS; hence many have different opinions and few adopt the JCLS in teaching and learning in schools (Gilavand, 2015). Slavin (2011) defined cooperative learning as instructional methods in which teachers organise students in small groups, which then work together to help one another learn academic content. Most teachers consider cooperative learning to be a very useful strategy to promote learning and other related positive social skills among students (Slavin, 2011).

Across the globe, educational revolution in recent times has led to the entrenchment of educational rights of people in the constitutions of the countries (Shao, et. al. 2021). In order to achieve this constitutional demand, many countries have come out with the inclusive educational policy aimed at making formal educational experience

accessible to all people (Gilavand, 2015). Similarly, many countries spend a significant proportion of their Gross Domestic Product (GDP) on education (Gilavand, 2015). However, one of the most challenging hindrances to achieving academic excellence in developing countries is instructional discrepancies (Ghana Education Service, 2014). Consequently, efforts towards helping to achieve effectiveness and efficiency in the educational process are desirable in order to ensure that students have the most benefits of what education offers them (Ghana Education Service, 2014).

Furthermore, the traditional method of teaching in the secondary schools consists of verbal techniques where the teacher does most of the talking, leaving the student to listening as their predominant role (Wyk, 2015). Sawer (2015) noticed that, the traditional lecture method of instruction has tremendous limitation as its verbal mode of presentation does not create room for pro-appraisal of students in order to realize if the students have the necessary cognitive readiness to absorb what is been taught. In this regard, the lecture method does not usually yield the desired results (Abidin, 2013). Learning must be an active process in which meaning is accomplished on the basis of experience (Abidin, 2013).

Researchers such as Bukunola and Idowu (2012), Osokoya (2013), Alabi (2014), Oni (2014), Kabutu, Oloyede and Bandele (2015) and Samuel (2017) observed that poor instructional strategies employed in the teaching of subjects by teachers contribute to students' under-achievement. Students find it difficult to understand the basic concepts taught, hence a child that is not well grounded in science and technology at the basic level, will not show interest in science concepts.

Even though there is no single method of teaching that can yield all the desired outcomes, the jigsaw cooperative learning has been proven to be very helpful in enhancing achievement among learners (Abidin, 2013). In their study, Johnson, Johnson, Roseth and Shin (2014) discovered that situations characterized by positive interdependence as in cooperative learning resulted in greater motivation and achievement than did negative or no interdependence situations. Similarly, Tahan and Acar (2012), stated that using jigsaw method yields better understanding than the conventional method after teaching chemistry.

Moreover, Zember and Blume (2011) revealed gender disparities in the effect of jigsaw method as girls perform better than boys in schools after the introduction of the jigsaw method. On the contrary, the findings of a study by Abidin (2013), shows that boys achieved significantly higher than girls when taught using the Jigsaw method.

In a very recent study, Eachempati and Ismail (2017) used a descriptive approach to compare the jigsaw cooperative learning technique to the traditional lectures and their respective effectiveness. Simple random selection of 72 students was done and 36 students were assigned into either the jigsaw or traditional lecture groups (n = 36). The Jigsaw learning method was administered to the experimental group for four weeks. At the same time, the control group experienced the lecture-based learning method. At the end of four weeks, the data obtained was analyzed using independent sample t-test. It was found that, post-test scores were better for jigsaw group with statistical significance.

Sabbah (2017) also found similar outcomes after conducting a quasi-experimental pre-posttest design to investigate the effect of using jigsaw cooperative strategy on

English Language Students' achievement in reading comprehension. Convenience sampling of the two classes was used from the female students enrolling in Level 4 in Qatar. The two classes were assigned randomly to two groups: the experimental group (n=16 students) which was taught via the jigsaw strategy and the control group (n=10 students) which was taught via the traditional strategy. Analysis of Covariance revealed better results in favour of JCLS.

It is worth stating that, collaborative nature of scientific and technological work should be strongly reinforced by frequent group activity in the classroom. Scientists and engineers work mostly in groups and less often as isolated investigators. Similarly, students should gain experiences sharing responsibility for learning with each other. In the process of coming to a common understanding, students in a group must frequently inform each other about procedures and meanings, argue over findings, and assess how the task is progressing. In the context of team responsibility, feedback and communication become more realistic and of a character very different from the usual individualistic textbook-homework recitation approach (Wyk, 2015). Learning is a collaborative process, rather than a collection of factual and procedural knowledge. This fact about learning process is even much more the reality regarding the scientific process of acquiring knowledge. The scientific method requires knowledge to be gained through observation and experimentation. The Jigsaw method fulfils the demands of the scientific method of enquiry and hence is perceived to be very effective in the instruction of chemistry.

In the Jigsaw structure, students are members of two different groups, the 'home groups' and the 'expert groups' with 4-6 members, to work on an instructional material that has been broken down into sections. Each student from every 'home

group' is assigned a portion of the material. Then the home groups break apart, like pieces of the jigsaw puzzle, and each home team sends representatives to join with other representatives from all the other teams and form the 'expert groups'. While in the expert groups, the students study intensively their particular material to ensure that they understand it well, and prepare it for peer tutoring. Later, each student returns to his/her respective home group where he/she teaches his assigned material to the rest of his/her group and learns the other sub-topics from his /her peers in the group. After the completion of the assigned learning tasks over a number of class periods each student takes an individual test.

In South Africa, Wyk (2015) discovered that, majority of teachers expressed positive attitudes towards Jigsaw cooperative learning as it was noted that, the Jigsaw method created the opportunity for the school children to develop group spirit. Besides, the Jigsaw method was also noted to have most effectively addressed the problem of racial differences in racially diverse communities (Wyk, 2015). Despite the effectiveness of JCLS, it is amazing that many teachers across Africa neglect its application. In Ghana, Sawer (2015) revealed that, majority 28(50.9%) of teachers in the second cycle schools still used lecture method regularly.

Another delimit in current research is that, researchers still agree that not all cooperative learning techniques are equivalent and that empirical evidence has to be clearly established before making recommendations to practitioners (Slavin, 2008). In fact, cooperative learning can take several forms which can be articulated around different goals or procedures (Slavin, 2011). Even though this literature reveals to the existence of an overall positive effects of cooperative learning on learning outcomes, there are significant variations in the effects of different cooperative learning methods

on learning outcomes (Slavin, 2011). Debates notably remain about the effects of the jigsaw method, a very popular cooperative learning method. Although this method has been the object of a recent surge of interest in the scientific community (Roseth et al., 2019), its structure has often been questioned (Johnson & Johnson, 2002.) and only a relatively small number of studies have tested the general claim that jigsaw promotes learning (Baloche & Brody, 2017). There is the need to explore issues related to the effectiveness of the JCLS so as to come to a consensus.

1.2 Statement of the Problem

Students in Bompeh and Adiembra Senior High Schools have difficulty understanding the concept rate of chemical reaction. The mere exposure of students to curriculum of a particular segment does not guarantee the achievement of the objectives of such a curriculum unless such exposure is well disseminated to the understanding of the students who in turn exhibit such understandings in their performance or output. This fact underscores the relevance of an effective method of instruction that can help the teacher to instruct more effectively. Louis (2018) evaluated that, the traditional lecture method of instruction lacks the creativity and engagement of the students such that, it makes topics difficult to understand as the students are just passive learners.

Moreover, it has been noted over time that, students struggle with Rate of reactions; and that the female folks have lagged behind their male counterparts in many ways (Fortokin & Odagboyi, 2010). Meanwhile, Chemistry is one of the exceptional disciplines in the academic curriculum of science. It is the heart to many science disciplines such as medicine, pharmacy, biochemistry and laboratory technology.

Furthermore, the Jigsaw Cooperative learning strategy has been recommended by some authors (Odagboyi, 2015) as an effective means of improving instructional output. However, one peculiar characteristic of the Jigsaw Cooperative Strategy is that, its efficiency depends on the characteristics of the localised participants/students. Current research that have been done to evaluate the effectiveness of the Jigsaw Cooperative learning strategy were mostly based on the findings from a particular localised area.

The researcher is of the view that, for reliable evidence to be gathered in any school or locality about the efficiency of the Jigsaw Cooperative learning strategy, such evidences must be based on the exploration of the localized situation. No prominent study also exist that had explored the effectiveness of jigsaw cooperative learning strategy (JCLS) in Adiembra and Bompeh Senior High and Technical Schools respectively. This need of exploring the local situation, coupled with prevalence of failure among students in Chemistry at Bompeh and Adiembra Senior High Schools has validated the need to conduct this study to explore effects of jigsaw cooperative learning strategy (JCLS) on chemistry students' understanding of rate of chemical reactions.

1.3 Purpose of the Study

The purpose of this study was to investigate the effects of jigsaw cooperative learning strategy (JCLS) on chemistry students' understanding of rate of reactions in Bompeh Senior High Technical School and Adiembra Senior High Schools in the Western Region, Ghana.

1.4 Objectives of the Study

The objectives of the study were to:

i. Identify the difference in the performance of learners taught using the jigsaw method and those taught using chalk-and-talk approach in Rate of reactions.
ii. Investigate the effect of the jigsaw method on males' and females' performance in Rate of reaction in Bompeh Senior High Technical School and the Adiembra Senior High School.
iii. Determine students' perception about the usefulness of JCLS in learning rate of chemical reaction.

1.5 Research Questions

The following research questions guided the study:

i. What is the difference in the performance of learners taught using the jigsaw method and those taught using chalk-and-talk approach in Rate of reaction?
ii. What is the effect of the jigsaw method on boys' and girls' performance in Rate of reaction?
iii. What are students' perception about how JCLS is helpful to them or otherwise?

1.6 Research Hypotheses

H_0: There is no significant difference in the performance of students taught rate of chemical reaction using the JCLS and those taught using traditional chalk and talk method.

H_{02}: There is no significant difference in the performance of girls and boys taught Rate of reaction using the JCLS

1.7 Significance of the Study

This study's findings will help teachers to adopt appropriate instructional strategy that can contribute to instructional effectiveness and efficiency. The study outcomes will also serve as a good ground for policy makers such as the Ghana Education Service in the formulation, or review of policies aimed at ensuring instructional efficiency in Ghanaian Schools. The study will also yield to the redress of poor performance in Rate of reaction and hence Chemistry as a subject. The outcome of this study will also advance existing knowledge regarding effective instructional strategies for teaching and therefore can serve as a viable point of reference for future study on related topic.

1.8 Delimitations of the Study

The study was geographically delimited to the two schools explored – Bompeh Senior High Technical School and the Adiembra Senior High School. The variables were delimited to the difference in the effects of the JCLS and chalk and talk methods, difference in girls and boys performances after being taught using JCLS, as well as views or perceptions of students about the helpfulness of JCLS. Meanwhile the study was not interested in exploring the performance difference between the two schools (Bompeh Senior High Technical School and the Adiembra Senior High School).

1.9 Limitations

The study was limited by the sample size as it made use of only two schools because of the time frame. In this way the study findings were limited to the localised situation of Western Region, Ghana. This limitation has some restriction on the generalizability of the findings of the study.

Secondly, the study outcomes, especially regarding the interview on the perception of students on how the JCLS was helpful to them was limited by the pretence index since some of the students could pretend and give pieces of information which was not the fact despite the efforts made to ensure confidentiality. Moreover, learners' lacked of enthusiasm and interest in the study as well as their negative attitudes towards physical sciences education in general also militated against the study process as it requires instructing the students for a while and conducting a test on them. Some of the students were not regular in the instruction periods posing some difficulties of recapping lesson in order to get them along with others when they were present.

1.10 Definition of Operational Terms

Performance:

This refers to the overall combination of students' academic outcomes in the pre-test and post-test of this study

JCLS:

It is a grouping strategy in which members of a class are organised into groups then rearranged in new groups to share their learning.

Instructional Approach

The structure, system, methods, techniques, procedures and processes that a teacher uses during instruction to lesson

1.11 Organisation of the Study

The study is organized into five chapters. Chapter One includes items that discussed the introduction. These items include background of the study, problem statement, purpose of the study, specific objectives, and research questions, significance of the

study, delimitations of the study, limitations of the study, definition of terms and organization of the study.

Chapter Two consists of the presentation of reviewed literature consisting of articles, journals and other authorships that are relevant to the topic. The review is presented under theoretical framework and various themes that relate to the specific objectives of the study

Chapter Three presents the methodology. It gives more insight into the study approach, study design, study variables, study area, study population, sampling techniques, sample size determination, data collection instrument, data collection procedure, data analysis procedure and ethical considerations.

Chapter Four deals with the results of the analysis and syntheses of the information gathered. The analysis is presented under each research question so as to provide a direct understanding of the prevailing findings regarding each research question.

Chapter Five which is the last chapter, comprises a summary of the entire study procedure and a highlight on the key findings. Based on the findings, the conclusions and recommendations were drawn.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter presents conceptual framework and a review of available literature on the topic under consideration. Literatures sources that were used included journals such as PLoS, SAGE and other journals of educational development. Also, literature was retrieved from prominent university websites and google scholar. Materials under this chapter were presented under theoretical framework, conceptual framework, review of related studies and a brief summary of the chapter.

2.1 Conceptual Framework

This study was underpinned by the Ausubel's model of meaningful reception learning and systems theory. This model was developed by Ayot and Patel (1987). The framework shows Jigsaw teaching strategy as an intervention in the teaching and learning process of science concepts. The model describes the relational architecture between teaching methods and students' academic performance.

Figure 1 below shows the relationship between the variables of the model adapted to fit this study.

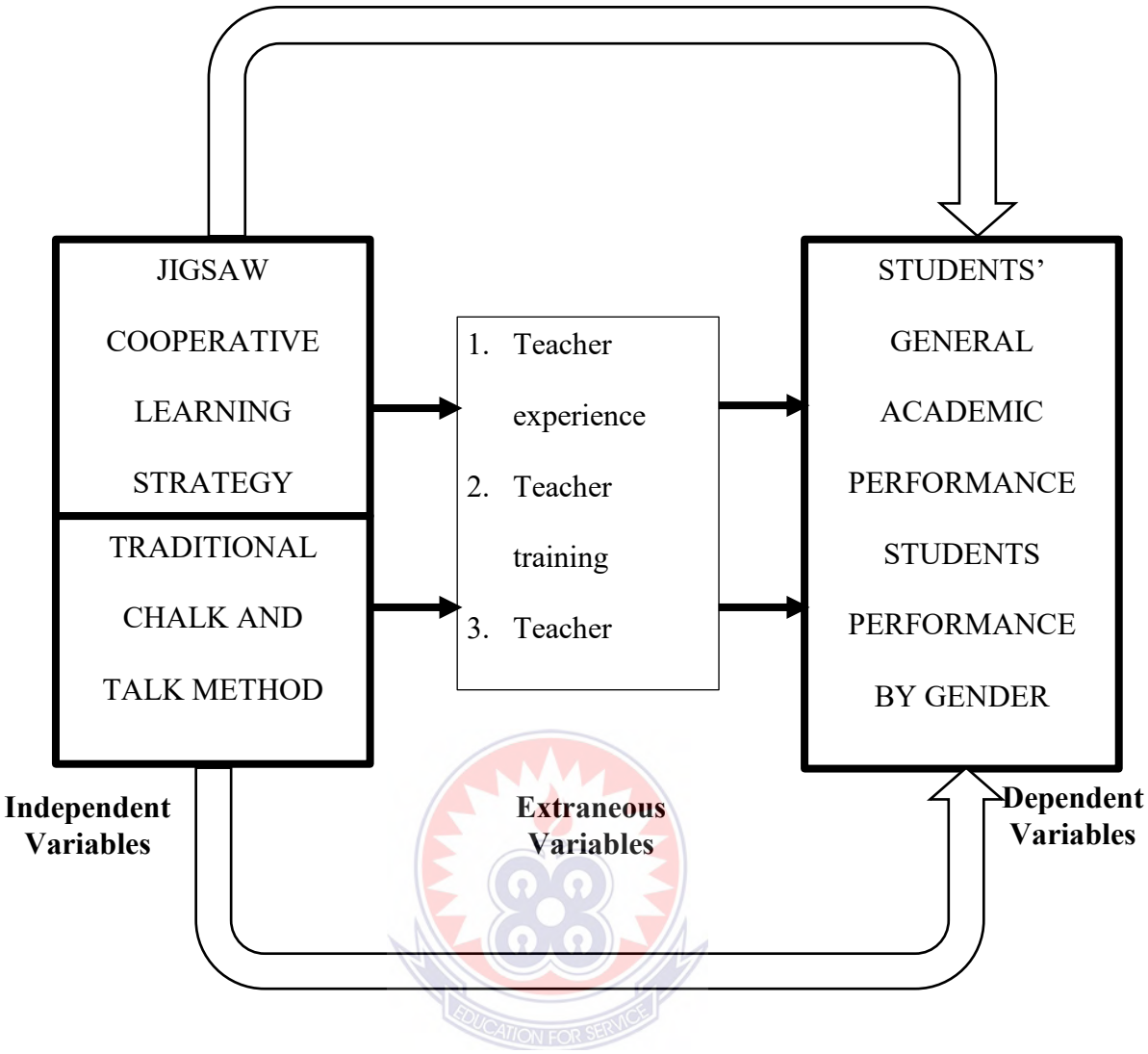

Figure 1: Ausubel's model of meaningful reception learning and systems theory

The Ausubel's model of meaningful reception learning and systems theory reflects a vivid relationship between teaching strategy which is an independent variable and students' learning outcome which is the dependent variable. Yet such relationship is also affected by teacher characteristics and related factors which are extraneous factors. In this study, the teaching strategies or model in view were the Jigsaw Cooperative Learning strategy and the Traditional Chalk and Talk Method of Teaching. These formed the independent variables whose effects or influence on the dependent variables were being measured. The dependent variable in view is students' academic performance which is classified into general performance and gender

related performance. However, the model admits that, the relationship is also affected by teacher related factors such as teacher experience, teacher training and teacher characteristics.

2.2 Definition of Concepts

2.2.1 Cooperative learning strategy

Recent research generally portrays the advantage inherent in teaching and learning methods that are more collaborative and interactive in nature (Ahles & Contento, 2006; Doymus, 2008; Doymus, 2010). In view of this, several researches in broader terms suggest the acceptance of cooperative learning methods in teaching science (Bandiera & Bruno, 2006; Ahles & Contento, 2006; Doymus, 2008; Doymus, 2010; Walker & Crogan, 1998).

