UNIVERSITY OF EDUCATION, WINNEBA

FACULTY OF SCIENCE EDUCATION

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USING GROUP LEARNING STRATEGIES TO ENHANCE STUDENTS' UNDERSTANDING OF SELECTED CHEMICAL CONCEPTS IN SCIENCE. A CASE STUDY AT BAGABAGA COLLEGE OF EDUCATION, TAMALE

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GONYALUG ISAAC AZUMAH

(7090130378)

A RESEARCH THESIS PRESENTED TO THE SCHOOL OF GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE EDUCATION (CHEMISTRY)

DECEMBER, 2011.

DECLARATION

Candidate:

I hereby declare that, except for the references to other people's work which have been duly cited and acknowledged, this thesis is the result of my own original research and that no part of it has been presented for a similar award in the University of Education, Winneba or elsewhere.

Name: ……………………………………………………………..Sign: …………………………..

Date: ……………………………………………………..

Supervisor:

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

Name: ……………………………………………………………….Sign: …………………………

Date: ……………………………………………………………

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To my family, I say thank you for your love and motivation during the period of my study.

DEDICATION

I specially dedicate this research thesis to my daughter, Valentina Wentema Gonyalug, son, Emmanuel Wensakya Gonyalug and lovely wife, Isaac Cynthia Gariba (Mrs.).

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LIST OF SYMBOLS

IUPAC	-	International Union of Pure and Applied Chemistry
FDC 114	-	Foundation Development Course for first year, first semester science students of colleges of education in Ghana
RPK	-	Relevant Previous Knowledge
CA	-	Continuous Assessment
CCAPrT	-	Chemical Concepts Achievement Pre-Test
CCAPoT	-	Chemical Concepts Achievement Post-Test
PrAT	-	Pre-Attitude Test
PoAT	-	Post-Attitude Test
SPSS	-	Statistical Package for Social Sciences
FCLG	-	Formal Cooperative Learning Groups
CL	-	Cooperative Learning
ICLG	-	Informal Cooperative Learning Groups
CBGs	-	Cooperative Based Groups
STLM	-	Student Team Learning Method
STAD	-	Student Team Achievement Division
TGT	-	Teams-Games Tournament
SDM	-	Structured Dyadic Method
CR	-	Cooperative Review
GP	-	Group Projects
CSCL	-	Computer Supported Collaborative Learning

CKI - Collaborative Knowledge Interoperability

LS - Learning Sciences

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ABSTRACT

The pre-test, post-test small group control experiment with an element of descriptive survey study was used to examine the effects of group learning on college students' understanding of chemical concepts in science. The study was conducted at Bagabaga College of Education, Tamale. A total of 102 first year students were used for the study.

Test and survey questionnaire were the main instruments used for the study. These consisted of Chemical Concepts Achievement Pre-test (CCAPrT); Chemical Concepts Achievement Post-test (CCAPoT); Chemical Concepts Retention Test CCRT as well as Pre-Attitude test (PrAT) and Post-Attitude test (PoAT). These were developed by the author for the purpose of this study. The test items consisted of 40 questions while the survey questionnaires contained 24 items.

The data obtained were analysed using t-test to determine if there were significant differences between the experimental and control groups in terms of performance and retention at 0.05 confidence level, while the Levene's test for equality of variances was used to investigate the differences in research question 3 at 0.05 confidence level. The t-test analysis of the results showed that there was no significant difference between the control and experimental groups in terms of performance in the pre-test but, there was significant difference between the two groups in the post-test in favour of the experimental group after the treatment.

Also, analysis of the post-test and retention-test mean scores of the control and experimental groups showed that the experimental group's level of retention was higher than that of the control group. Again, analysis of pre-attitude test and post-attitude test mean scores showed significant difference, indicating that the students had improved upon their attitudes towards the learning of chemistry after the intervention.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter includes the background to the study, the purpose and significance of the study, research questions and hypotheses. The chapter also presents the delimitation, limitations, operational definitions and organization of the research report.