One of the most important arguments regarding collaborative or cooperative learning is the fact that, one's confidence and self-esteem is built mostly on collaborative learning activities using group discussions (Slavin, 2014). Integrating new information actively into one's prior knowledge based on peer scaffolding, collective analysis of a problem, instructiveness of the problem-solving process, giving explanations and writing group reports seem to be the underpinning of the effectiveness of all cooperative learning strategies (Khalil, Nahid & Mohammed, 2014). Generally, cooperative learning environment fosters learner activity and participation, joint acquisition of content and mutual knowledge and the collaborative efforts towards understanding concepts (Slavin, 2014). Cooperative learning has been noted to have promoted team work and collaborative skills among students of all ages and grades (Slavin, 2011).

Cooperative learning was defined as a teaching method that involves students in learning process in order to understand and learn content of the subject (Slavin, 2011). Traditional class activities create a win-win situation, where one can only succeed if others loose. However, cooperative learning is direct and opposite of such a win-win environment. In the latter case, all learners contribute towards a common goal of understanding and performing the task involved in a more accurate and excellent manner through a non-competitive spirit. In a cooperative learning, learners complement each other rather than competing with each other (Bukunola & Idowu, 2012). It has been argued that cooperative learning has an edge over other teaching methods in terms of its effectiveness for improved cognition, social skills and motivation leading to enhancement of learner interest (Bukunola & Idowu, 2012; Kabuttu, Oloyede & Bandele, 2013; Gambari & Yusuf, 2017).

Many studies have recommended that, the concept of self-perception or self-concept of the students must be prioritised as the best approach of arriving at higher students' academic performance (Box & Little, 2004; DaRos-Voseles, Denis, et al 2006). Prioritizing students' perspectives and self-perception is the bedrock of cooperative learning (Box & Little, 2004). The fact that each and every student and his or her opinion matters to the rest of the group members being taught must be upheld because each and every student in a study group is important in driving the learning process and hence must be given the chance to contribute, and explain his or her view so as to make clear the known in other to help the instructor to add the unknown aspect of what is being taught. This approach of involving students in the learning process is very cardinal in increasing self-perception, confidence and trust of the individual students, which has a major influence on the performance of all the students in a cooperative learning groups (Khalil, Nahid & Mohammed, 2014).

Several other studies also point out another major point central to the issue of interdependency and helping behaviour among the group members (Ahles & Contento, 2006; Walker & Crogan, 1998). The overall result in majority of studies on cooperative learning is that, cooperation in general and jigsaw in particular have a significant positive effect on academic achievement, liking of peers, racial prejudice, interpersonal attraction and inclusion of low achieving and even disadvantageous students (Johnson & Johnson, 1982; Khalil et al., 2014).

A study by Stockdale and Williams (2004) suggested that, low and average-achieving students improved significantly during jigsaw cooperative study whereas the previously high achievers' achievement decreased in one way or the other. This outcome suggests that, cooperative learning acts towards contributing the unique qualities of each learner towards the benefit of the entire group. Though somehow disadvantageous to the highly performing students in terms of mark achievements, its overall advantage to the vast number of learners cannot be overemphasized (Stockdale & Williams, 2004).

The role of the teacher is changing as can be seen from provider of knowledge as is in the explicate teaching, to be the provider of an environment in which students are responsible for the learning material, prepared in advance. The teacher can order students to plan suitable steps in accomplishing the learning task in an active process. The class (course) moves from a teacher centred to student centred. By this method of learning, the ideal role of the teacher can be displayed. The teacher can move from one group to another, to arouse, to ask, to answer and to devote more time to those who need him/her more and praising students for their effort towards learning. The

teacher here is referred to us a “floating teacher”. Students differ in their cognitive stages, abilities, learning styles, preferences, choices, interests and needs (Khalil, Nahid, & Mohamed, 2014).

Generally, students who are peripherals, find it difficult expressing their learning difficulties when the teacher ask the entire class “did you understand?” or “do you have any questions?” with the frontal expository teaching method, it is amazing in this situation of being in front of whole class getting a student to announce, “I did not understand”. Unlike the cooperative group where a student can ask a colleague “tell me again” and the words used are more meaningful than those used by the teacher. The teacher can also be more helpful helping a student discretely than in front of the entire class (Khalil, *et al.*, 2014).

Cooperative learning is a pedagogical practice that provides learners with the cognitive, affective and psychomotor attainments when they have the opportunity to interact with others to achieve common goals (Devi, Musthafa & Gustine, 2015). Cooperative learning is formed as a promising teaching innovation to enhance the cognitive, affective and social learning attainments. A great number of cooperative learning techniques and structures exist today. These models differ from one another in terms of some important aspects such as enabling individual learning and intergroup collaboration as well as in-group collaboration and competition. In addition, certain basic elements such as positive dependency, individual accountability and face-face interaction are common in these models (Slavin, 2015; Sharan, 2015). One of the various classroom practices of cooperative learning is Jigsaw technique. Jigsaw activity is a teaching practiced in which learners are responsible for learning the material and teaching it to other learners.

2.2.2 The Jigsaw model as cooperative learning model

The jigsaw model is a teaching strategy in which the instructor prepares several different, related tasks for the class. The instructor designs specific number of tasks, one for each of specific number of groups. Each group then prepares on one of the tasks. Once each group is prepared, the class is divided according to the number of the designed tasks. Each group will have one group member from each of the groups. Each member of the group is responsible for teaching the rest of the group what he/she has learned from his/her previous group task. The group then puts all of the pieces together and completes a group task that can only be answered once all of the team pieces are together (hence the name "jigsaw").

One critical assumption (unavoidable condition) that the instructors using the Jigsaw model framework must take into consideration is that the individuals in each group must know and master their own task better than any of the ones presented by their peers in other groups. This is true partly because students must know their own tasks well enough to explain them and partly because their peers are typically not skilled presenters. The jigsaw technique is a cooperative teaching strategy specifically designed to provide students the opportunity to become "experts" in a particular concept, and share that knowledge with their peers (Karacop, 2019).

Kagan (1994) describes the jigsaw teaching model as a method in which teams of students are assigned to investigate different aspects of the same problem or issue. Each team analyses a different but related data set on the same concept.

Once each team member thoroughly understands his/her team's aspect of the problem, new groups are formed, with at least one representative from each original team. Each

individual then explains his/her team's aspect of the problem to the new group. In this way, every student learns every aspect of the problem. Each group then uses the combined information to evaluate a summary issue" (Kagan, 1994). As a form of cooperative learning, the jigsaw method is a teaching strategy that helps students to develop skills for working effectively in teams, an important competency for socio-environmental synthesis (Johnson & Johnson, 2002). Grounded in social interdependence theory (Johnson, Johnson et al., 2014), the jigsaw model is an established educational approach robustly supported by plethora studies (Johnson & Johnson, 2002). The central principle of the jigsaw model framework is that learning is rather than competing with each other or being indifferent to each other, students engaged in cooperative learning "work together to maximize their own and each other's learning" (Johnson & Johnson, 2002 p. 11).

Jigsaw method has in the past been successfully used with students starting in kindergarten through the university level. An investigation was made by Souvignier and Kronenberger (2007) on an interesting question, concerning the minimum age of students as a potential limitation of the jigsaw method. The authors suggested, while using the jigsaw with younger children (third grade), an additional help like a questioning training and well-structured material might be needed for satisfactory learning outcomes (Khalil et al., 2014) The jigsaw method of cooperative learning builds on the principles of constructivism (Piaget, 1932) and social interaction (Vygotsky, 1978). The implementation of these two factors combined seems to bring positive learning outcomes when used across the entire scale of ages (Khalil, *et al.*, 2014).

Kagan (1994, pp.5-11) lists six (6) principles that are important for a group to cooperate effectively. Some of the principles are:

- There must be positive interdependence: Positive interdependence refers to the feelings of responsibility that group members have towards each other. Each feels that he/she shares the success or failure of others, that what helps one helps all and what hurts one hurts all. This feeling can be promoted by roles, information distribution and rewards
- There must be individual accountability: This implies the idea that group success depends on the learning of each individual member. This feeling can be promoted by individual quizzes or assignments following group work.
- There must be high levels of collaborative skills: Developing social and communication skills is a necessity for cooperation to be successful. These skills include asking for help, making suggestions, disagreeing politely, leadership, decision-making, trust-building, communication, conflict management skills, turn-taking, polite interruption, encouragement and moral support.
- There must be heterogeneous nature of group: Groups should, if possible, contain both male and female students of different ability levels so that each group will have one top-level, two middle levels and one struggling.
- There must be equal participation: Group activities can be structured to encourage all group members to participate to an equal degree. Means of doing this include providing each member with a turn to speak on particular information that they need to contribute to a group. The opportunity for

students to discuss, to argue, to present and hear one another's viewpoints is the critical element of cooperative learning with respect to their achievement.

- There must be easy coordinated but undistracted interaction: One person speaks at a time. When group activities are used, one person per group may be speaking, that is if a class of 40 students are working in groups of four, ten people may be talking simultaneously.

In planning cooperative learning, teachers take several roles. First, teachers make preinstructional decisions about grouping students and assigning appropriate tasks. Teachers have to be able to explain both the academic task and the cooperative structure to students and then must monitor and intervene when necessary. Finally, the teacher is also the one who is responsible for evaluating student learning and the effectiveness of each group's work (Cohen, 1994). The cooperative structure includes both the roles of students and the rules of interaction.

Jigsaw activity has been a teaching activity that can be used by teachers of all grades in their classrooms. Many educators have adapted and employed the revised versions of Jigsaw technique in their classes (Zacharia, Xenofontos & Manoli, 2011; Zhan & Georgia, 2011). Jigsaw technique encourages student participation in a classroom where learners have a critical role for success and this success depends on active cooperation and participation. Using Jigsaw technique increases the variety of learning experiences, and teaches learners course content and cooperative social skills (Perkins & Tagle, 2011).

In the Jigsaw technique, as the only way for a student to learn the other parts of the content that are not under his/her responsibility is to carefully listen to his/her teammates, these practices encourage learners to support and care about the work of

others (Huang et al., 2014; Mari & Gumel, 2015). Jigsaw technique has been designed to promote cooperation by making individuals dependent on each other. In this technique, each student is responsible for learning a part of a broad topic and teaching it to other learners. That is, each learner is dependent on other group members to learn the main topic (Buhr et al., 2014; Carroll, 1986; Maden, 2011).

As each learner in the cooperative work group is responsible for a small part of the learning material and teaching it to other members, the sense of having a responsible role places them in the center of knowledge creation process (Slavin, 2014). Jigsaw model is an effective approach to develop dependency and cooperation. However, there are some disadvantages of this model that affect learners' participation in group work in a negative way. When students believe that their individual efforts are not related to their group's performance, some negative group procedures such as social evasion and fool effect may occur. In order to use this teaching method effectively, some limitations of the technique need to be considered. When the cooperative tasks given to the group members are not challenging enough to require joint effort, group members can view their individual contributions as unnecessary.

Moreover, if the cooperative work does not comprise sufficient tasks for each group member to contribute, students are inclined to social evasion. This instability gives inconvenience to the group members who have to undertake the majority of work. Also, it is important for the main content chosen for the group work to be divided into sub-categories for the equal responsibility of group members (Devi, Musthafa & Gustine, 2015; Doymus & Karacop, 2010).

2.2.3 Students' academic achievement/performance

Students' Academic Achievement is a student's ability of accomplishing an academic task successfully. Its purpose is to find out the stand of a student at a given moment (Akani, 2017). It has to do with testing the knowledge acquired by the student which helps the teacher and the student to evaluate and predict the degree of learning attained. It is useful in testing the retention of information and skill. It is also a determinant of the efficacy and efficiency of a given instruction (Kabutu, Oloyede & Bandele, 2015).

Under this study, academic achievement is considered synonymous to learning outcomes. Learning is an interaction that occurs between the internal state of students and cognitive processes of students with stimuli from the environment (Akani, 2017). Changes in behaviour caused by the learning process make students have mastery of the subject matter delivered by the teacher to achieve learning goals. Learning outcomes are changes in human behaviour resulting from learning and can be in the form of learning impacts or accompaniment impacts. This is a peak in the learning process.

Learning outcomes consist of three domains, namely the cognitive domain (Bloom, et al, 1973) which consists of six levels of behavior, affective domain which consist of five types of behavior, and psychomotor domains (Simpson) which consists of seven behaviors. The cognitive learning outcomes consist of six levels of behavior (Anderson & Krathwohl, 2001 p.137) namely:

1) Remembering, including the ability to remember things that have been learned and which are stored in memory. Knowledge regarding facts, events, understanding, rules, theories, principles, or methods.

2) Understand, includes the ability to capture the meanings of things that have been learned.
3) Implement, including the ability to apply methods to deal with real or new problems.
4) Analyse, including the ability to specify a unit into parts so that the overall structure can be well understood.
5) Evaluating, including the ability to form opinions and assess based on certain criteria.
6) Creating, including the ability to create planning or design in performance.

Affective domain according to Bloom, Krathwohl, and Masia (1973) book 2 consists of five types of behavior, namely:

1) Acceptance, including sensitivity and attention to something.
2) Participation responds, including the willingness to pay attention and participate in an activity.
3) Assessment, including acceptance of a value, respecting, acknowledging, and determining attitudes.
4) Organization, including the ability to form a value as a life guide.
5) The formation of values, including the ability to live up to values and shape them into a pattern of values in personal life.

Psychomotor learning outcomes according to Dave (Muslim, 2013, p. 4-) consist of five levels, namely:

(1) Imitation, students can carry out activities by imitating what has been seen.
(2) Manipulation, students can carry out certain activities on the basis of instructions or orders.

(3) Precision, students are able to carry out activities that are of a precision nature, which includes elements of accuracy, accuracy, and balance even though these activities have not yet been seen as a whole.

(4) Articulation, students are able to coordinate a series of activities that are precision in order and appropriate.

(5) Naturalization, students are able to do activities that are naturally sequential and carried out with minimum energy.

In the present study, students' achievement is also defined to be gender specific. One specific issue which has generated much debate in educational circles over the years is a question of whether differences in performance exist or not between males and females in a defined learning task. A definite answer to this question seems to be a complex one. Thus, gender issues are currently the main focus of discussion in the world over and Ghana is not an exception. The complexity arises because empirical and theoretical literatures have produced diverse and contradictory results (Oluwatayo, 2011).

In recent times, there have been studies on the performance of senior secondary school accounting students with emphasis on gender dimension. However, empirical results on this issue have not been consistent. Whilst some studies reveal that female students outperform their male counterparts, others reveal that male students outperform their female counterparts. Still, others show no significant differences. Nobbert-Bennet (2002) indicates that academic achievement reports have repeatedly indicated that there is increasing evidence that females are outperforming males academically in secondary education across a range of subjects. Croxford (2000) confirmed that the average levels of attainment for boys are lower than those of girls at all stages and across almost all areas of the curriculum.

Adeosun (2002) is also of the same view. He confirmed that there is no significant difference in the achievement score between males and females in a study conducted on the effects of multimedia packages and students' achievement in social studies. Abdu-Raheem (2012) also concluded that there is no significant difference between the performance of male and female students in Social Studies. Aboagye, Mensa and Dumba (2013) also researched on the performance of English students in senior high schools in Ghana and came out with the conclusion that female students perform better in English language than their male counterpart. A research conducted by Kyere, Gyeabour and Anaba (2012) on gender differences and performance of history students in senior high schools in Cape Coast metropolis concluded that there is no significant gender difference between female students who are studying history and their male counterpart. According to the Ministry of Education (MoE, 2013) report on gender, especially enrolment and achievement remain unequal for males and females in the senior high schools.

2.2.4 Theory of performance

Theory of Performance was propounded by Elger (n.d.) which develops and relates sex foundational concepts to form a framework that can be used to explain performance as well as performance improvements. To perform, according to Cambridge Advanced Learner's Dictionary (2007) is to do an action or piece of work in order to achieve results. That is, to perform is to take a complex series of actions that integrate skills and knowledge to produce a valuable result. A performer therefore is an individual or a group of people engaging in a collaborative effort. Developing performance is a journey, and level of performance describes location in the journey. Students in the world are capable of wonderful achievement. Extraordinary accomplishments among students also occur in day-to-day practice in the classroom.

Teachers in general motivate and inspire students to follow their dreams. Some teachers magically link themselves to their students to the level of helping each student to be academically brilliant in order to perform best in the educational activities such as external exams. Since worthy achievements are produced from high-level performances, a theory of performance (ToP) is useful in many learning contexts (VanScotter, Motowidlo & Cross, 2000).

In traditional contexts, the theory of Performance informs learning in classrooms, student's workshops, and other venues that are traditionally associated with learning. In non-traditional contexts: A theory of Performance informs learning in contexts that are not traditionally conceptualized as learning environments. Examples of these contexts include academic advising, self-development, departments, academic committees, professional research groups, colleges.

Students' performance alters as a result of learning. Prior research has indicated that performance initially increases with increasing time spent in a specific task and later reaches a peak (McDaniel, Schmidt, & Hunter, 1988). Moreover McDaniel, et al. indicated that the processes that underline students' performance change over time. For instance, during early phases of skill acquisition, students' performance largely 27 depend on 'controlled processing', the availability of declarative knowledge and the optimal allocation of limited intentional resources, whereas later in the skill acquisition process, performance largely relies on automatic processing, procedural knowledge, and psychomotor abilities (Ackerman, 1988).

To pinpoint the processes underlying changes of students' task performance, Murphy (1989) separated a transition from a maintenance stage. According to Murphy (1989), the transition stage occurs when students are new in studying a particular subject and

when the activities involved in learning of that subject are novel. The maintenance stage occurs when the knowledge and skills needed to perform the task are learned and when task achievement becomes automatic. For doing better during the transition phase, cognitive ability is extremely relevant. During the maintenance stage, cognitive ability becomes less important and dispositional factors (motivation, interests, and values) increase in relevance. There is increasing empirical evidence that students differ with respect to patterns of intra-individual change (Hockey, 1997).

These findings show that there is no uniform pattern of performance development over time. Additionally, there is short-term variability in student performance which is due to changes in their psycho-physiological state, including processing capacity across time (Ployhard & Hakel, 1998). These changes may be caused by long school hours, exposure to stress and may result in fatigue or in a decrease in their school work. However, these states do not necessarily result in a performance decrease. Individual students are, for example, able to compensate for fatigue, be it by switching to different strategies or by increasing effort (Hockey, 1997).

The performance of individual students in the various schools largely depends on the components of the system and on the interactions between these components. Each component is described using rules and exemplars. Campbell (1990) describes the component of students' performance (level of identity, skills and knowledge; context of performance, personal factors and fixed factors as a function of three determinants (a) declarative knowledge, (b) procedural knowledge and skills, and (c) motivation.