1.1 Background to the Study

The idea of having Teacher Training Colleges in Ghana dates back to 1920, when a local committee appointed by the Gold Coast Government to deliberate on the major requirement of education in the country recommended that three new institutions should be built: a secondary school, a new Government training college for male teachers to replace the existing buildings of the college which had been founded in 1909, and a training college for female teachers.

Governor Guggisberg took this further when he assumed office. He set up another committee in 1922 which suggested that the three separate institutions recommended by the 1920 Committee could not be afforded by the Government, and should therefore be combined into one comprehensive institution. The Committee recommended that the site chosen at Achimota, in Accra, should provide general secondary education, teacher training, and technical education for male and female students. When it finally opened in 1927, the Prince of Wales College, which later became Achimota College School, offered General Secondary Education as well as Post Secondary Technical Education and Teacher Training for both sexes.

The training of teachers was a Government priority and by 1933 there were a total of 449 teacher trainees. In 1937, the White Fathers' Mission founded a two-year teacher training college at Navrongo.

The Post Independent Era saw vigorous improvement reforms in the educational sector. The number of teacher training colleges increased. These run 4-year Post-Middle School Teacher Training Programme.

Under the Education Reform Programme, the 4-year Post-Middle School Teacher Training Programme was phased out in 1991, giving way to only a 3-year Post Secondary Programme. Quality teacher education is crucial for effective education outcomes. To this end, facilities in all the 38 Teacher Training Colleges have been rehabilitated under the German Agency for Technical Cooperation (GTZ) in collaboration with the Government assistance programme. Entry requirements into Teacher Training Colleges have been streamlined to ensure the recruitment of students with good grades and who also have a passion for the teaching profession. Also, under a new programme known as In-In-Out, teacher trainees are expected to spend two years at school and use the third year for practical training in the classroom.

(http://politicalpola.wetpaint.com/page/HISTORY+OF+EDUCATION+IN+GHANA)

Tertiary Education Reforms were launched in 1991 with the publication of a Government White Paper on the University Rationalisation Committee Report. The White Paper on Tertiary Education redefined higher education to include Universities, Polytechnics, and Teacher Training Colleges etc. (*Modern Ghana.com*).

Finally in 2005, the Teacher Training Colleges were upgraded to Diploma Awarding Institutions and the names changed to Colleges of Education. Today, there are 40 Colleges of Education in Ghana with the mandate of training teachers for the basic schools in the country. Out of these, Bagabaga College of Education is one.

Colleges of education in Ghana are faced with a big challenge of low academic performance of students, especially, in the area of science. In the Ghanaian education system, the Colleges of Education train teachers for the basic schools. Therefore, the quality of basic education depends largely on the quality of teachers produced by the Colleges of Education. In 2005, the colleges of education in Ghana were upgraded from certificate awarding institutions to diploma awarding institutions so as to upgrade basic school teachers' qualification to ensure quality teaching and learning at the basic school level.

However, the performance of first year students of Bagabaga College of Education in science, over the six years indicates that the learning of integrated science is a serious challenge to the students, especially, the areas related to chemistry. The researcher has observed many students working hard with course materials both day and night but their exam results over a period of time reveals that some students do not understand the basic concepts of the science or simply they cannot express their answers clearly and logically. This observation featured prominently in the chief examiner's reports under "students' weaknesses" as follows: "most candidates could not balance chemical equations and, name compounds using the IUPAC system of nomenclature" (FDC 114, Chief Examiner's Report, 2005); "candidates' performance in physics and chemistry was abysmally low and so, attention needs to be paid to these subjects" (FDC 114, Chief Examiner's Report, 2010); "questions on biology were answered very well, however, candidates could not answer questions on chemistry" (FDC 114, Chief Examiner's Report, 2011). Some principals of Colleges of Education and heads of partner schools where the trainees do their internship attribute this to the approach used in teaching and learning of science at this level while others blame it on very little or poor background of the students, which underscores the importance of relevant previous knowledge (RPK). But whatever the cause is, the author agrees with Ruggiero (cited in Johnson & Johnson, 1994, 57) that, "the only significant change that is required is a change in teaching methodology".