A declarative knowledge includes knowledge about facts, principles, goals, and the extent to which the student know his/her self. It is assumed to be a function of a person's abilities, personality, interests, education, training, experience, and aptitude-

treatment interactions. On the other hand, procedural knowledge and skills include cognitive and psychomotor skills, physical skill, self-management skill, and interpersonal skill. The predictors of procedural knowledge and skills are again abilities, personality, interests, and education, training, experience, and aptitude-treatment interactions and additionally practice. Lastly, motivation comprises choice to perform, level of effort, and persistence of effort. Campbell does not make specific assumption about the predictors of motivation. He therefore assumes that there are 29 interactions between the three types of performance determinants, but does not specify them in detail (Campbell, Gasser & Oswald, 1996).

Although gender issues are talked about in schools, it appears that little is being actually done about such issues. It has been demonstrated that there are some academic benefits to be gained from single-sex schooling (Kelly, 1996), and some co-educational schools have begun to segregate males and females for parts of their academic life (Kelly, 1996).

2.3 Effect of JCLS on Students' Achievement

Tarim and Akdeniz (2008) reported that cooperative learning method results in higher achievement than the traditional method of instruction. In the view of Slavin (2013) well-structured methods such as cooperative learning produce more positive effect sizes than those evaluating other instructional practices such as the use of innovative curriculum text books or the use of technology in reading and mathematics.

Sedegah, et al. (2019) conducted a study to examine the influence of cooperative learning approach on senior high school students' understanding of ionic bonding in integrated science. The investigation was carried out in Adeiso Presby Senior High School in the Eastern Region of Ghana. The study involved two intact form two

classes of 85 students and one chemistry teacher in the Senior High School. Developmental approach was used in this study. Ionic bonding achievement pretest was administered to the study sample students. The class which obtained higher mean score of 13.52 was designated as control group and the class which obtained lower mean score of 12.35 was designated the experimental group. The prototypes for cooperative learning approach in teaching and learning of ionic bond were developed through four stages before they were implemented in the class of the experimental group. An interactive workshop was organised to discuss the developed prototype materials with the chemistry teacher. The possible advantages and challenges were discussed. During the classroom implementation stage, the teacher taught the experimental group about ionic bonding using the cooperative learning strategy for five weeks. The same teacher taught the control group about ionic bonding using the traditional teaching method. Quantitative data gathering procedures were used to obtain data for the study. The quantitative data involved a pretest and a posttest ionic bonding achievement test items which were reviewed by two chemistry lecturers of the University of Education and one SHS chemistry teacher. The reliability of the pretest and posttest ionic bonding achievement test items was determined after a pilot study, using cronbach alpha. The reliability for the pretest and posttest ionic bonding achievement items was 0.78 and 0.79 respectively. Independent one–tail t-test analysis was performed on both groups. The findings from the study indicated that the experimental group performed better than the control group in the posttest as a result of the cooperative learning strategy applied in teaching the experimental group. Again, the findings showed that the various heterogeneous groupings of mixed ability in the experimental group contributed significantly to the improvement in their performance in the posttest after the implementation of the cooperative learning

technique. It is recommended that cooperative learning strategy should be incorporated into the science education curriculum

Moreover, evidence from synthesis of elementary science programs by Slavin, Lake, Hanley, and Thurston (2014) indicated that science teaching methods which focused on enhancing teachers' classroom instruction throughout the year, such as cooperative learning have significant potential to improve science learning. In short, there is overwhelming evidence that cooperative learning as a pedagogical practice has had a profound effect on student learning and socialisation (Slavin et al., 2014).

Karacop (2019) conducted a descriptive study to determine the influence of a Jigsaw method based on cooperative learning and a confirmatory laboratory method on prospective science teachers' achievements of physics in science teaching laboratory practice courses. The sample of this study consisted of 33 female and 15 male third-grade prospective science teachers (6th term) who attended science teaching laboratory practices course in the 2014-2015 academic year. In the research, science teaching laboratory practices course was carried out in accordance with a Jigsaw method based on cooperative learning in an experimental group and a confirmatory laboratory method in a control group. Following the treatment, Science Laboratory Physic Achievement Test (SLPAT) was administered as the post-test. The data obtained with the instruments were evaluated using descriptive statistics, independent samples t-test, and ANCOVA. The results indicated that the student teachers had higher levels of achievement in physics topics which were taught through the Jigsaw method based on cooperative learning than through a confirmatory laboratory method. In addition, according to the SLPAT results, students' high levels of misunderstanding revealed that there were problems in the teaching process of

physics concepts. It was determined that the student teachers in the research groups had conceptual misunderstandings about sound, electricity, magnetism, light and optics issues. Based on the applications performed in this study, the original Jigsaw was adapted to science laboratory applications as an alternative to the existing Jigsaw techniques in the literature. With similar efforts, the experiences of prospective science teachers can be enhanced for implementing modern teaching methods in their respective areas in the pre-service period. Thus, the provision of professional development of the pre-service science teachers can be supported.

According to Gocer (2010), students are to be aware of the fact that they should work so as to maximize the learning levels of not only themselves but also that of their peers. In cooperative learning, peers assist each other's learning and establish proper communication among them. Students with different culture, experiences, and learning modes get together to achieve success towards a common goal by assuming the responsibility of each other's progress.

Adjibolosoo et al. (2019) discovered that, in general, instructors used a range of different pedagogies to communicate content-based concepts to students with varied cultural and educational settings. Meanwhile, most of the teachers ignore the application of jigsaw cooperative learning strategies. Consequently, Adjibolosoo et al. (2019) undertook a study to investigate the female students' concept mastery and to identify students' intrinsic motivation in science concepts learning when the concept is taught using jigsaw teaching model. Ninety-four (94) first year female students from the Presbyterian Women's Colleges of Education were randomly selected to form the study sample. Experimental data were collected using pre-test and post-test. Structured questionnaire was also administered to a sample of 40 conveniently

selected female students from the experimental group. Observation and interview were also conducted to gather self-reported data on students' intrinsic motivation. The quantitative data was analyzed using descriptive, t-test and chi-square statistics. The qualitative data was analyzed using thematic content analysis. The results of the study indicate that greater number of students obtained better results as they learnt and remembered better through jigsaw model. Further, students' participation was generally higher and intrinsic motivation shown in the students when they learnt through jigsaw model. The study recommends that teachers in the colleges of education, particularly those in female colleges, should use the jigsaw model to encourage and motivate students to learn science. The study also recommends that the model should be extended to other colleges of education dealing with mixed students to further expand the efficacy of the model in science concepts mastery and building of intrinsic motivation.

When discussing the impact of Jigsaw Cooperative Learning, it is important to note that, many studies have identified its flexibility and user-friendliness in benefiting students of varied backgrounds and abilities. Septiani (2020) examined the community learning benefits of Jigsaw Cooperative Learning Strategy and revealed that JCLS has the potential of helping students from varied classes and potentials. Septiani (2020) revealed that, the JCLS brings positive outcomes regardless of the type of student, culture, level or performance. Septiani's idea does not exist in isolation, it has also been confirmed by Jainal and Shahrill (2021). Jainal and Shahrill (2021) conducted an action research aimed at effectively incorporating JCLS into the training and practice of teachers. In his study, Jainal and Shahrill (2021) affirmed after several investigations that, Jigsaw Cooperative Learning Strategy has a

pedagogical flexibility and user-friendliness that could accommodate students of different backgrounds and strengths.

Odagboyi (2015) noted that classroom groups with supportive friendship patterns enhance academic learning, while interpersonally tense classroom environment in which peer group rejection is strong and frequent, are hindrances to learning. Cooperative learning help satisfy many psychological conditions of students. Each individual member of the team works until each member of the team fully understands and completes the assignment (Adams, 2013).

Studies indicate that most commonly adopted strategies for science classroom instruction in Ghana is in line with what can be called "traditional teacher-centred approach (Emaikwu, 2012). This is the approach where teachers monopolize communication, dominate classroom discussion, and maintain structures that heavily rely on teacher-centered approach. Emaikwu (2012) went further to assert that, this approach permits teachers to dominate classroom talk and control classroom activities with little or no opportunity for students' contribution. From this view, students' responsibility is to listen carefully and copy notes given by the teacher (Emaikwu, 2012). Meanwhile, very few science concepts are taught using student-centered approaches such as 'Jigsaw model'. Most lessons are conducted based on teacher-centered approach. One of the reasons is because of the teachers' beliefs and experiences in school which have influenced them in a way to practice this approach (Emaikwu, 2012).

According to Woolnough (1997), although, it is satisfying to see the high achievements of students when the teacher-centered approach is used in schools, nevertheless, students' emotional interest in learning should also be taken into account

as it is fundamental to boost their intrinsic motivation, their commitment, their enjoyment and creativity in science.

According to Adams (2013), there are three major ways for people to learn about the world. These included discovering things about the world from personal observations and experiences with the environment; acquire knowledge transmitted directly from other people or construct personal knowledge by transforming discovered and acquired knowledge in meaningful ways. Studies on teaching strategies emphasize that all students irrespective of needs and background are to be provided with intellectually challenging classrooms work (Bature & Jibrin, 2015) and that if such students are engaged with intellectually challenging work during their classroom instruction, there is the probability of having their learning outcomes improved (Emaikwu, 2012). Moreover, in order to raise students with critical thinking skills, giving students intellectually challenging classroom task is important as it helps students' collaboration and interaction during classroom instruction around solving difficult problems (Bature & Jibrin, 2015).

Besides, Alsharif and Atweh, (2012) suggested that, providing students from diverse background a supportive classroom environment possesses the possibilities of creating classrooms where students are given the opportunity to 'take risks' without being ridiculed or pull down by their classmates and or their teachers. Finally, the recognition of different social groups in a science classroom suggests the need to recognize and value the cultural backgrounds existed among students with the aim of developing the learning experiences of different students in a classroom (Hayes et al., 2006). The desire, therefore, to introduce the jigsaw model framework into the

Ghana's science classroom with the view to reforming its instruction is not out of place.

In view of these, this study seeks to use jigsaw model as a framework to reforming the teaching and learning of science in Ghanaian science classroom with the view of achieving quality classroom instruction and students motivation to science learning. This study seeks to investigate the effect of jigsaw-based learning method on students' concepts mastery and development of intrinsic motivation towards learning. The study critically investigates the effectiveness of jigsaw teaching model in science concepts learning among randomly selected first year female students in the colleges of education.

Thompson and Pledger (1998) explored the efficacy of two methodologies: Traditional lecture versus cooperative learning. Samples of 50 students were taken from a mid-size, southern, metropolitan university in the South-Eastern United States. The subjects were divided into two groups: 27 students who learned course material via the traditional lecture format and 23 students, who learned course material via a cooperative learning technique called jigsaw. The results did not reveal any significant differences in the scores of students taught by the two strategies.

Halliday (2002) investigated whether cooperative learning could improve the academic performance of students in inner city middle school located in Gary, Indiana. Two 7th-grade classes taught by one African American male teacher served as one experimental group of 20 at-risk students, and one non-experimental group of 24 high achievers. Both groups took the same pretest on a unit about India. The experimental group was taught using cooperative learning. Achievement results

indicated that the cooperative learning strategies worked well with the group of at-risk students.

Natalia (2001) examines the implementation and effectiveness of whole class teaching followed by task-oriented cooperative group activities in comparison with whole class teaching followed by individual work on learning English. Two classes of at least 80 students were assigned as an experimental group that used cooperative group activities and a control class that was taught by the traditional method. The results of the study indicated that cooperative learning improved the quality of language practiced, improved the quality of students' talk, created a positive affective climate, increased students motivation, and enhanced thinking.

Ghaith and Abd-ELMalak (2004) examine the effect of the cooperative Jigsaw method on improving literal and higher order English reading comprehension of forty-eight university students of EFL. Applying the experimental design, the result indicated no significant differences between the control and experimental group on the dependent variables of overall reading comprehension and literal comprehension. However, the results revealed a statistically significant difference in favour of the experimental group on the variable of higher order comprehension.

Abu-Khader (2006) examines the effect of cooperative learning strategies Jigsaw and Learning Together Strategies on Palestinian EFL freshmen's reading comprehension. The population of the study consisted of 600 Palestinian freshman EFL learners distributed into 12 assigned sections at Al-Quds University in the second academic semester 2005-2006. The participants of the study were engaged in experimental and control groups. A pre-posttest technique for the reading comprehension was administered. The results showed that there were significant differences in students'

scores on the overall reading comprehension in the post-test between the two groups in favor of the experimental group which was taught by cooperative learning strategies.

Ghaith and Bouzeineddine (2003) investigate the relationship between reading attitudes, achievement, and learners' perceptions of their Jigsaw cooperative learning (CL) experience. One hundred eleven (n = 111) eighth-grade students of English as a Foreign Language (EFL) enrolled in four sections in a middle school in Lebanon participated in the study. The participants completed two questionnaires and a semantic differential scale that assessed their reading attitudes and perception of their Jigsaw II cooperative learning experience. In addition, the participants took a pretest and a posttest specifically designed for the purpose of the study. The results indicated that reading attitudes and reading achievement were positively internally related, but not related to the perception of the Jigsaw cooperative experience. Furthermore, the results revealed certain statistically significant differences between high and low achievers and between males and females across the variables of reading attitudes, achievement, and perception of the Jigsaw cooperative experience.

Shaaban (2006) investigates the effects of the jigsaw cooperative learning (CL) model and whole class instruction in improving learners' reading comprehension, vocabulary acquisition, and motivation to read. Forty-four grade-five English as a foreign language learners participated in the study, and a posttest-only control group experimental design was employed. The results did not indicate any statistically significant differences between the control and experimental group reading comprehension and vocabulary acquisition. However, the results revealed statistically

significant differences in favor of the experimental group on motivation to read and its dimensions, the value of reading, and reading self-concept.

Badawi (2008) attempts to investigate the improvements in 44 learners' reading achievement and motivation as a result of the employment of jigsaw technique in contrast to the holistic approach. The results of treatment showed that although there were no differences between the experimental and control groups with regard to the vocabulary acquisition and reading achievement, there were significant effects for the students' affective aspects such as self-concept, their value, and motivation.

Kazemi (2012) investigates the effects of the jigsaw teaching method on the achievement of Iranian EFL learners. One intact group 38 Guilan university students, majoring in engineering, management and biology, participated in this study. The experimental group participants included 38 freshman and sophomore intermediate level male (N=17) and female students (N=21). The students received pre-test and post-test. Jigsaw technique was used with experimental group participants where there was an emphasis on the cooperative learning of the language and specially the reading comprehension. The results of a paired-samples t-test showed that the students' post-test reading scores improved significantly (P= 0.000) when compared with their pre-test scores.

In Ghana, Adams (2013) conducts an action research study on 40 pupils and 10 teachers of Basic six of Holy Child Practice Primary School. Adams explored the causes of the poor performance of students. The intervention was the effect of cooperative learning with the use of Jigsaw technique. Action research design was used in addition to a case study design to conduct the study. The research instruments were observation and questionnaire. The researcher employed the Jigsaw technique as

the intervention. Responses gathered from both the observation and the administration of the instruments indicated that some of the causes of pupils' poor performance in school were poor teaching methods during lessons and the inability of teachers to vary teaching techniques.

Eachempati and Ismail (2017) conducted a very recent study to compare the jigsaw cooperative learning technique to the traditional lectures for learning cast partial denture designing. Method: Seventy-two fourth BDS students were randomly assigned into either the jigsaw or traditional lecture groups (n = 36). A pre-test on the topic 'designing of cast partial dentures' was administered to all students before the start of the study. The Jigsaw learning method was administered to the experimental group for four weeks. At the same time, the control group experienced the lecture-based learning method. At the end of four weeks, all students were re-tested (post-test) on the subject. A retention test was administered three weeks after the post-test. Mean scores were calculated for each test for the experimental and control groups, and the data obtained was analysed using independent sample t-test. Results showed that, no significant difference was determined between the jigsaw and lecture-based methods at pre-test. However, post-test and retention scores were better for jigsaw group with statistical significance. The highest mean test score was observed in the post-test with the jigsaw method. In the retention test, success with the jigsaw method was significantly higher than that with the lecture-based method. It was concluded that, the jigsaw method can be used as an effective learning tool. However, different topics with varying complexity and different cohorts of students need to be tested in future studies.

Sabbah (2017) also conducted a quasi-experimental pre-posttest design to investigate the effect of using jigsaw cooperative strategy on ELS students' achievement in reading comprehension. Convenience sampling of the two classes was used from the female students enrolling in Level 4 reading classes in the Foundation Program in the Community College of Qatar in the fourth quarter of the academic year of 2013-2014. It is a non-probability sampling technique where two classes were selected because of their convenient accessibility to the researcher as the researcher was supposed to teach them reading. The two classes were assigned randomly to two groups: the experimental group (n=16 students) which was taught seven units in Real Reading Textbook via the jigsaw strategy and the control group (n=10 students) which was taught via the traditional strategy-no grouping. Analysis of Covariance (ANCO) was used to analyse students' scores on the post-test. The results revealed significant differences in favour of the experimental group.

Agu and Samuel (2018) also investigated the effect of Jigsaw Cooperative Learning Strategy, Team-Assisted Instruction and Guided Discovery instructional strategies on the interest and achievement of Basic Science and Technology students. Quasi experimental research design was employed for the study. The population of the study comprised JSS II students in public co-educational secondary schools in Doma Local Government Area of Nasarawa State, Nigeria. The sample for the study was 147 JSS II Basic Science and Technology students from four intact classes selected in the study area. Two research questions and two hypotheses guided the study. Students' Interest Rating Scale in Basic Science and Technology (SIRSBST) and Basic Science and Technology Student's Achievement Test (BSTSAT) were used as instruments for data collection. The reliability of SIRSBST was determined using Cronbach Alpha and the coefficient obtained was 0.82 while BSTSAT was determined using K-R21

formula and the reliability coefficient obtained was 0.85. Mean and Standard Deviation were used to answer the research questions while the hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA). Scheffe's Post-hoc test was used to determine the magnitude of the differences. The findings of the study revealed that there was significant improvement in the interest and achievement of students taught using Jigsaw Cooperative Learning.

According to Krishnan, et al. (2021), the jigsaw method is one of the learning methods that has great potential to make students learn a large amount of information in a short period of time. It is a classroom technique where students act as blocks of jigsaw puzzle and learn cooperatively with all the participating students acting as teachers as well as learners.