Dressel and Marcus (1982) and Herron (1996) believed that, learning is dependent upon many factors, such as the teacher, the nature of the materials, and the characteristics of the learners. Therefore, since learners have individual learning characteristics, it is good that teachers facilitate their learning by placing them in an environment that will enable them to actively construct and process information. One such environment is group learning. Encouraged by the idea that group learning approach would be exciting to students and facilitate their learning, the author decided to try this strategy with some selected chemical concepts, namely writing and naming of chemical compounds; balancing of chemical equations; chemical bonding and mole concept.

Group learning refers to an instructional method in which students at various performance levels work together in small groups towards a common goal. The approach has been recognized as one of the most successful learning strategies in educational history (Slavin, 1996).

1.2 Statement of the Problem

Bagabaga College of Education trains science, mathematics, English and social studies teachers, as well as specialised technical and French teachers for the Primary and Junior High School levels. By the academic structure, all students study science, except those studying French. The technical students are selected based on the strength of their mathematics and science grades from the senior high school while the social studies classes are selected including those with simple passes in mathematics and science. As a result, students in the social studies classes are generally weak in science, especially, in chemistry related areas. For a period of six years, the continuous assessment marks of the students have consistently not been encouraging and this has reflected in their end of semester examination results. Students generally complain that science, especially chemistry, is difficult to learn and this has been an institutional concern which the principal and tutors have bemoaned over the years.

Chemistry is a highly conceptual discipline which requires an ability to deal with symbolic representations at all levels. However, its core concepts are essential for the understanding of almost every aspect of science (Rao & Lakshmi, 2009). Thus, the aim and professional obligation of a chemistry teacher is to make the subject accessible in such a way that maximum meaningful learning can take place. This study, therefore, sought to examine the effectiveness of group learning on students' understanding of chemical concepts in science, the effectiveness of group learning on the retention of chemical concepts, and attitudes of students towards learning of chemistry.

1.3 The Purpose of the Study

The purpose of the study is to:

1. determine the effectiveness of group learning on first year colleges of education students' understanding of some selected chemical concepts in science.
2. examine the effectiveness of group learning on the retention of chemical concepts learnt.

3. examine the attitudes of students toward learning of chemistry before and after using group learning.

1.4 Research questions

1. Are there any differences between the pre-test and post-test mean scores of students taught using group learning?
2. Are there any differences between the post-test and retention-test mean scores of students after using group learning?
3. Are there any differences in the attitude of students towards the learning of chemistry before and after using group learning?

1.5 Hypotheses

To achieve the above objectives, the following null hypotheses were tested:

1. There is no significant difference between the pre- and post-test mean scores of students taught using group learning strategy.
2. There is no significant difference between the post-test and retention test mean scores of students after using group learning.
3. There is no significant difference in the attitude of students toward the learning of chemistry before and after using group learning.

1.6 Significance of the Study

The research was designed to explore the effectiveness of group learning strategies on the academic achievement of Bagabaga College of Education students in chemistry. It is hoped that, the outcome of the study would be useful in the following ways:

1. It would be beneficial to the students by enhancing their understanding of chemical concepts to improve their academic performance in science.
2. When successful, the intervention used would serve as a model for teaching chemistry to tutors at the colleges of education.
3. The evidence of behaviours of students in learning and opinions towards group learning would bring insights about this teaching-learning approach in the Ghanaian context.
4. It would persuade teachers to use group learning methods or seek other appropriate methods in order to enhance students' understanding of chemical concepts.
5. It would be useful to educators and curriculum planners, since the outcome could contribute to taking decision on science curriculum design and implementation.