Krishnan, et al. (2021) conducted a study to assess the effectiveness of jigsaw active learning method in comparison to conventional didactic method in promoting knowledge gain and retention among final year medical students. A quasi-experimental crossover protest and post-test study was conducted among final year medical students of a tertiary care teaching hospital in North Kerala from June 2021 to July 2021 during the integrated sessions by Surgery and Pharmacology Departments. Students were randomly divided into two groups A and B of 28 students each. They were taught two topics such as hyperthyroidism and hypothyroidism, as two sessions by either a jigsaw (experimental) or didactic (control) method. The first topic was taught by the two methods and then the same groups were later crossed over for the second topic. Knowledge gain and retention were assessed by immediate and delayed post-tests consisting of 20 multiple choice questions with a single correct response. All data collected was analysed statistically. Statistical significance was

considered at p-value less than 0.05. The mean age of students was 22.321±0.734 years. Mean scores of immediate post-tests were significantly higher in the jigsaw group for the first session (16.64 vs 14.21, p=0.001) and the crossover session (17.61 vs 15.14, p=0.001). Mean scores of delayed post-tests were significantly higher in the jigsaw group for the first session (14.32 vs 11.03, p=0.001) and the crossover session (14.85 vs 11.28, p=0.001). It was concluded that, Jigsaw method was found to be more effective than didactic method in promoting knowledge gain and retention among medical students.

However, Stanczak et al. (2022) conducted a descriptive study and found contrary outcomes. Stanczak et al. (2022) conducted their study to test the hypothesis that a jigsaw intervention would yield a meaningful effect size (d = 0.40) on learning outcomes, in five randomized experiments conducted among 6th graders. The jigsaw intervention was compared to an "individualistic" (N Experiment 1 = 252; N Exp. 2 = 313) or a "teaching as usual" (N Exp. 3A = 110; N Exp. 3B = 74; N Exp. 3C = 101) approach on the same pedagogical content. Across the five experiments, the authors did not find empirical support for their hypothesis. Internal meta-analytic estimates (ES = 0.00, 95% CI [-0.10, 0.09]) showed that, overall, the jigsaw intervention did not produce the expected positive effects on learning.

It is observed however that. The study conducted by Stanczark et al. (2022) did not explore a localized situation.

2.4 Gender Disparity in Jigsaw Cooperative Learning Outcomes

Mbacho and Changeiywo (2013) conducted a study to find out if the use of Jigsaw Cooperative learning Strategy during instruction of Surds and further logarithm in mathematics to Form Three students had effects on their gender differences in

performance. These was as a result of inadequate information in research conducted in Kenya on effects of the use of Jigsaw Cooperative learning Strategy on students' achievement in mathematics by gender difference. Solomon Four non-equivalent control group design was used in the study. A simple random sample of four district secondary schools was selected from Laikipia East District. The sample size was 160 students out of population of about 20,000 students in the district. A mathematics achievement test (MAT) was used for the data collection. The instrument was piloted in a school which was not used in the study in the same district and a reliability coefficient of above the required threshold of 0.70 was found. The instrument was validated by education experts from the University. Data was analysed using t-test to test hypotheses at Coefficient alpha (ά) level of 0.05. The results showed that there are no statistically significant gender difference in mathematics achievement when students are taught using Jigsaw cooperative learning strategy. The findings may be useful to policy makers, curriculum developers and education officers in deciding on the appropriate learning strategy for learners to reduce gender disparities.

Similarly, the work of Armstrong (1981) showed that no sex differences existed in mathematics achievement throughout the junior school but that at the end of high school males had higher achievement scores and performed better on higher level cognitive tasks. Meanwhile, a study conducted by Blith, et al. (1994) reports a consistent difference in mean performance in favour of boys at the secondary school level in New Zealand after employing the interventional approach to investigate the mathematics achievement scores for pre-test and post-test.

Besides, Manger (1996) investigated the relationship between gender and mathematical achievement with Norwegian 3rd graders using an achievement test covering numeracy problems, fraction problems, geometry problems and word

problems. Boys were found to have higher total test scores than girls, but the difference was small.

The literature therefore reveals that, in many cases, some disparities exist between the effect Jigsaw Cooperative Learning Strategy has on the achievement marks and overall performance of boys and girls depending on the subject in view. In many cases boys were noted to have been favoured by the positive effects of cooperative learning. This might be due to the natural outgoingness of the male gender compared to the female gender. Boys might be more participatory in the group cooperation exercises.

2.5 Chapter Summary

The chapter presents the conceptual framework, review of concepts and empirical literature relating to the topic under study. The study concerns the relationship between teaching strategies and academic outcome not losing sight of the extraneous variables such as teacher characteristics, teacher training and teacher experience.

Cooperative learning was defined as a teaching method that involves students in learning process in order to understand and learn content of the subject (Slavin, Lake, Hanley & Thurston, 2014). It has been established that, the jigsaw model is a type of cooperative teaching strategy in which the instructor prepares several different, related tasks for the class. The instructor designs specific number of tasks, one for each of specific number of groups. Each group then prepares on one of the tasks. Once each group is prepared, the class is divided according to the number of the designed tasks. Each group will have one group member from each of the groups. Each member of the group is responsible for teaching the rest of the group what he/she has learned from his/her previous group task. The group then puts all of the

pieces together and completes a group task that can only be answered once all of the team pieces are together (hence the name "jigsaw").

It was also found that, students' academic achievement was generally viewed by current research as student's ability of accomplishing an academic task successfully. Its purpose is to find out the stand of a student at a given moment (Akani, 2017). It has to do with testing the knowledge acquired by the student which helps the teacher and the student to evaluate and predict the degree of learning attained (Kabutu, Oloyede & Bandele, 2015). Students' achievement consists of three domains, namely the cognitive domain, affective domain and psychomotor domains (Bature & Jibrin, 2015; Sedegah, et al., 2019). Theory of Performance was propounded by Elger (n.d.) which develops and relates sex foundational concepts to form a framework that can be used to explain performance as well as performance improvements.

It has been established that, a revolution of studies were conducted to understand the impact and effectiveness of the cooperative learning strategy (Sedegah, et al., 2019; Karacop (2019); Adjibolosoo, et al., 2019; Odagboyi, 2015; Adams, 2013). In recent times, the emergence of the Jigsaw Cooperative Learning Strategy as a specific type of cooperative learning has been much upheld as an effective learning strategy that can positively impact students' academic achievement (Alsharif & Atweh, 2012; Eachempati & Ismail, 2017; Sabbah, 2017; Agu & Samuel, 2018; Stanczak et al., 2022).

Another rising area of concern for current research is the gender disparity in the effect of Jigsaw Cooperative Learning Strategy on academic performance of students. This aspect has received a mixed outcome. Few studies conducted to examine the gender differences in the effect of JSCLS on students achievement (Blith, Forbes, Clark &

Robinson, 1994; Manger, 1996) established that, there are gender differences in performance when the JSCLS is used whiles other studies such as Mbacho & Changeiywo (2013) and Armstrong (1981) contested the claim.

Meanwhile, the argument on the effectiveness of the Jigsaw Cooperative Learning Strategy has not reached consensus since some couple of studies also found no positive effect of the JSCLS on students' academic performance. This portrays an immature research field with gaps worth exploring.

2.6 Students' Perceptions of Chemistry Concepts

Students' perception s on their teachers have been reported in literature to influence their interest, attitudes and motivation to learn and also influence their understanding of concepts in a subject. The concept hybridisation is one of the difficult concepts for chemistry students to grasp at all levels of learning. Research showed the students conceptual difficulty ranged from their lack of the pre-requisite knowledge for grasping the topic hybridisation to chemical bond formation and orientations of atomic orbitals. (Huaru, 2023. et. al) investigated the difficulty students face in learning hybridisation. The study adopted mixed – method approach using the sequential exploratory design. Purposive sampling was used to select six schools that offer elective chemistry. Simple random sampling was then used to select one hundred and twenty Senior High School form one students to take part in the study. Convenient sampling was used to interview twenty-four students from the sample. Hybridization Achievement Test (HAT) semi- structured interviews were constructed and used to collect data. Descriptive statistics and content analysis were used to analyse the data. Results showed that, majority of students had difficulty in explaining

the concept of hybrid orbitals, writing the electronic configuration of 6C, explaining the effect of hybridisation and shapes of compounds.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter presents the materials and processes adopted in the investigation. The chapter describes the study design, the study variables, study population, study sample, the sampling techniques, the data collection instruments and their reliability and validity, data collection procedure, data analysis and ethical considerations.

3.1 Research Design

A quasi - experimental design was used for this study. This is because, the quasi - experimental design provides the platform of examining the effectiveness of a particular experimental process as against the other. Furthermore, the experimental process of study also helps to stair up interest of participants in taking part in the particular experimental practise. Considering the phenomenon being investigated (the effectiveness of the Jigsaw Cooperative Learning Strategy), a cooperative experimental process is needed to examine such a difference in the effects of traditional instructional approach and the Jigsaw cooperative learning approach. The process of experiment helped to catch attention of students in cooperating during studies, and also increases the interest of students in the subject area especially Chemistry – Rate of reaction in particular (Khalil *et al.,* 2014). The experimental process also helped in the satisfaction of the core requirements for the acquisition of knowledge through a scientific method through the application of experimentation and observation. Experimental design also gives findings that are more specific to the phenomenon investigated because the process gives the researcher a higher level of control over the experimental process. Therefore, the experimental design was used to

effectively investigate the problem so as to base findings on adequate empirical evidence.

3.2 Study Area

3.2.1 Bompeh Senior High Technical school

Bompeh Senior High Technical School is a senior high school located in Sekondi-Takoradi in the Western Region of Ghana. The school is located on the Axim road on the geographical coordinates 4.8897748°N 1.7609876°W. The school operates with the motto; Knowledge, Hard Work and Service. The school was established 37 years ago in 1985. The educational officer in charge of the school is the Sekondi Takoradi Metropolitan education office.

The school seeks to produce high caliber of students who are capable of pursuing academic interests at the tertiary level to enable them meet the socio-economic cultural and academic needs of the nation.Bompeh Senior High Technical School seeks to provide quality and relevant academic and practical oriented education to enable her students to be productive and responsible citizens as to enhance their contributions to the community and the nation at large.

3.2.2 Adiembra Senior High school

Adiembra Senior High School is a community Senior High School which was established in 1991. It is located in Adiembra township near Sekondi in the Sekondi/Takoradi Metropolis. It is located on a hill to the North-East of the Parks and Gardens in the Metropolis. The school, which has its slogan as 'The Conquerors,' is also known by the Adiembra community as the Hill of Hope, where Academic Excellence is vigorously pursued.

New pupils are admitted in September every year through a computerized system under the control of the Ghana Education Service. The system works based on the results of an entry examination known as the Basic Education Certificate Examination (B.E.C.E). This examination is held for junior high schools at various centres throughout the country. Entry Forms for the above examination are obtained from the West African Examination Council (W.A.E.C) through the headteachers of the respective junior high schools within the country. Once the computerised selection process is completed, the list of admitted students are made available by the Ghana Education Service to the school. The list is then made public through the school's notice board.

An opportunity is also given to foreign nationals who wish to apply for admission into the school through a written entrance examination organised by the school. Students from other senior high school or fresh senior high school starter who wishes to continue the education at the school can also contact the school's administration through the contact list provided in the contact section of this page. After a student gains admission, he is given the school's official prospectus. This book helps new students about the school and all that is required of them.

3.3 Study Population

The study population comprised chemistry students in Bompeh Senior High Technical School and Adiembra Senior High Schools in the Western Region, Ghana. Specifically, the accessible population included second year students offering chemistry in the stated schools.

3.4 Sampling and Sampling Technique

Purposive sampling technique was used for the selection of participants for this study. The second year class was selected purposively for this study. Eighty-four (84) second year students were selected from the Bompeh Senior High Technical School and Adiembra Senior High School altogether using the purposive sampling technique. The second-year students were purposively selected because, the Rate of reaction, as a topic in the chemistry curriculum is scheduled to be studied in second year. This suggests that, expert curriculum developers have evaluated the topic of Rate of reaction that, at second year stage in the Senior High School, a student is matured enough to understand Rate of reaction without difficulties. The participants were in two separate classes and schools with even sample of 42 each (84 in all). Using a simple random sampling, 42 female students (21 from each school) and 42 males (21 from each school) were selected. The application of the simple random sampling to select equal number of genders was done in order to reduce researcher bias and gender balance in the study process since gender difference in the effect of the Jigsaw Cooperative Learning Strategy is a major part of the study.

3.5 Research Instruments

Two main data collection instruments were used for the study. These are test and questionnaire.

3.5.1 Test

Twenty (20) multiple choice test items and two theory test questions were developed to determine the understanding of the concept of rate of reaction among both experimental and control group students. To ensure that, the test items were constructed based on the content of the chemistry syllabus which is used for all senior

high schools in Ghana, the test items were drawn from past questions of West African Senior Secondary Certificate Examination prepared by the West African Examination Council. Also, the nature of questions asked relating to Rate of reaction were selected in such a way that, they detailed curriculum objectives carved for the topic by curriculum developers. Each of the multiple-choice items had four options: one correct answer and three plausible distracters. Each multiple-choice question, if answered correctly attracted 2 marks. Thus, the total mark for the multiple-choice part was 40.

The Test consisted of a theory part made up of two theory questions to test the students' understanding on concepts and practical application of such concepts in Rate of reaction. Each theory question was marked over 30. Thus the theory part attracted 60 marks in all. Consequently, the entire test was marked over 100.

3.5.2 Questionnaire

A self-designed questionnaire based on in-depth knowledge from literature was used to investigate the views of students on what they think about the helpfulness or otherwise of Jigsaw Cooperative learning Strategy. Questionnaire was used because it helps to collect data in an already organised manner that can easily be put into meaningful analysis. Thus, making sense of data collected using a questionnaire is easier and straightforward. Moreover, Questionnaire was preferred because it is good data collection tool especially at settings and population that comprise literates who can read and write. The questionnaire was structured into two major sections. Section A investigated demographic characteristics of the respondents whiles section B also comprised ten items framed to investigate what students think about the helpfulness of Jigsaw Cooperative Learning Strategy.

3.6 Validity and Reliability of Instruments

The instruments used for the study were subjected to a reliability and validity test to discover their reliability and to obtain the necessary information for the study. Maintaining reliability and validity measures is a fundamental and essential component of a good research as indicated by Creswell (2005).

3.6.1 Reliability

The reliability of a test is the consistency with which the test repeatedly measures what it is intended to measure. Test and retest method was used in determining the reliability of the instrument. This was done by coding the pilot study results into SPSS version 23. The alpha coefficients were calculated, and when the alpha result is below 60, modifications were made to the questionnaire by rephrasing an item that showed inconsistency. The final alpha coefficients were 72% and 77% respectively. Data collection instruments were organized to collect relevant information required to achieve the study objectives. The necessary amendments were made to eliminate all biases and questions were constructed in a manner to deduce the needed answers.

3.6.2 Validity

Validity refers to how well an instrument measures what it is intended to measure. The instruments were face-validated by experts comprising researchers and teachers. Tests were conducted in a strict environment to avoid malpractices by respondents.

3.7 Data Collection Procedure

Two categories of data were collected. These include secondary data and primary data.

3.7.1 Collection of secondary data

Secondary data collection started with the review of literature when the researcher began to look for more information about the topic. Secondary data were collected from sources such as research reports which were published relating to the research topic and research questions. These research reports were drawn from journal houses and websites such as PLoS, Research Gate, SAGE and google scholar. These studies were searched through search engines by the use of keywords such as effects of Jigsaw learning, cooperative learning and traditional instructional approach.

3.7.2 Collection of primary data

Primary data collection started with the running of pre-test and post-test as well as the questionnaire. Primary data were collected as information from the respondents using questionnaire, and test instrument. The class was divided into two (2) separate groups with one as the control and the other as experimental. One class was taught using the traditional method and the other by the jigsaw cooperative strategy with models. This continued for a period of four (4) weeks. Pre and post-test were conducted with the results taken base on gender. Students and teachers were guided to answer the questionnaire.

3.8 Pre-Intervention Stage

Before the entire experimental process began, preparations were made to ensure that the interventions brought about the best results of the study. The researcher sought clearance from the Head of the Science Department as well as the management of the selected schools. The students were also informed ahead of time and teaching and learning materials were made available. The essence of this intervention was to create a conducive environment which will stimulate students learning and to help student

acclimatize with the environment. It involved organization of resources and arrangement of students in a manner that attracted the attention and interest of the students to the lesson. Also, the students were taken through a day orientation session on the intent of the study and how they were expected to respond to the various instruments that were used. All instruments used were designed by the researcher and validated by a team of experts.

3.9 Intervention Stage

A fundamental step in ensuring successful implementation of the intervention was its organization and design to attract students' attention, incite interest and ensure positive attitude to its use in the teaching and learning process to determine their suitability to present the lesson. Students were randomly grouped into fives per group to prevent biasness. The researcher developed Learning Instructional Guides used in implementing the different learning strategies in the study.

i. Jigsaw Cooperative Learning Strategies with Models
ii. Lecture Method without Models

Each learning strategy guide contained equal number of lesson units to cover.

3.9.1 Classes taught using jigsaw cooperative strategies with models

The students in this group were encouraged to learn the social skills and rules guiding the principles of the Jigsaw cooperative skills and manipulation of models. The process of the Jigsaw classroom practice followed the following steps:

1. The teacher introduced the topic to be studied.
2. The teacher introduced strategy for the study (Jigsaw Cooperative Learning Strategy).

3. Teacher assigned each student to 3 "home groups" of 14 students each.
4. Teacher divided the topic of rate of reaction into 14 subsections. The subdivisions of the topic of rates of reaction were done as follows:
   i. Overview of rate of reactions
   ii. Factors affecting reaction rates
   iii. Collision theory
   iv. Order of reaction
   v. Rate law
   vi. Integrated rate laws
   vii. Half-Life concept
   viii. Integrated Rate law and the concept of half-life
   ix. Rate constant
   x. Reaction Mechanisms
   xi. Steps to determine rates of reaction
   xii. Catalysts
   xiii. Enzymes
   xiv. Catalysts and rates of reactions
5. Teacher created 14 "expert groups" that consist of students across "home groups" who read the same selection or subtopic.
6. Teacher gave all students a framework for managing their time on the various parts of the jigsaw task so as to achieve their aim within time available (Law, 2011).
7. Teacher provided key questions to help the "expert groups" gather information in their particular area.

8. Teacher provided materials and resources necessary for all students to learn about their topics and become "experts."
9. The teacher ensured that, the reading material assigned is at appropriate instructional level (Crone & Portillo, 2013).
10. Teacher discussed the rules for reconvening into "home groups" and provided guidelines as each "expert" reported the information learned.
11. Teacher prepared a summary chart or graphic organizer for each "home group" as a guide for organizing the experts' information report.
12. Teacher reminded students that "home group" members are responsible to learn all content from one another.
13. Teacher conducted assessment of the learning that took place with few relevant questions.

Moreover, the students were encouraged observe the procedure and interact with themselves and constantly check their work with other students in their groups and agree. Help each other and as such helping themselves and learning better. Discuss their work with one another so as to improve individual and group performance. Realize that the goal of the strategy was for every student in the group to learn the material. Students interacted physically and verbally to be able to maximize the benefits of cooperative learning. Group members were called by their names in the course of interaction. The students also listened to each other when talking.

The instructor observed the models and related these models to the topics being treated. Instructor learned how to use and manipulate instructional models in their different cooperative groups. Students were helped to relate their models to the

concepts being taught. There were two groups involved in the study, one experimental group and one control group within a time period.

1. The experimental group was taught using Jigsaw cooperative learning strategy with models.
2. Group two was taught using traditional lecture learning method without models.

This experimental group was taught using jigsaw cooperative learning strategy with models. The Students Teams Achievement Divisions (STAD) technique of cooperative learning was adopted. The grouping was heterogeneous in terms of ability and gender, based on the pre- test diagnostic test scores. This means that each group consisted of members with high, average and low scores. For the cooperative experimental group, the lessons took place in a laboratory with a special sitting arrangement that facilitated easy interaction and conveniently accommodated the sitting arrangement of the various groups. The arrangement of the seats becomes very important as it influences the level of interaction of the members of each group (Adeyemi, 2002).

The experimental group was given models of the concepts being learnt. Members were given role cards, which stated the roles of each member of the group at any point in time. For each period of cooperative lesson, the teacher presented the objectives, followed by teaching which is basically giving background information. The use of cooperative learning strategy does not mean abandoning teacher –fronted mode; it means combining various modes of learning (Cohen, 1994).

The students were then given worksheets and they worked together within each team to make sure that all members of the team learnt the concepts taught. Students asked questions from the teacher to clarify issues and the teacher responded accordingly, and vice versa. Each group was encouraged to work together, to assist each other to master the topic under discussion, as they would be jointly rewarded based on level of performance of individual member. They studied worksheets on the learning materials, practiced the exercises, identified discrepancies, checked and drilled each other and reached consensus and prepared themselves for the assessment, which were done individually, but they were collectively rewarded. To encourage the cooperation among the subgroups, they were advised to practise cooperative learning skills such as calling each other by name, asking questions to group members. They were also reminded of the necessity to work together during the learning process, help others and ask others for assistance. The teacher was going around the groups and assisting where necessary thus acting as a facilitator in the learning process. The learners used the models provided in their course of interaction, discussion, and doing the exercises on the worksheets. They were also assessed at the end of each lesson. The activities of the worksheets were completed, marked after each lesson. The actual treatment lasted for four weeks of two periods per week, after which the cooperative learning subjects sat for post-test after the fourth week.

3.9.2 Class learning with lecture method

This group was selected as the control group and the mode of instruction was the lecture method only. They were informed that, they needed to be punctual to the class, be very attentive to the lecturer, ask and answer questions when asked. There was no use of models and no grouping. In this group, the lecture teaching and learning method prevailed. The subjects like the other groups of the experiment, had been

given pre-test, and the group was also found to be heterogeneous in terms of strength, ability and gender. The class was not put into groups, not exposed to cooperative teaching learning strategy and not provided with models, or any form of learning aid, except the marker board being used by the teacher. In each period of teaching, the teacher used marker and board method. The teacher presented the objectives of the lesson; the students listened and took notes. Difficult concepts were explained in a more generalized way to the class. The period of teaching also lasted for four weeks double periods after which post-test was administered.

3.10 Post Intervention Stage

After the implementation of the intervention design, a test was conducted to assess the level of students' understanding of the lesson in rate of reaction for experimental and control groups using traditional instructional approach. Students were made to answer same sets of questions and the marks obtained computed to ascertain which set of students (applying which instructional approach) had much understanding of the lesson taught.

3.11 Data Analysis

Data was analyzed using Statistical Package for Social Sciences (SPSS) version 23. The data was organized into the software through coding process where nominal, scale and string data were organized into the data view of the SPSS. After coding, the 'Analyse' tab was used to quarry data descriptively such that the software generated frequency tables and charts as well as calculated test statistics. At confidence level of 95%, a p-value below 0.05 signified significance level and a p-value of greater than 0.05 signified no significance. The z – test approach was used to assess the significance of the influence or impacts of the JCLS and the Lecture Method for

comparison; and t – test approach to compare gender disparities in performance scores. The result was then extracted from the SPSS onto a Microsoft Word software and interpreted using frequencies and percentages. After interpretation, the key findings were discussed by comparing them with the findings of other studies and also drawing implications from the findings established. The results and discussion of findings were presented in accordance with the research questions framed for the study.

3.12 Ethical Considerations

Ethics and proper practices were upheld in the study process. Ethical issues that were considered are permission, consent, anonymity and confidentiality. With regards to permission, a clearance letter of permission was taken from the University of Education Winneba and submitted to the Education office. Follow ups were made until approval was granted. Copies of the approved letter was submitted to selected schools to inform them about the intended study. During the data collection, the consent of the respondents were dully sought in order for them to willingly take part in the study. To also ensure the principle of anonymity, respondents were not required to write their names on the questionnaires and question papers. The data that was collected was also put together and analyzed. No peculiar response or result was ascribed to any individual respondent. Regarding confidentiality, the respondents were assured of confidentiality by letting them know that, data collected would be kept secret and used for the intended academic purpose only. This increased the disclosure index. The promise of confidentiality that was given to the respondents was also observed during the data management and analysis.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Introduction

This chapter focuses on the presentation of the results of the data analysis. The chapter also presents the discussion of the results as well as the findings gathered from the studies. The result is presented by means of frequency tables, charts and test statistical tables. The frequency tables, charts and test statistical tables are interpreted and discussed by comparing them to prevailing body of literature as well as drawing implicative insights from the results presented. Material in this chapter is presented on the demographic characteristics of the respondents as well as on the research questions set for the study. Key findings are also summarized to provide a concise impression of the outcomes of the study and for easy understanding.

4.1 Presentation of Results

4.1.1 Demographic characteristics of the respondents

The demographic characteristics of the respondents that were investigated include gender, age group, religious affiliation, type of student and who student is staying with. Results from the analysis of these demographic characteristics are as distributed in Table 1.

Table 1: Demographic characteristics of respondents

Demographic Characteristic	Frequency (f)	Percentage (%)
Gender		
Male	42	50.0
Female	42	50.0
Total	84	100.0
Age group (in years)		
below 15	6	7.1
15-20	56	66.7
21-25	19	22.6
above 25	3	3.6
Total	**84**	**100.0**
Religious affiliation		
Christianity	62	73.8
Islamic	19	22.6
Traditional African	2	2.4
Atheism	1	1.2
Total	**84**	**100.0**
Type of student		
Day	46	54.8
Boarding	38	45.2
Total	**84**	**100.0**
If Day, whom respondent was staying with		
Parents	18	39.1
Relatives	21	45.7
On your own	7	15.2
Total	**46**	**100.0**

Source: Field Study, 2022

Table 1 reveals that, 42 of the respondents constituting 50% were males whiles the other 42 of them also constituting 50% were females. Majority (56) of the respondents constituting 66.7% were aged 15-20 years whiles few (3) of them constituting 3.6% were above 25 years of age. Majority (62) of the respondents constituting 73.8% were Christians whiles only 1 of them constituting 1.2% was an Atheist (claimed he did not

believe that there is God). A greater number (46) of the students constituting 54.8% were day students whiles 38 of them constituting 45.2% were boarding students. Of the 46 day students, 21 constituting 45.7% lived with their relatives whiles few (7) constituting 15.2% lived on their own.

4.2 Research Question 1

What is the difference in the performance of learners taught using the jigsaw cooperative learning strategy (JCLS) and those taught using chalk-and-talk approach in rate of reaction?

The first research question seeks to establish the difference in the performance of students taught using the jigsaw cooperative learning strategy (JCLS) and those taught using chalk-and-talk approach (or traditional lecture method). This was done by first establishing the differences in the marks obtained in a pre-test and post-test among students taught using jigsaw cooperative learning strategy (the experimental group) and those taught using chalk-and-talk approach or the traditional lecture method (the control group). These differences constituted the changes brought in the performance of the students after they were taught using the respective approaches (JCLS and the traditional lecture method). The differences were then compared to establish which method brought about the maximum improvement in the performance of the students in the respective groups. The following hypothesis were set to help in the final decision making on the test statistics:

H_{01}: There is no significant difference in the performance of students taught Rate of reaction using the JCLS and those taught using traditional chalk and talk method..

Table 2 presents the summary of the results on the pre-test and post-test of students taught using the jigsaw cooperative learning strategy (JCLS) – the experimental group.

Table 2: Effect of JCLS on students' performance (Experimental Group)

S/N	Gender	Exp. Grp Pre-test Score	Exp. Grp Post-test Score	Difference
1	F	57	82	25
2	M	34	80	46
3	F	56	91	35
4	M	5	45	40
5	F	47	71	24
6	F	41	46	5
7	M	21	33	12
8	F	13	19	6
9	M	44	50	6
10	F	56	71	15
11	F	23	49	26
12	F	8	21	13
13	M	18	52	34
14	F	6	9	3
15	M	12	67	55
16	M	14	54	40
17	M	9	65	56
18	M	26	43	17
19	F	45	74	29
20	F	50	77	27
21	F	52	71	19
22	F	10	61	51
23	F	9	41	32
24	M	43	91	48
25	M	61	98	37
26	F	18	42	24
27	M	78	98	20
28	F	23	56	33
29	M	73	84	11
30	M	17	68	51

31	M	36	64	28
32	F	51	70	19
33	F	27	66	39
34	M	48	70	22
35	M	17	33	16
36	M	4	7	3
37	F	82	96	14
38	F	11	39	28
39	F	8	21	13
40	M	41	87	46
41	M	19	74	55
42	M	17	68	51
Total Score		**1330**	**2504**	**1174.0**
Mean Score		**31.7**	**59.6**	**28.0**
Max Score		**82.0**	**98.0**	**16.0**
Min Score		**4.0**	**7.0**	**3.0**
SD		**21.6**	**24.0**	**2.4**

Table 2 reveals that, after being taught using JCLS, the total score of students increased from 1330 (obtained in the pre-test) to 2504 in the post-test. This resulted in a mark increment of 1174. There was also an increase in the mean mark from 31.7% (in the pre-test) to 59.6% in the post-test resulting in a mean difference of 28.0%. The maximum score obtained in the pre-test (82.0%) also increased to 98.0% in the post-test showing an increment of 16%. Moreover, the minimum mark obtained in the pre-test (4.0%) also increased to 7.0% showing an increment of 3%. These results descriptively indicate an improvement in the performance of the students in the experimental group.

To descriptively test for this result, a z-test was conducted and results distributed in Table 3.

Table 3: Z-test on difference in marks after being taught using JCLS (Experimental Group)

Variable	N	Mean	variance	df	z	Sign. (2tailed)*
Pre-test	42	31.7	465.398	82	5.6177	0.000*
Post-test	42	59.6	574.437			

Key: *Significant; p < .05, @ 95% C.I. N=no. of observations

The z test indicates a z value of z= 5.6177 reporting a P-value of P = 0.0000. This shows that, the overall improvement in the performance of the students in the experimental group after being taught using JCLS was significant since the P-value is less than 0.05.

Table 4 shows the distribution of the differences in the marks obtained in the pre-test and in the post-test by students taught using the traditional lecture method (control group).

Table 4: Impact of traditional lecture method on student performance

S/N	Gender	Ctrl Grp Pre-test Score	Ctrl Grp Post-test Score	Difference
43	M	41	56	15
44	M	13	5	-8
45	F	5	26	21
46	F	57	66	9
47	M	23	48	25
48	F	9	43	34
49	M	4	29	25
50	M	7	39	32
51	F	21	54	33
52	F	62	89	27
53	M	12	54	42
54	F	5	38	33
55	F	18	35	17

56	F	48	67	19
57	M	76	90	14
58	M	12	56	44
59	F	36	54	18
60	F	8	37	29
61	F	44	57	13
62	M	6	35	29
63	F	18	50	32
64	M	14	38	24
65	F	21	59	38
66	M	9	46	37
67	M	63	76	13
68	F	11	65	54
69	F	72	91	19
70	M	69	88	19
71	M	28	50	22
72	M	72	87	15
73	F	46	53	7
74	F	17	28	11
75	M	29	44	15
76	F	48	57	9
77	F	21	34	13
78	M	42	61	19
79	M	9	18	9
80	M	18	33	15
81	M	36	50	14
82	F	39	66	27
83	F	55	67	12
84	M	25	36	11
Total Score		**1269**	**2175**	**906**
Mean Score		**30.21**	**51.79**	**21.6**
Max Score		**76**	**91**	**15.0**
Min Score		**4**	**5**	**1.0**
SD		**21.79**	**19.95**	**-1.8**

Table 4 indicates that, there was an improvement in the marks obtained by the students in the control group as well. This was shown as the total score obtained in the

in the pre-test (1269) increased to 2175 in the post-test. Thus, there was an increment of 906 marks. The mean score also increased from 30.21% in the pre-test to 51.79% in the post-test. Thus, there was an increment in the mean score by 21.6%. The maximum score also increased from 76 in the pre-test to 91 in the post-test. Moreover, the minimum mark also increased from 4 in the pre-test to 5 in the post-test. These results descriptively indicate an improvement in the performance of the students in the control group (taught by the traditional lecture method) as well.

To descriptively test for this result, a z-test was conducted and results distributed in Table 5.

Table 5: Z-test on difference in marks after being taught using traditional lecture method (Control Group)

Variable	N	Mean	variance	Df	Z	Sign. (2tailed)*
Pre-test	42	30.21	474.7091	82	**4.7318**	0.000*
Post-test	42	51.79	398.1725			

Key: *Significant; p < .05, @ 95% C.I. N=no. of observations

The z-test showed that, z = 530.277 with a P-value of 0.000. These descriptive results showed that, there was a significant change in the marks of students when the traditional lecture method was also used. The differences or improvements in students' performance brought about by the various teaching methods were then compared in other to establish which method resulted in better improvement. This is distributed in Table 6.

Table 6: Comparison of the effect of JCLS and traditional lecture method on students' performance

S/N	Difference 1: Exp Grp Impact of JCLS	S/N	Difference 1: Ctrl Grp Impact of Lecture
1	25	43	15
2	46	44	-8
3	35	45	21
4	40	46	9
5	24	47	25
6	5	48	34
7	12	49	25
8	6	50	32
9	6	51	33
10	15	52	27
11	26	53	42
12	13	54	33
13	34	55	17
14	3	56	19
15	55	57	14
16	40	58	44
17	56	59	18
18	17	60	29
19	29	61	13
20	27	62	29
21	19	63	32
22	51	64	24
23	32	65	38
24	48	66	37
25	37	67	13
26	24	68	54
27	20	69	19
28	33	70	19
29	11	71	22
30	51	72	15
31	28	73	7

32	19	74	11
33	39	75	15
34	22	76	9
35	16	77	13
36	3	78	19
37	14	79	9
38	28	80	15
39	13	81	14
40	46	82	27
41	55	83	12
42	51	84	11
Total	**1174**	**Total**	**906**
Mean	**28.0**	**Mean**	**21.6**
Max	**16.0**	**Max**	**15.0**
Min	**3.0**	**Min**	**1.0**
SD	**2.4**	**SD**	**-1.8**

The result in Table 6 shows that, the experimental group (taught using JCLS) experience greater improvement in the performance of students compared to the control group (taught using the traditional lectures method as the total mark improvement in the experimental group (1174) is higher compared to the total improvement in the marks experienced in the control group (906). This shows a greater improvement of 268 over the control group. There was also greater improvement in the mean mark as experienced in the experimental group (28.0%) compared to that experienced in the control group (21.6%). This shows 6.4% greater improvement in the mean mark over the control group. There was also a greater improvement of 1% in the maximum mark obtained in the experimental group over the control group.

The total achievement scores for JCLS and Traditional Lecture Method are compared and shown in Figure 2 below.

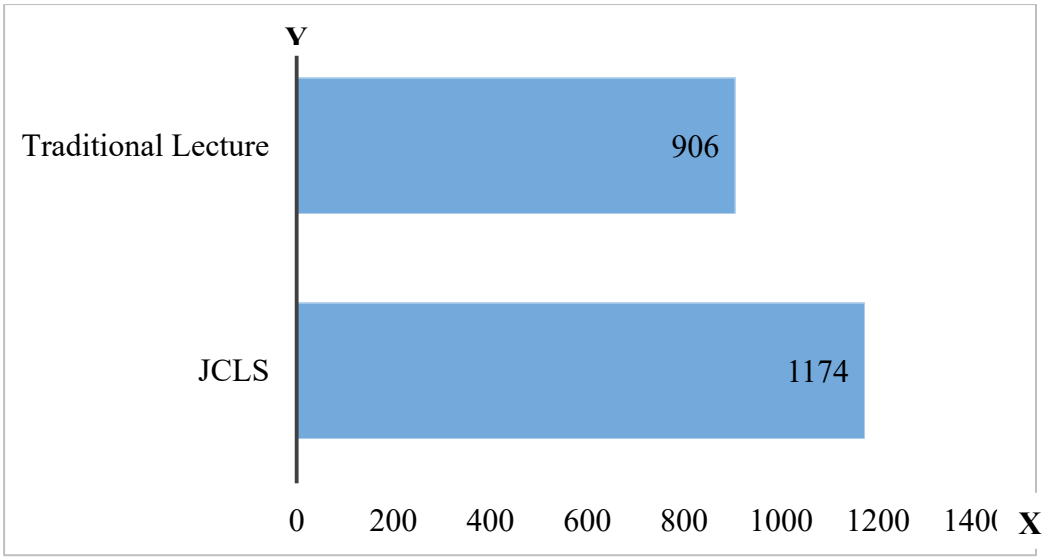

Figure 2: Comparison of the total achievement scores for JCLS and traditional lecture method

Figure 2 shows JCLS yielded more achievement score 1174 compared to the traditional chalk and talk method (906)

To descriptively test for this result, a z-test was conducted and results distributed in Table 7.