1.7 Delimitation of the Study

The study was delimited to Bagabaga College of Education in the Northern Region of Ghana. Again, it was delimited to the study of some selected chemical concepts: writing and naming of compounds, balancing of chemical equations, chemical bonding and mole concept in the Integrated Science, foundation development course (FDC 114).

1.8 Limitations

Data in this study were collected and analysed by the investigator in both qualitative and quantitative style. Although an attempt was made to collect data as objectively as possible, and fairly analyse the results, the subjectiveness of the investigator cannot be avoided absolutely and may have influenced the findings.

Closely related to the observer bias is observer effect- where persons being observed behave differently and pretentiously from usual, precisely for the simple reason that they are being observed. This possibly could not have been completely eliminated, though, some effort was made by blinding the subjects during the administration of the survey questionnaires to minimise the effect (pretence and self-adjustment).

Also the study was conducted with first year students of Bagabaga College of Education studying integrated science. Though the results may be genuine and reliable, it may be difficult to generalise it to all the colleges of education in Ghana, considering the size of the sample population.

Again, performance and retention of students were measured on a few selected chemical concepts, so the accuracy of the report is open to question.

1.9 Operational Definitions

Throughout the study, a number of terms are used which are often presented in educational research literature with a variety of slightly different meanings. These brief definitions are therefore offered for the convenience of the reader:

1. **Group Learning -** defined in terms of cooperative learning as an approach to classroom instruction, which involves a number of students working together to complete an assigned task(Towns & Grant, 1997).
2. **Hawthorne Effect -** a form of reactivity whereby subjects pretentiously adjust or modify an aspect of their behaviour being experimentally measured simply in response to the fact that they are being studied.
3. **IUPAC system of nomenclature -** International Union of Pure and Applied Chemistry System of naming chemical compounds.
4. **Blinding of Subjects-** making the subjects unaware of the treatment being giving to them in order to avoid "Hawthorne effect" (pretence and self-adjustment).
5. **Conventional Errors**- errors due to non-adherence to laid down rules or conventions.

1.10 Organization of the Research

The research report is organised into five chapters. The first chapter is the introduction which comprises the background, the problem statement, the purpose, objectives, research questions, significance, delimitation, limitations and organization of the study. The second chapter presents the review of literature related to the topic. Chapter three involves the methodology. It discusses the design of the research, the instruments and data collection procedure, and the procedure adopted for the data analysis. The fourth chapter presents analyses and discusses the results of the study while chapter five presents the summary of the research, conclusion and recommendations for improvement and lasting solution.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter provides a review of relevant literature related to the research topic. The review is done under the following subheadings:

- The meaning of group learning
- Theoretical basis for group learning
- Rationale for using group learning in chemistry
- Benefits of group learning as an instructional approach
- General characteristics of group learning

- Types of group learning
- Forms of group Learning Methods
- Group knowledge construction and negotiation processes
- The influence of group learning on retention
- The challenges of using group learning

2.1 The Meaning of Group Learning

Group learning, because of its positive impact and level of trust, has been a focus of research in recent times. Group learning, as an instructional approach, has been given different names by various researchers, all depending on the style and approach to it. While some call it "collaborative learning' in a broader sense to mean all formal and informal activities which involve peer student interaction, others call it "cooperative learning", referring to a form of student group interaction that fosters positive interdependence, individual accountability, interpersonal and small group skills, and group processing of activities through verification of information accuracy (Cuseo, 2002). "Learning community" is also used, and this involves several approaches such as linked courses, learning clusters, freshman interest groups, federated learning communities, and coordinated studies (Gabelnick, MacGregor, Matthews, & Smith, 1990). In this study, group learning is used interchangeably with cooperative learning.

According to Roger , Olsen and Kagan (1992), "cooperative learning is group learning activity organized in such a way that learning is based on the socially structured change of information between learners in groups in which each learner is held accountable for her or his own learning and is motivated to increase the learning of others".

Parker (1994) saw small group cooperative learning as classroom environment where students interact with one another in small groups while working together on academic task to attain a common goal.

Deutsch (1949) defined cooperative and competitive groups by considering the basic differences in their goal structures. That is, in cooperative groups, goals can be achieved by all or most group members, whilst in competitive groups, goals can be achieved by some but not all. Comparing the two groups, Deutsch observed greater coordination of effort, obligation to participate, attentiveness to group members, diversity of contribution, sub-division of labour, understanding of communication, pressure to achieve, productivity per unit time, orientation and orderliness in the cooperative group

David Johnson and Robert Johnson explained that, in competition, there is “a win-lose struggle” to see who is best and reach their goals only if those against whom they are competing do not, whilst in group cooperation, members help each other master assigned material, and students reach their goals only if the others in their group also reach theirs, and with individualistic learning, students learn independently, and the achievement of goals is unrelated to the success or failure of others (Johnson & Johnson, 1975).

Artz and Newman (1990) defined cooperative learning as “small groups of learners working together as a team to solve a problem, complete a task or accomplish a common goal”. In cooperative situations, individuals seek outcomes that are beneficial to all other group members (Johnson & Johnson, 1998).

2.2.0 Theoretical Basis for Group Learning

The underlying premise of Group Learning is rooted in the social constructivist epistemology. Social constructivism emphasizes the importance of culture and context in understanding what occurs in society and constructing knowledge based on this understanding (Derry, 1999; McMahon, 1997).

Social constructivism is based on some specific assumptions about reality, knowledge and learning. To understand and apply models of instruction that are rooted in the perspectives of social constructivists, it is important to know the premises that underlie them.

Social constructivists believe that reality is constructed through human activity. Members of a society together invent the properties of the world (Kukla, 2000). For the social constructivist, reality cannot be discovered; it does not exist prior to its social invention. Also, knowledge is a human product, and is socially and culturally constructed (Ernest, 1999; Gredler, 1997). Individuals create meaning through their interactions with each other and with the environment they live in.

To the social constructivist, therefore, learning is a social process. It does not take place only within an individual, nor is it a passive development of behaviours that are shaped by external forces (McMahon, 1997). Meaningful learning occurs when individuals are engaged in social activities.

The social constructivist's perspective is closely associated with many contemporary theoretical perspectives such as the cognitive development theories of Vygotsky and Bruner, and social cognitive theory of Bandura (Schunk, 2000), as well as the motivational theoretical perspective.

2.2.1 The Cognitive Development Theory

Piaget (1977) asserts that learning occurs by an active construction of meaning, rather than by passive recipients. He explains that when we, as learners, encounter an experience or a situation that conflicts with our current way of thinking, a state of disequilibrium or imbalance is created. We must then alter our thinking to restore equilibrium or balance. To do this, we make sense of the new information by associating it with what we already know, that is, by attempting to assimilate it into our existing knowledge. When we are unable to do this, we accommodate the new information to our old way of thinking by restructuring our present knowledge to a higher level of thinking.

But Vygotsky argued that the mental processes involved in the construction of meaning, as rightly articulated by Piaget, are not independent of the environment within which the construction of the knowledge is taking place. Social interaction plays a fundamental role in the cognitive processes and development.