Table 7: Z-test to compare effects of JCLS and traditional lecture methods on students' performance

Variable	N	Mean	Variance	df	z	Sign. (2tailed)*
Experimental	42	28.0	248.144	82	2.0979	0.0359*
Control	42	21.6	140.397			

Key: *Significant; p < .05, @ 95% C.I. N=no. of observations

The z-test analysis also indicates that, the improvement in the total mark experienced in the experimental group is significantly more than the effect in the control group (z=2.0979, P = 0.0359).

Since the p-value is less than 0.05, the researcher therefore, reject the null hypothesis.

4.3 Research Question 2

What is the effect of the jigsaw method on boys' and girls' performance in rate of reaction?

To adequately explore this research question, the effect of JCLS on females' (girls') performance was first established inferentially and descriptively. Secondly, the effect of the JCLS on the performance of males/boys was also established inferentially and descriptively.

Furthermore, the effect of JCLS on girls/females and boys/males were then compared using t-test to determine which of them experienced the greater effect or improvement in their performances.

To help make decision on this research question using the inferential statistic, a z-test approach was used to test the following hypothesis:

H_o: There is no significant difference in the performance of girls and boys taught rate of reaction using the JCLS

Table 8 shows the effect of JCLS on the performance of girls/females.

Table 8: Effect of JCLS on females' performance

S/N	Gender	Females Taught with JCLS Pre-test Score	Females Taught with JCLS Post-test Score	Difference in Score
1	F	57	82	25
3	F	56	91	35
5	F	47	71	24
6	F	41	46	5
8	F	13	19	6
10	F	56	71	15
11	F	23	49	26
12	F	8	21	13
14	F	6	9	3
19	F	45	74	29
20	F	50	77	27
21	F	52	71	19
22	F	10	61	51
23	F	9	41	32
26	F	18	42	24
28	F	23	56	33
32	F	51	70	19
33	F	27	66	39
37	F	82	96	14
38	F	11	39	28
39	F	8	21	13
Total		**693**	**1173**	**480**
Mean		**33**	**55.9**	**22.9**
Max		**82**	**96**	**14.0**
Min		**6**	**9**	**3.0**
SD		**22.183**	**24.646**	**11.930**

Table 8 reveals that, there was an improvement in the total marks obtained by the girls taught using Jigsaw Cooperative Learning Strategy (JCLS) from 693 in the pre-test to 1173 in the post-test. Thus, there was a total improvement of 480 in the marks of the females taught using JCLS. There was also an improvement on the mean mark from 33% in the pre-test to 55.9% in the post-test. Thus there was an improvement of

22.9% in the mean mark. Furthermore, there was also an improvement in the maximum mark from 82% in the pre-test to 96% in the post-test. Thus, there was an improvement of 14.0% in the maximum marks. The minimum mark also improved from 6% to 9% showing a change of 3%.

To descriptively test for this result, a t-test was conducted and results distributed in Table 9.

Table 9: T-test on effect of JCLS on performance of females students

Variable	N	Mean	Variance	df	t-Stats	Sign. (2tailed)*
Pretest	21	33	492.100	40	10.4086	0.000*
Posttest	21	55.9	607.429			

Key: *Significant; p < .05, @ 95% C.I. N=no. of observations

The t-test score shows that, t = 10.4086 with a P-values of P = 0.000. This shows that, the changes in the marks of the females taught using JCLS were significant.

Table 10 shows the distribution of the impact/ improvement in the performance of males taught using JCLS.

Table 10: Effect of JCLS on males' performance

S/N	Gender	Males Taught with JCLS Pre-test Score	Males Taught with JCLS Post-test Score	Difference in Scores
2	M	34	80	46
4	M	5	45	40
7	M	21	33	12
9	M	44	50	6
13	M	18	52	34
15	M	12	67	55
16	M	14	54	40
17	M	9	65	56
18	M	26	43	17
24	M	43	91	48
25	M	61	98	37
27	M	78	98	20
29	M	73	84	11
30	M	17	68	51
31	M	36	64	28
34	M	48	70	22
35	M	17	33	16
36	M	4	7	3
40	M	41	87	46
41	M	19	74	55
42	M	17	68	51
Total		**637.0**	**1331**	**694**
Mean		**30.3**	**63.4**	**33.1**
Max		**78.0**	**98**	**20.0**
Min		**4.0**	**7**	**3.0**
SD		**21.406**	**23.248**	**17.659**

Table 10 also reveals that, there was some improvement in the marks of all males taught using JCLS. Also, the total mark of males improved from 637.0 in the pre-test to 1331 in the post test, showing an increment of 694. There was also an increase in the mean mark from 30.3% in the pre-test to 63.4% in the post-test, showing an

increment of 33.1%. The maximum mark for boys also increased from 78.0% in the pre-test to 98% in the post-test showing an improvement of 20.0%. The minimum mark for boys also increased from 4.0% in the pre-test to 7.0% in the post-test, showing an increase of 3.0%.

To descriptively test for this result, a t-test was conducted and results distributed in Table 11.

Table 11: T-test on effects of JCLS on performance of male students

Variable	N	Mean	variance	df	t-Stats	Sign. (2tailed)*
Pretest	21	30.3	458.2333	40	9.709	0.000*
Posttest	21	63.4	540.4476			

Key: *Significant; p < .05, @ 95% C.I. N=no. of observations

The t-test analysis also indicates that, t = 9.709 with P-value of P = 0.000. This shows that, JCLS had significant effect on the performance of male students.

Furthermore, the effects of JCLS on female performance and male performance were compared to ascertain the gender differentials in the effects. Table 12 shows the distribution of the comparison between the impact of JCLS among males and females.

Table 12: Comparing effect of JCLS on the performance of males and females

Difference For Females		**Difference For Males**	
S/N	**Difference**	**S/N**	**Difference**
1	25	2	46
3	35	4	40
5	24	7	12
6	5	9	6
8	6	13	34
10	15	15	55
11	26	16	40
12	13	17	56
14	3	18	17
19	29	24	48
20	27	25	37
21	19	27	20
22	51	29	11
23	32	30	51
26	24	31	28
28	33	34	22
32	19	35	16
33	39	36	3
37	14	40	46
38	28	41	55
39	13	42	51
Total	**480**	**Total**	**694**
Mean	**22.9**	**Mean**	**33.0**
Max	**14.0**	**Max**	**20.0**
Min	**3.0**	**Min**	**3.0**
SD	**11.9**	**SD**	**17.7**

Results in Table 12 reveal that, there was more improvement in the marks obtained by males (694) than obtained by females (480). Thus the difference in the improvement in the performance of males and females when JCLS was applied is 214. The improvement in the mean mark for boys (33.0%) is also more than the improvement

in the mean mark for girls (22.9%). Thus, the improvement in the mean mark of boy exceeded that of girls by 10.1%. Also, the maximum mark for boys (20.0%) exceeds that of girls (14.0%) by 6%. However, the changes in the minimum mark for boys and for girls was the same (3.0%).

The difference in total achievement marks for boys and girls are compared and shown in Figure 3 below.

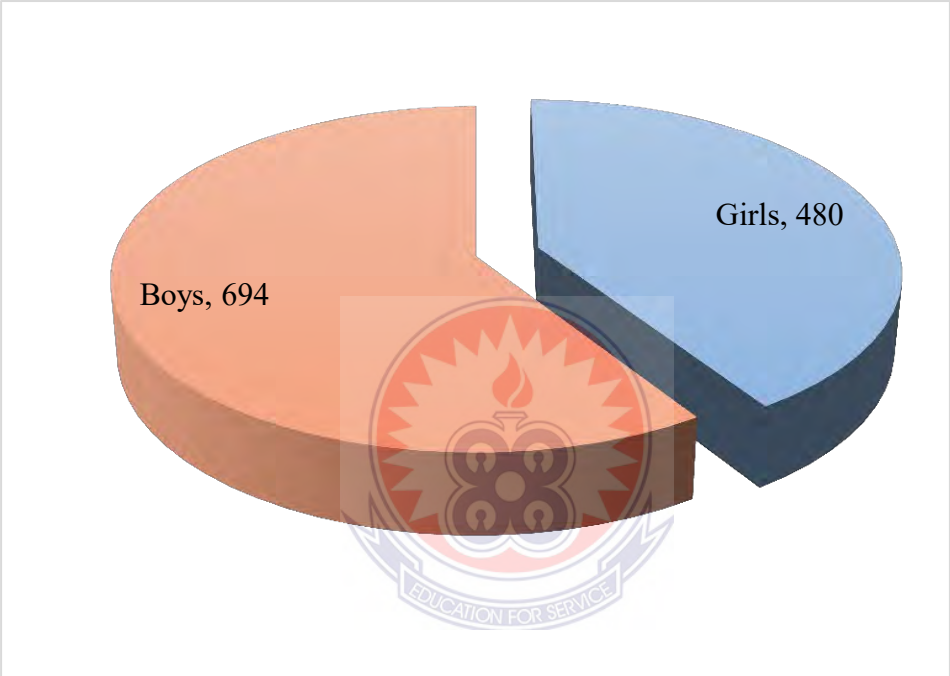

Figure 3: Improvement in marks for boys and girls taught using JCLS

To descriptively test for gender differentials in the impact of JCLS, a t-test was conducted and results distributed in Table 13.

Table 13: T-test to compare effects of JCLS on male and female performances

Variable	N	Mean	variance	Df	t-Stats	Sign. (2tailed)*
Females	21	22.9	142.3286	40	19.3117	0.000*
Males	21	33.0	311.8476			

Key: *Significant; p < .05, @ 95% C.I. N=no. of observations

The t-test analysis also reveals that, there is a significant difference between the impact of JCLS on female students' performance and male students' performance.

Since the p-value is less than 0.05 the researcher therefore, rejects the null hypothesis.

4.4 Research Question 3

What is students' perception about how JCLS is helpful to them or otherwise?

This research question was investigated by examining the views of students who were taught using JCLS about how the method has been helpful to them during their study. The results regarding this are showing in Table 14.

Table 14: Students' Perception about how JCLS is Helpful to them or otherwise

Item	Agree		Neutral		Disagree		Total	
	Freq	%	Freq	%	Freq	%	Freq	%
Jigsaw Learning Strategy helped me to obtain help from friends about what I find difficult to understand	31	73.8	8	19.0	3	7.1	42	100.0
Jigsaw Learning Strategy helped me to have the opportunity to share knowledge with other friends	30	71.4	8	19.0	4	9.5	42	100.0
Jigsaw Learning Strategy helped me to overcome tribal differences	21	50.0	10	23.8	11	26.2	42	100.0
Jigsaw Learning Strategy helped me to develop team working skills	34	81.0	5	11.9	3	7.1	42	100.0
Jigsaw Learning Strategy helped me to improve my self-esteem	28	66.7	9	21.4	5	11.9	42	100.0
Jigsaw Learning Strategy helped me to develop my communication skills	25	59.5	12	28.6	5	11.9	42	100.0
Jigsaw Learning Strategy helped me to improve my motivation to learn	26	61.9	14	33.3	2	4.8	42	100.0
Jigsaw Learning Strategy helped me to enjoy the learning process	31	73.8	6	14.3	5	11.9	42	100.0
Jigsaw Learning Strategy helped me to understand the lesson on rate of reaction better than ever	23	54.8	10	23.8	9	21.4	42	100.0
Jigsaw Learning Strategy helped me emotionally	24	57.1	12	28.6	6	14.3	42	100.0
Average	**27**	**65.0**	**9**	**22.4**	**6**	**12.6**	**42.0**	**100.0**

Table 14 indicates that, the majority (31) of the respondents constituting 73.8% agreed that, Jigsaw Learning Strategy helped them to obtain help from friends about what they found difficult to understand whiles only few (3) constituting 7.1% disagreed. Majority (30) of the respondents constituting 71.4% agreed that, Jigsaw Learning Strategy helped them to have the opportunity to share knowledge with other friends whiles few (4) constituting 9.5%) disagreed. Half (21) of the respondents who were taught using JCLS constituting 50.0% agreed that, Jigsaw Learning Strategy helped them to overcome tribal differences whiles some (10) constituting 23.8% were neutral. Most (34) of the respondents who were taught using JCLS constituting 81.0% agreed that, Jigsaw Learning Strategy helped them to develop team working skills whiles 3 of them constituting 7.1% disagreed. A greater number (28) of the respondents who were taught using JCLS constituting 66.7% agreed that, Jigsaw Learning Strategy helped them to improve their self-esteem whiles 5 constituting 11.9% disagreed. Many (25) of the students taught with JCLS constituting 59.5% agreed that, Jigsaw Learning Strategy helped them to develop their communication skills whiles 5 (11.9%) disagreed. A greater number (26) of the students constituting 61.9% claimed Jigsaw Learning Strategy helped them to improve their motivation to learn whiles two of them constituting 4.8% disagreed.

Moreover, most (31) of the respondents constituting 73.8% agreed that, Jigsaw Learning Strategy helped them to enjoy the learning process while 5 (11.9%) disagreed. Some (23) of the respondents constituting 54.8% agreed that, Jigsaw Learning Strategy helped them to understand the lesson on rate of reaction better than ever whiles 9 constituting 21.4% disagreed. Many (24) of the student taught using JCLS constituting 57.1% agreed that, Jigsaw Learning Strategy helped them emotionally whiles 6 (14.3%) disagreed. On average, the majority (27) of the students

constituting 65.0% agreed that JCLS was helpful to them whiles only 6 of them constituting 12.6% disagreed. This is shown on Figure 4 below.

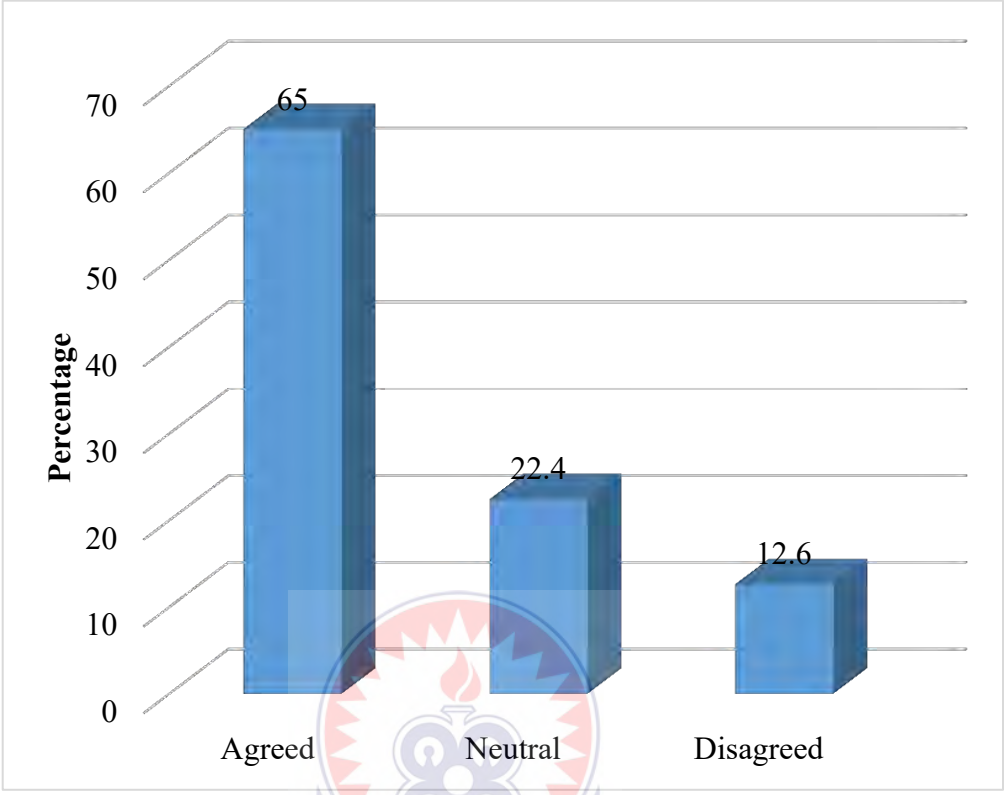

Figure 4: Students overall agreement on whether JCLS was helpful

4.5 Discussion

Research Question 1: What is the difference in the performance of learners taught using the jigsaw cooperative learning strategy (JCLS) and those taught using chalk-and-talk approach in rate of reaction?

The first research question focuses on exploring the difference in the performance of students taught using the jigsaw cooperative learning strategy (JCLS) and those taught using chalk-and-talk approach (or traditional lecture method). This analysis was achieved by establishing the pre-test and post-test scores for both the experimental group (taught using JCLS) and the control group (taught using Traditional Lecture method). The impacts of the two methods of teaching were then compared.

Findings reveal that, all the teaching methods have significant impact on the performance of students generally. The JCLS applied for instruction in the experimental group brought about significant changes in the mean marks, total marks and individual performances of the students. For instance, the total score of students increased from 1330 in the pre-test to 2504 in the post-test after students in the experimental group were taught using the JCLS. This reveals a mark increment of 1174 altogether. This implies that, JCLS helps improve the general performance of the students. The mean mark also increase from 31.7% (in the pre-test) to 59.6% in the post-test resulting in a mean difference of 28.0%. This implies that, on the average, JCLS has the potential to improve the performance of every student in the group. The maximum score obtained in the pre-test (82.0%) also increased to 98.0% in the post-test showing an increment of 16%. This implies that, JCLS could help a performing student to perform even higher.

Moreover, the increase in the minimum mark obtained in the pre-test from 4.0% to 7.0% (3% increment) implies JCLS is desirable for non performing students as well. Thus, the results inferentially indicates an improvement in the performance of the students in the experimental group; and such improvement was not limited to some few specific students. The effect of JCLS on students' performance cuts across all categories of students – whether the student is a high performer or clever student, an average performing student or very low performing student. All students can benefit from JCLS.

The fact that, all categories of students can benefit from the Jigsaw Cooperative Learning Strategy has caught the attention of several contemporary researchers. The idea has been asserted by Septiani (2020) in his classic work entitled "Jigsaw as a

community learning strategy: improving students" that, the JCLS brings positive outcomes regardless of the type of student, culture, level or performance. This idea of the JCLS being beneficial for all kinds of students has also been confirmed in another study conducted by Jainal and Shahrill (2021) which examined how Jigsaw Cooperative Strategy could be incorporated to help students through action research. Jainal et al. (2021) reveals that, the pedagogical practice of JCLS is user friendly and could accommodate students of different backgrounds and strengths.

Notwithstanding this, a z-test was adopted at 0.05 level of significance and 95% Confidence Interval, to establish how significant the impact brought about by JCLS. This analysis was guided by the null hypotheses "that there is a significant difference in the performance of students taught rate of reaction using the JCLS and those taught using traditional chalk and talk method" and an alternative hypothesis "that there is no significant difference in the performance of students taught rate of reaction using the JCLS and those taught using traditional chalk and talk method". The z – test results showed great significance of the impact of the JCLS on the students of the experimental group ($z= 5.6177$; P-value of $P = 0.0000$).

This finding is a confirmation of the outcomes of a study conducted by Tarim and Akdeniz (2008), who investigated a jigsaw learning outcome and reported that jigsaw cooperative learning strategy results in higher achievement scores among students than the traditional method of instruction. Similarly, the finding in this study that, there was improvement in the marks of students taught using jigsaw cooperative strategy also similar to the outcomes of a study conducted by Sedegah, et' al (2019) in Adeiso Presby in the Eastern Region of Ghana to examine the influence of cooperative learning approach on Senior High School students' understanding of ionic

bonding in integrated science using two different form two classes of 85 students each. Ionic bonding achievement pre-test was first administered to the students and marks recorded. The class which obtained higher mean score of 13.52 was designated as control group and the class which obtained lower mean score of 12.35 was designated the experimental group. The experimental group was taught ionic bonding using the cooperative learning strategy for five weeks whiles the same teacher taught the control group the same topic (ionic bonding) using the traditional teaching method and independent one–tail t-test analysis was performed on both groups and it was found that the experimental group performed better than the control group in the post-test as shown by the higher marks obtained by students taught using cooperative learning strategy compared to those in the control group.

Moreover, the results in this current study indicate that, improvements in the performance of students was not only realized through the application of JCLS; there was also an improvement in the marks obtained by the students in the control group (taught using traditional lecture method) as well. This was shown as the total score obtained in the pre-test (1269) increased to 2175 in the post-test. Thus, there was an increment of 906 marks. The mean score also increased from 30.21% in the pre-test to 51.79% in the post-test. Thus, there was an increment in the mean score by 21.6%. This also shows that, the lecture method can also benefit average students. The maximum score also increased from 76 in the pre-test to 91 in the post-test. The minimum mark also increased from 4 in the pre-test to 5 in the post-test. These results descriptively indicate an improvement in the performance of the students in the control group (taught by the traditional lecture method) as well. It also implies that, the traditional lecture method also has a very wide benefits, being able to bring about

some improvement in the performance of low performing students, average students as well as high-performing students.

The improvement in the marks of students taught using traditional lecture method was also tested using a descriptive test statistic namely z – test. It has become clear that, the traditional lecture method also had significant impact on the performance of students in the control group.

The results imply that, despite the many criticisms of the traditional lecture method of teaching in literature (Slavin, Lake, Hanley, and Thurston, 2014; Karacop, 2019; Gocer, 2010; Adjibolosoo, et al., 2019; Septiani, 2020; Odagboyi, 2015; Adams, 2013; Emaikwu, 2012), the traditional lecture method is not without positive effects. It also brings about some effects or improvements on the performance of students. Meanwhile, Woolnough (1997) stated that, although, it is satisfying to see the high achievements of students when the teacher-cantered approach is used in schools, nevertheless, students' emotional interest in learning should also be considered as it is fundamental to boost their intrinsic motivation, their commitment, their enjoyment and creativity in science. The issue is not only about the forceful impartation of knowledge but emotional acceptability of that knowledge by the learner so as to motivate them to retain and apply the knowledge acquired.

Since there were significant improvements both in the application of the JCLS and the traditional lecture method, there was the need to compare such improvements and see which method brought the greatest impact. The differences or improvements in students' performance brought about by the various teaching methods were then extracted and analysed and it was discovered that, there was greater improvement in the marks of the JCLS over and above the traditional method of teaching. The mean

difference for students of the experimental group (taught using JCLS) is 6.4% greater than that of the control group (taught using traditional lecture method). The z-test also reveals that, this difference in the improvement brought about by the JCLS over the traditional method is significant (z = 2.0979; P = 0.0359).

Therefore, the null hypothesis was rejected. is accepted whiles the alternative hypothesis failed to reject the null hypothesis.

This finding that, there was greater improvement in the marks of students taught using JCLS compared with the changes in the marks obtained by students taught using the traditional lecture method implies that, the JCLS is a more effective pedagogical approach to teaching rate of reaction in Senior High Schools. This is similar to the outcomes of another descriptive study conducted in Turkey by Karacop (2019) to determine the influence of a Jigsaw method based on cooperative learning and a confirmatory laboratory method on prospective science teachers' achievements of physics in science teaching laboratory practice courses. The sample of Karacop's study consisted of 33 female and 15 male third-grade prospective science teachers (6th term) who attended science teaching laboratory practices course in the 2014-2015 academic year. In the research, science teaching laboratory practices course was carried out in accordance with a Jigsaw method based on cooperative learning in an experimental group and a confirmatory laboratory method in a control group. Following the treatment, Science Laboratory Physic Achievement Test (SLPAT) was administered as the post-test. The data obtained from the study were analysed using descriptive statistics and the results indicated that the student teachers had higher levels of achievement in physics topics which were taught through the Jigsaw method based on cooperative learning than through a confirmatory laboratory method. Thus,

the JCLS has advantage in the teaching of science concepts when compared with other teaching methods.

This finding that, there was greater improvement in the marks of students taught using JCLS compared with the changes in the marks obtained by students taught using the traditional lecture method is a confirmation of the study conducted by Krishnan, (2021), it was stated that, the jigsaw method is one of the learning methods that has great potential to make students learn a large amount of information in a short period of time. It is a classroom technique where students act as blocks of jigsaw puzzle and learn cooperatively with all the participating students acting as teachers as well as learners. Krishnan, et al. (2021) conducted a study to assess the effectiveness of jigsaw active learning method in comparison to conventional didactic method in promoting knowledge gain and retention among final year medical students. A quasi-experimental crossover pretest an post-test study was conducted among final year medical students of a tertiary care teaching hospital in North Kerala from June 2021 to July 2021 during the integrated sessions by Surgery and Pharmacology Departments. Students were randomly divided into two groups A and B of 28 students each. They were taught two topics i.e., hyperthyroidism and hypothyroidism, as two sessions by either a jigsaw (experimental) or didactic (control) method. The first topic was taught by the two methods and then the same groups were later crossed over for the second topic. Knowledge gain and retention were assessed by immediate and delayed post-tests consisting of 20 multiple choice questions with a single correct response. Each correct response was given one mark and incorrect responses were given no negative marks. All data collected was analysed statistically. Statistical significance was considered at p-value less than 0.05. The mean age of students was

22.321±0.734 years. Mean scores of immediate post-test were significantly higher in the jigsaw group for the first session (16.64 vs 14.21, p=0.001) and the crossover session (17.61 vs 15.14, p=0.001). Mean scores of delayed post-test were significantly higher in the jigsaw group for the first session (14.32 vs 11.03, p=0.001) and the crossover session (14.85 vs 11.28, p=0.001). It was concluded that, Jigsaw method was found to be more effective than didactic method in promoting knowledge gain and retention among medical students**.**

However, the finding of greater impact of JCLS compared with traditional lecture method is contrary to the outcomes of another study conducted in United States by Thompson and Pledger (1998) to explore the efficacy of the two methodologies (traditional lecture and cooperative learning) The subjects were divided into two groups: 27 students who learned course material via the traditional lecture format and 23 students, who learned course material via a cooperative learning technique called jigsaw. After analysing the achievement scores in the pre-test and the post-test, the results did not reveal any significant differences in the scores of students taught by the two strategies.

Stanczak et al. (2022) also conducted a descriptive study and found contrary outcomes to the findings of the present study. Stanczak, et al. (2022) conducted their study to test the hypothesis that a jigsaw intervention would yield a meaningful effect size (d = 0.40) on learning outcomes, in five randomized experiments conducted among 6th graders. The jigsaw intervention was compared to an “individualistic” (N Experiment 1 = 252; N Exp 2 = 313) or a “teaching as usual” (N Exp 3A = 110; N Exp 3B = 74; N Exp 3C = 101) approach on the same pedagogical content. Across the five experiments, the authors did not find empirical support for their hypothesis.

Internal meta-analytic estimates (ES = 0.00, 95% CI [-0.10, 0.09]) showed that, overall, the jigsaw intervention did not produce the expected positive effects on learning.

Research Question 2:

The second research question seeks to address the difference in the effect of the jigsaw method on boys' and girls' performance in rate of reaction To adequately explore this research question, the impact of JCLS on females' (girls') performance was first established inferentially and descriptively. Secondly, the impact of the JCLS on the performance of males/boys was also established inferentially and descriptively. Furthermore, the impact of JCLS on girls/females and boys/males were then compared to determine which of them experienced the greater impact or improvement in their performances.

To help make decision on this research question using the descriptive statistic (t – test), a null hypothesis was set to the effect that, "there is no significant difference in the performance of girls and boys taught rate of reaction using the JCLS"; and an alternative hypothesis was also set to the effect that, "there is a significant difference in the performance of girls and boys taught rate of reaction using the JCLS".

The result reveals generally that, teaching males and females using JCLS leads to significant improvements in the achievement marks of both gender. In the case of girls or females, it was discovered that, there was an improvement in the total marks obtained after the girls were taught using Jigsaw Cooperative Learning Strategy (JCLS): the total mark increased from 693 in the pre-test to 1173 in the post-test. Thus, there was a total improvement of 480 in the marks of the females taught using

JCLS. This implies that, there is aggregate positive impact of JCLS on females' performance.

Notwithstanding this, there was also an improvement in the mean mark from 33% in the pre-test to 55.9% in the post-test. Thus there was an improvement of 22.9% in the mean mark for the girls. This implies that, a girl or female who is an average student could benefit from JCLS.

Furthermore, there was also an improvement in the maximum mark from 82% in the pre-test to 96% in the post-test. Thus, there was an improvement of 14.0% in the maximum marks. This also implies that, JCLS, could still make significant improvement even if the female students involve is performing very high or excellently. The minimum mark also improved from 6% to 9% showing a change of 3% which implies that, JCLS is also impactful among low-performing female students. By implication, the finding indicates that, for female students, it does not matter the academic potential of the student, JCLS can still be helpful. In effects, all categories of female students (ranging from low-performing, average performing and high performing students) can benefit from JCLS.

Furthermore, a t –test analysis was used to test the significance of the effect of JCLS on female students' performance. The results indicate a significant effect of JCLS on girls' performance ($t = 10.4086$; $P = 0.000$).

This finding is similar to the outcomes of a descriptive study conducted by Adjibolosoo et al. (2019) to explore the female students' concept mastery and intrinsic motivation in science concepts learning when the concept is taught using jigsaw learning strategy. Ninety-four (94) first year female students from the Presbyterian Women's Colleges of Education were randomly selected to form the

study sample. Experimental data were collected using pre-test and post-test. Structured questionnaire was also administered to a sample of 40 conveniently selected female students from the experimental group. Observation and interview were also conducted to gather self-reported data on students' intrinsic motivation. The quantitative data was analysed using descriptive, t-test and chi-square statistics. The qualitative data was analysed using thematic content analysis and the results indicate that greater number of the female students obtained better results as they learnt and remembered the concepts better through jigsaw learning strategy. The study recommends that teachers in the colleges of education, particularly those in female colleges, should use the jigsaw model to encourage and motivate students to learn science. The study also recommends that the model should be extended to other colleges of education dealing with mixed students to further expand the efficacy of the model in science concepts mastery and building of intrinsic motivation.

Data on the impact/ improvement in the performance of males taught using JCLS reveals that, there was some improvement in the marks of all males taught using JCLS. Also, the total mark of males improved from 637.0 in the pre-test to 1331 in the post test, showing an increment of 694. This indicates a positive aggregate effect on the performance of the male students. There was also an increase in the mean mark from 30.3% in the pre-test to 63.4% in the post-test, showing an increment of 33.1%. This implies that, an average preforming male student will also find JCLS beneficial.

The maximum mark for boys also increased from 78.0% in the pre-test to 98% in the post-test showing an improvement of 20.0%. This implies that, a highly performing male student will perform even more excellently when JCLS is applied in teaching.

The minimum mark for boys also increased from 4.0% in the pre-test to 7.0% in the post-test, showing an increase of 3.0%. This finding implies that, a poorly performing male student could improve when JCLS is use in teaching. Thus, among male students too, JCLS could be beneficial to all categories of students regardless of the academic strength or previous performance.

A t – test was used to test whether the improvement brought about in the marks of the male students was significant and it was found that, the improvement brought about in the performance of boys by using JCLS is significant ($z = 9.709$; $P = 0.000$).

The fact that, the changes in the marks of the individual male students were significant reporting P-values less than 0.05 is a confirmation of a study conducted by Agu and Samuel (2018) who investigated the effect of Jigsaw Cooperative Learning Strategy, Team-Assisted Instruction and Guided Discovery instructional strategies on the interest and achievement of Basic Science and Technology students. Quasi experimental research design was employed for the study. The population of the study comprised JSS II students in public co-educational secondary schools in Doma Local Government Area of Nasarawa State, Nigeria. The sample for the study was 147 JSS II Basic Science and Technology students from four intact classes selected in the study area. Two research questions and two hypotheses guided the study. Students' Interest Rating Scale in Basic Science and Technology (SIRSBST) and Basic Science and Technology Student's Achievement Test (BSTSAT) were used as instruments for data collection. The reliability of SIRSBST was determined using Cronbach Alpha and the coefficient obtained was 0.82 while BSTSAT was determined using K-R21 formula and the reliability coefficient obtained was 0.85. Mean and Standard Deviation were used to answer the research questions while the hypotheses were

tested at 0.05 level of significance using Analysis of Covariance (ANCOVA). Scheffe's Post-hoc test was used to determine the magnitude of the differences. The findings of the study revealed that there were significant improvement in the interest and achievement of students taught using Jigsaw Cooperative Learning.

In order to further understand which of the genders report the highest improvement in performance when the JCLS is used, the improvement marks for the two genders were compared. The comparison between the impact of JCLS among males and females was first done inferentially and then descriptively. The results reveal that, there was more improvement in the total marks obtained by males (694) than obtained by females (480). Thus the difference in the improvement in the performance of males and females when JCLS was applied is 214. The improvement in the mean mark for boys (33.0%) is also more than the improvement in the mean mark for girls (22.9%). Thus, the improvement in the mean mark of boy exceeded that of girls by 10.1% among averagely-performing students. Also, the maximum mark for boys (20.0%) exceeds that of girls (14.0%) by 6%. This means the improvement in marks for boys was better than the female among highly-performing students as well.

However, the changes in the minimum mark for boys and for girls was the same (3.0%). This indicates that, among low performing students, both males and females benefit almost equally from JCLS.

Overall, the t – test indicated that there was better significant improvement in the achievement scores for male students compared to female students when JCLS is applied for teaching. Therefore, the null hypothesis was rejected and the researcher faid to reject the alternative hypothesis . That is to say, gender disparities exist in the effect of JCLS among students. This is a confirmation of a study conducted by

Mbacho and Changeiywo (2013) to find out if the use of Jigsaw Cooperative learning Strategy during instruction of Surds and further logarithm in mathematics to Form Three students had effects on their gender differences in performance. There is was as a result of inadequate information in research conducted in Kenya on effects of the use of Jigsaw Cooperative learning Strategy on students' achievement in mathematics by gender difference. Solomon Four non-equivalent control group design was used in the study. A simple random sample of four district secondary schools was selected from Laikipia East District. The sample size was 160 students out of population of about 20,000 students in the district. A mathematics achievement test (MAT) was used for data collection. The instrument was piloted in a school which was not used in the study in the same district and a reliability coefficient of above the required threshold of 0.70 was found. The instrument was validated by education experts from the University. Data was analysed using t test to test hypotheses at Coefficient alpha (ά) level of 0.05. The results showed that there is no statistically significant gender difference in mathematics achievement when students are taught using Jigsaw cooperative learning strategy.

The finding that, the difference in effect of Jigsaw Cooperative Learning Strategy on boys over girls is significant is similar to a study conducted by Armstrong (1981) who investigated the effect of JCLS on achievement scores of boys and girls and showed that no sex differences existed in mathematics achievement throughout the junior school but that at the end of high school males have higher achievement scores and perform better on higher level cognitive tasks.

Similarly, a study conducted by Blith, Forbes, Clark & Robinson (1994) reports a consistent difference in mean performance in favour of boys at the secondary school

level in New Zealand after employing the interventional approach to investigate the mathematics achievement scores for pre-test and post-test.

Besides, Manger (1996) investigated the relationship between gender and mathematical achievement with Norwegian 3rd graders using an achievement test covering numeracy problems, fraction problems, geometry problems and word problems. Boys were found to have higher total test scores than girls, but the difference was small.

The discussion on the first research question reveals that, for science related concepts, the effect of JCLS on students' achievement scores do favour boys than girls.

Research Question 3: What are students' perception about how JCLS is helpful to them or otherwise?

This research question was investigated by examining the views of students who were taught using JCLS about how the method has been helpful to them during their study. The results indicated that students gave positive remarks about the JCLS. This became clear as majority (31) of the respondents constituting 73.8% agreed that, Jigsaw Learning Strategy helped them to obtain help from friends about what they found difficult to understand; majority (30) of the respondents constituting 71.4% agreed that, Jigsaw Learning Strategy helped them to have the opportunity to share knowledge with other friends; half (21) of the respondents who were taught using JCLS constituting 50.0% agreed that, Jigsaw Learning Strategy helped them to overcome tribal differences. Most (34) of the respondents constituting 81.0% agreed that, Jigsaw Learning Strategy helped them to develop team working skills. A greater number (28) of the respondents constituting 66.7% agreed that, Jigsaw Learning Strategy helped them to improve my self-esteem. Many (25) of the students

constituting 59.5% agreed that, Jigsaw Learning Strategy helped them to develop their communication skills.

A greater number (26) of the students constituting 61.9% claimed Jigsaw Learning Strategy helped them to improve their motivation to learn. Most (31) of the respondents constituting 73.8% agreed that, Jigsaw Learning Strategy helped them to enjoy the learning process. Some (23) of the respondents constituting 54.8% agreed that, Jigsaw Learning Strategy helped them to understand the lesson on Chemical Kinetics better than ever. Many (24) of the student taught using JCLS constituting 57.1% agreed that, Jigsaw Learning Strategy helped them emotionally. Generally, the finding implies that, many students agreed that JCLS was helpful to them in their study process in so many ways as indicated.

The finding that, JCLS helped students to develop team working and communication skills is similar to a study conducted by Slavin, et' al (2014) which indicated that science teaching methods which focused on enhancing teachers' classroom instruction throughout the year, such as cooperative learning have significant potential to improve science learning through increasing students socializing and team work which made it a better pedagogical practice for instruction in schools.

The cooperative and group advantage offered by the jigsaw cooperative learning strategy as found in this current study is similar to the tenets of the social interdependence theory (Johnson & Johnson, 2005) which enunciated that, the jigsaw model is an established educational approach with the central principle of completing each other rather than competing with each other. The focus of the jigsaw model framework for instruction is that, learning must not be a competition with each other

or being indifferent to each other, but rather students must engage in group activities that facilitate social learning or cooperative learning. In other words, the JCLS helps students to work together to maximize their own and each other's learning abilities. The jigsaw method is an effective way to increase student engagement through group work that facilitates inter-peer learning which has a great social and emotional advantage for the students as it elevates their self-perception and communication skills.

Moreover, the fact that JCLS leads to group learning advantage is also a confirmation of the findings in the study conducted by Gocer (2010), who discovered that, students awareness of the fact that they should work so as to maximize the learning levels of not only themselves but also that of their peers. In cooperative learning, peers assist each other's learning and establish proper communication among them. Students with different culture, experiences, and learning modes get together to achieve success towards a common goal by assuming the responsibility of each other's progress.

In this current study, it was also found that, the JCLS helped the students by motivating them to learn more which is in congruence with the idea of intrinsic drive which has been evidenced as associated with the JCLS in prevailing literature. For example, the fact that, JCLS increases intrinsic motivation of students to learn is similar to the outcomes of a study conducted by Adjibolosoo, et. al. (2019) which investigated the female students' intrinsic motivation in science concepts learning when taught using jigsaw learning strategy. Ninety-four (94) first year female students from the Presbyterian Women's Colleges of Education were randomly selected and investigated using observation and interview to gather self-reported data on students' intrinsic motivation and the thematic analysis shows that, students' participation was

generally higher and intrinsic motivation shown in the students when they learnt through jigsaw cooperative strategy increased greatly as reported by themselves.

Better still, Odagboyi (2015) also found similar outcomes in his study as he noted that classroom groups with supportive friendship patterns enhance academic learning, while interpersonally tense classroom environment in which peer group rejection are strong and frequent, are hindrances to learning. Cooperative learning help satisfy many psychological conditions of students. Each individual member of the team works until each member of the team fully understands and completes the assignment.

In fact, one of the most important requirements for effectiveness in the professional arena after school is the ability to demonstrate a greater team skills which helps persons to easily collaborate to work with a team of people. Many job avenues uphold this competency as one of the first among all the competencies required on the job. Since JCLS helps to enhance team competence of students, it can also be said that the JCLS contributes benefits beyond even the academic performance of students to affect their professional outputs in the future after school. In this regard, it is worth mentioning that, the JCLS is very desirable if contemporary academic and professional outputs would be enhanced. Yet for schools to be able to get JCLS applied extensively among teachers, schools must be resourced with the various materials and equipment needed for its practice. For the absence of these resources coupled with conservativeness, many teachers continue to apply the traditional lecture method with minimal impacts when compared to the JCLS (Odagboyi, 2015)

4.6 Chapter Summary

This chapter presents results on the study analysis as well as the discussion of the results. Generally, the presentation and discussion of results established that, teaching rate of reaction using both JCLS and traditional lecture method leads to some improvement in the performance of students. Yet, the impact of JCLS on the performance of students was more statistically significant when compared to that of the impact produced by the traditional lecture method. Moreover, the JCLS leads to positive improvements in the performances of both boys and girls when used to teach rate of reaction. However, the impact of JCLS on the academic performance of males or boys is more statistically significant when compared with the impact of JCLS on the performance of girls. Besides, students generally perceived that, JCLS was helpful to them as it helped to increase their intrinsic motivation to study, helping them to share and obtain ideas from their peers. The discussion has made it clear that the JCLS holds comparative advantage for both students' academic and professional performances.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS, RECOMMENDATIONS AND SUGGESTIONS FOR FURTHER STUDIES

5.0 Introduction

The study applied an experimental case study design to explore the effects of jigsaw cooperative learning strategy (JCLS) on chemistry students' understanding of rates of reaction in Bompeh Senior High Technical School and Adiembra Senior High Schools in the Western Region, Ghana. Eighty-four (84) second year students were selected using the purposive sampling technique and separated into an experimental and control group. The experimental group was taught using JCLS whiles the control group was taught using traditional lecture method. Data was analysed using SPSS version 23. This chapter presents the summary of the key findings gathered from the study. Based on the key findings, conclusion is drawn and recommendations are given.

5.1 Summary of Key Findings

What is the difference in the performance of learners taught using the jigsaw cooperative learning strategy (JCLS) and those taught using chalk-and-talk approach in rate of reaction?

Results revealed that, both the jigsaw cooperative learning method and the traditional lecture method had some positive impact on students' performance after being taught rate of reaction using the two methods. The jigsaw cooperative learning method increased the total score of students by 1174. It also increased the mean score and the maximum scores of students by 28.0% and 16% respectively. The traditional lecture

method (chalk and talk method) also led to some improvements in the marks obtained by the students in the control group as it increased the total mark, mean mark and maximum mark by 906, 21.6% and 15 respectively. However, comparing the impact of the two methods (jigsaw cooperative learning strategy and the traditional lecture method) it became clear that, the jigsaw cooperative learning method produced more significant impact on students' performance in rate of reaction. This difference in the impact produced by the jigsaw cooperative learning method over the traditional lecture method was statistically tested to be significant using the z – test approach as it produced a p-value less than 0.05. Therefore, the null hypothesis (that there is a significant difference in the performance of students taught rate of reaction using the JCLS and those taught using traditional chalk and talk method) is accepted whiles the alternative hypothesis (that there is no significant difference in the performance of students taught rate of reaction using the JCLS and those taught using traditional chalk and talk method) is rejected.

What is the effect of the jigsaw method on boys' and girls' performance in rate of reaction?

Furthermore, findings reveal that, there was improvement in the performance of both girls and boys taught using jigsaw cooperative learning strategy. For females or girls, jigsaw cooperative learning strategy (JCLS) increased total marks 693 in the pre-test to 1173 in the post-test showing a total improvement of 480 in the total marks of the females taught using JCLS. JCLS also increased the mean mark of girls from 33% in the pre-test to 55.9% in the post-test showing an improvement of 22.9%. The maximum mark for girls also changed from 82% in the pre-test to 96% in the post-test indicating an improvement of 14.0% in the maximum marks. For males, JCLS increased the total mark from 637.0 in the pre-test to 1331 in the post test, showing an

increment of 694. There was also an increase in the mean mark of males from 30.3% in the pre-test to 63.4% in the post-test, showing an increment of 33.1%. The maximum mark for boys also increased from 78.0% in the pre-test to 98% in the post-test showing an improvement of 20.0%. However, when the impacts of JCLS on girls' performance and boys' performance were compared, it turned out that, the impact on males' performance was more significant. In other words, the JCLS produced more impact on the performance of boys than girls. This impact was statistically tested to be very significant through a z - test approach as it produced a p-value less than 0.05.

5.2 Conclusion

Based on the study findings, it is concluded that, the jigsaw cooperative learning strategy is more effective in improving the performance of students in rate of reaction compared to the traditional lecture or the chalk and talk method. This became clear as the jigsaw learning strategy contributed to higher and statistically significant increase in the performance of students compared to lower increase in performance produced by the traditional learning method.

Moreover, it has established that, the jigsaw cooperative learning strategy produces more significant effect on the performance of boys comparative to their female counterparts.

Meanwhile, the JCLS has been highly esteemed by students to be very helpful in their study process as it aided them to share ideas, improve their communication skills, improve their self-esteem and also gives them the opportunity to do away with their tribal and personal differences.

In fact, the study outcomes portrayed that, JCLS is the way forward in the Bompeh Senior High Technical School and Adiembra Senior High School Senior High School as far as the teaching of rate of reaction is concerned. Yet, if JCLS could be applied effectively, teachers need to be equipped and schools need to be provided with resources needed. Therefore, educational policy makers should focus their attention on this method and how to get it extensively applied in teaching.

5.3 Recommendations

Based on the findings of the study, the following recommendations were made:

1. Because JCLS was reported to be extensively helpful among the students of Bompeh Senior High Technical School and Adiembra Senior High School; and that, many teachers continue to apply lecture method, the school authorities of Bompeh Senior High Technical School and Adiembra Senior High Schools in collaboration with education experts should organise an annual workshop for the teachers on Jigsaw cooperative learning strategy so as to equip them and also encourage them to apply the method in instruction of various subjects so as to increase academic performance of students.
2. Because resourcing schools and teachers is desirable for effective application of JCLS, the Takoradi Sub-Metropolitan Education Directorate in the Western Region should consider equipping Bompeh Senior High Technical School and Adiembra Senior High Schools in the Region with Jigsaw cooperative learning resources and other facilities such as laboratory so as to encourage effective use of cooperative learning strategy and other interactive models so as to increase students' academic outcomes.

3. Because of the extensive benefits of JCLS, contemporary Textbooks for Chemistry should include a Jigsaw guide for teachers of Bompeh Senior High Technical School and Adiembra Senior High Schools on how they can organize their classes to teach each of the topics included in chemistry. In that, all textbooks should provide an introductory guide for teachers and dedicate a section for Jigsaw cooperative guide for teaching the topic included in the textbook.
4. Because students performed better when taught using JCLS in Bompeh Senior High Technical School and Adiembra Senior High Schools the Ministry of Education and the Ghana Education Service should include jigsaw cooperative learning strategy guide in the syllabus of chemistry to guide teachers on how to go about classroom practice using the Jigsaw Cooperative Learning Strategy.

5.4 Suggestions for Further Studies

1. Even though this study explored the effectiveness of JCLS in the Bompeh Senior High Technical School and Adiembra Senior High Schools, it does not explore whether this effectiveness could be the same in all schools throughout the country. There is the need to conduct a nationwide longitudinal study with a meta-analysis to establish whether the effectiveness of JCLS is sustainable in all schools across the country.
2. Apart from the JCLS, there are other cooperative learning models that needs to be explored. Yet this study focused on the JCLS. Therefore, a similar study should be replicated using other cooperative models to establish whether there are other cooperative learning models that are more effective than the JCLS.

3. In addition, for policy makers to effectively intervene by providing cooperative resources to schools that are lacking it, it is important to explore the educational structure and schools across the nation to ascertain schools that need urgent provision of such cooperative researches and facilities so as to help channel these resources to the right places for effective use.
4. There is also the need to conduct a similar study using other subjects such as using JCLS in the teaching of mathematics and English Language. So as to ascertain whether the JCLS is still effective in the instruction of these subjects as well.

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APPENDICES

APPENDX A

Data Collection Instruments Test

Post test.

1. The minimum amount of energy required for a reaction to take place is the
    a. Activation energy
    b. ionization energy
    c. kinetic energy
    d. potential energy
2. The presence of catalyst in a reaction alters the
    a. Heat of reaction
    b. yield product
    c. equilibrium position
    d. rate of reaction
3. The rate determining step for the reaction
    2A + 3B →2C is A + 2B → D. What is the order of the reaction?
    a. 0
    b. 1
    c. 2
    d. 3
4. The minimum amount of energy required for effective collisions between reacting particles is known as
    a. Activation energy
    b. bond energy
    c. kinetic energy
    d. potential energy
5. The decay of a radioactive material is a first order reaction. This means that the rate of decay is proportional to
    a. Intensity
    b. pressure exerted on it.
    c. number of nuclei present

d. temperature of the material.

6. The activation energy of a reaction is the

a. Energy given out as the reaction proceeds

b. energy used up by the reaction

c. minimum energy that must be possessed by reactants to enable them to react d. energy absorbed as the reaction proceeds.

7. Which of the following parameters affects the rate of chemical reactions?

I. State of reactants II. Temperature III. Catalyst

a. I only

b. I and II only

c. I, II and III

d. I and III only.

8. The rate of reaction is $R = K[A]\ [B]^2$. By what factor will the reaction rate change if the concentrations of both A and B are doubled?

a. 4

b. 8

c. 27

d. 64

9. The rate of second order reaction will be numerically equal to the specific rate constant when

a. Reaction is homogenous

b. temperature of the reaction is valid

c. concentration of the reactants is doubled d. concentration of the reactant is unipolar.

10. Which of the following statement about reaction rates is true?

a. The rate of reaction varies with temperature of the system

b. the rate of reaction increases as the reaction proceeds

c. catalysts increase the rate of forward reaction only

d. the reaction between Na2CO3 and HCL is reversible

11. Consider the following reaction equation:

$Zn_{(s)} + 2HCL_{(aq)} \rightarrow ZnCL2_{(aq)} + H_2$

Which of the following conditions would affect the rate of production of hydrogen gas?

a. Using catalyst

b. using higher concentration of HCL

c. Increasing the pressure

d. decreasing the pressure.

12. The collision theory proposes that

a. Reactants collide more frequently to bring about reduction in the rate of reaction

b. All collision of reactants are effective

c. Reactants must collide with a certain minimum amount of energy to form products

d. The fewer the collisions the faster the reaction rate.

13. One of the characteristic properties of a catalyst is its

a. Ability to increase the collision rate of reactant particles

b. Ability to lower the heat of reaction

c. possession of large surface area

d. provision of an alternative reaction pathway.

14. Which of the following statements is true about the rate of chemical reactions? The rate

a. Depends on the size of the containing vessel

b. decrease with increasing temperature

c. Depends on the concentration of the reactants

d. Increases with increasing activation energy.

15. The reaction, $2NO_{(g)} + O_2 \rightarrow 2NO2_{(g)}$ was found to be first order with respect to each of the reactants. Th rate law should therefore be written as

a. Rate = $k[NO]^2 [O_2]$

b. Rate = $k [NO] [O_2]$

c. Rate = $k [NO]^2 [O_2]$

d. Rare = $k [NO] [O_2]^2$

16. A substance which affects the rate of chemical reaction without itself being permanently altered is a/an

a. Precipitate

b. catalyst

c. solvent

d. addictive

17. Equal masses of calcium trioxocarbonate (IV) were added to dilute hydrochloric acid at the temperature specified. Under which of the following conditions would the reaction be slowest?
    a. calcium trioxocarbonate (IV) powder at 40 °C
    b. calcium trioxocarbonate (IV) powder at 20 °C
    c. calcium trioxocarbonate (IV) chips at 20 °C
    d. calcium trioxocarbonate (IV) chips at 40 °C.
18. When 1.5g of calcium trioxocarbonate (IV) is added to excess dilute hydrochloric acid, carbon (IV) oxide is given out. The entire reaction takes 15 seconds. What is the rate of the reaction in mols-1? ($CaCO_3$=100)
    a. 1.0×10^{-1} mol s^{-1}
    b. 1.0×10^{-2} mol s^{-1}
    c. 1.0×10^{-3}mol s^{-1}
    d. 1.0×10^{-4} mol s^{-1}
19. Which of the following factors will not directly affect the rate of chemical reaction?
    a. Concentration of reactants
    b. melting point
    c. physical state
    d. temperature changes
20. The rate of reaction is $R = k [X]^2 [Y]$. By what factor will the rate of the reaction increase if the concentration of X and Y are both doubled?
    a. 4 times
    b. 8 times
    c. 27 times
    d. 64times

Theory

1. a) What is activation energy of a reaction?

    b) Explain why the rate of chemical reaction increases with an increase in temperature.

    c)An experiment was conducted to determine the rate law for the reaction $A_{(g)} + B_{(g)} \rightarrow C_{(g)}$. The results of the experiment are tabulated below.

Experiment	[A] ($moldm^{-3}$)	[B] ($moldm^{-3}$)	Initial rate of formation of C ($moldm^{-3}$)
1	1.0	32.0	3.0
2	2.0	32.0	12.0
3	32.0	6.0	5.3
4	32.0	18.0	15.9

(i) Write the general rate equation for the reaction.

(ii) Determine the rate law expression for the reaction.

(iii) State the order of the reaction with respect to each of A and B hence give the overall order of the reaction.

(iv) Calculate the rate constant for the reaction.

2. a) Explain briefly each of the following terms and illustrate with relevant examples

i. Order of reaction.

ii. Rate law

b) State three factors that may affect the rate of chemical reaction.

c)Write expression for the rate of the rate of the reaction

$2N_2O_{(g)} \rightarrow 4NO_{2(g)} + O_{2(g)}$ in terms of

i. The reactant

ii. One of the products.

c) State two postulates of the collision theory of reaction rates.

APPENDIX B

Questionnaire

Introduction

Dear Respondent,

This study is for academic purposes and the researcher would be very grateful if you could respond to the following questions to the best of your knowledge. You are assured that the information you will provide will be kept secret and confidential.

SECTION A: DEMOGRAPHIC CHARACTERISTICS

Please mark in the checkbox next to the appropriate option like this [√] or fill in the blank provided

1. Gender: Male [ ] Female [ ]
2. Age group (in years): below 15 [ ] 15-20 [ ] 21-25 [ ] above 25 [ ]
3. Religious affiliation: Christianity [ ] Islamic [ ] Traditional African [ ]

Other (specify)……

4. Type of student: Day [ ] Boarding [ ]
5. If Day, whom are you staying with? Parents [ ] Relatives [ ] On your own [ ]

SECTION B: STUDENTS VIEWS/PERCEPTION ABOUT THE USEFULNESS OF JCLS

For each item, indicate your agreement on how helpful or otherwise instruction using the Jigsaw Cooperative Learning Strategy has been to you

Item	Agree	Neutral	Disagree
1. Jigsaw Learning Strategy helped me to obtain help from friends about what I find difficult to understand			
2. Jigsaw Learning Strategy helped me to have the opportunity to share knowledge with other friends			
3. Jigsaw Learning Strategy helped me to overcome tribal differences			
4. Jigsaw Learning Strategy helped me to develop team working skills			
5. Jigsaw Learning Strategy helped me to improve my self-esteem			
6. Jigsaw Learning Strategy helped me to develop my communication skills			
7. Jigsaw Learning Strategy helped me to improve my motivation to learn			
8. Jigsaw Learning Strategy helped me to enjoy the learning process			
9. Jigsaw Learning Strategy helped me to understand the lesson on Chemical Kinetics better than ever			
10. Jigsaw Learning Strategy helped me emotionally			