Another important idea is that of the "Zone of Proximal Development", which Vygotsky defines as "the distance between the actual developmental level and that determined through problem solving under adult guidance or in collaboration with more capable peers." According to him, what the child is able to do in collaboration today he will be able to do independently tomorrow. According to Von Glasersfeld (1989), sustaining motivation to learn is strongly dependent on the learner's confidence in his or her potential for learning. These feelings of competence and belief in potential to solve new problems are derived from first-hand experience of mastery of problems in the past and are much more powerful than any external acknowledgment and motivation (Prawat and Floden, 1994). This links up with Vygotsky's "zone of proximal development" (Vygotsky, 1978) where learners are challenged within close proximity to, yet slightly above, their current level of development. By experiencing the successful completion of challenging tasks, learners gain confidence and motivation to embark on more complex challenges. Vygotsky, (1978) also highlighted the convergence of the social and practical elements in learning by saying that the most significant moment in the course of intellectual development occurs when speech and practical activity, two previously completely independent lines of development, converge. Through practical activity a child constructs meaning on an intrapersonal level, while speech connects this meaning with the interpersonal world shared by the child and her/his culture. Major theme in the theoretical framework of Bruner is that learning is an active process in which learners construct new ideas or concepts based upon their current/past knowledge.

Cooperative learning helps students acquire critical thinking skills. Because cooperative learning creates a situation in which students must explain and discuss various perspectives, a greater understanding of the material is obtained. Also, elaborative thinking is promoted because students give and receive explanations more often (Johnson, Johnson, & Holubec, 1986). The cognitive theoretical perspective focuses on the learning of cognitive skills and strategies. Students engage in those social learning activities that involve hands-on project-based methods and utilization of discipline-based cognitive tools (Gredler, 1997; Prawat & Folden, 1994). Together they produce a product and, as a group, impose meaning on it through the social learning process.

The use of cooperative learning also helps students clarify concepts and ideas through discussion and debate. Because the level of discussion within groups is significantly greater than in instructor led discussions, students receive immediate feedback, thus advancing the level of discussion. It is through this process of interacting with students of differing viewpoints that cognitive growth is stimulated. Emphasis is placed on learning how to cooperate in order to find the best possible solution to a problem. According to McMahon (1997), when students formulate their own solutions in this manner, then they are truly learning meaningfully.

2.2.2 Motivational Theory

Because students perceive that their success or failure is dependent upon their ability to work together as a group, students are likely to encourage each other to do whatever will help the group succeed. They are also more likely to help each other with the task(s) at hand. Therefore, cooperative learning increases student motivation to do academic work (Johnson, Johnson, & Holubec, 1986).

Cooperative goal structures are characterized by students working together to accomplish shared goals. What is beneficial for the other students in the group is beneficial for the individual and vice versa. Because students in cooperative groups can obtain a desired reward (such as a high grade or a feeling of satisfaction for a job well done) only if the other students in the group also obtain the same reward, cooperative goal structures are characterized by positive interdependence. All teams whose average quiz scores meet a preset standard receive special recognition (Slavin, 1995).

Cooperative structures lead students to focus on effort and cooperation as the primary basis of motivation. This orientation is reflected in the statement "We can do this if we try hard and work together." In a cooperative atmosphere, students are motivated out of a sense of obligation: one ought to try, contribute, and help satisfy group norms (Ames & Ames, 1984). Cooperative learning and reward structures are consistent with the constructivist approach since they encourage inquiry, perspective sharing, and conflict resolution.

2.3 Rationale for using Group Learning in Chemistry

There is a growing interest in the group learning techniques in college courses, some in science and engineering (Kogut, 1997). Johnson and Johnson both in surveys of the literature and in their own studies, determined that under most conditions groups are more productive than individual. Dougherty, Bowen, Berger, Rees, Mellon, and Pulliam (1995) reported that Group Learning (GL) had a positive impact on student retention and student performance in general chemistry. GL in chemistry is feasible and desirable. At least it increases the time students spend studying and encourages students to help each other to learn (Kogut, 1997).

According to Towns (1998), CL helps students build a feeling of community in the classroom and fosters a warmer classroom climate, which promotes learning and achievement. CL activities encourage students to engage in the type of discourse about concepts and problem solving that moves them away from rote learning strategies and toward more meaningful learning strategies. Students strive to understand different ways of explaining concepts and different perspectives on solving problems.

There are many factors supporting the use of group learning in higher education (Millis & Cottell, 1998; Tribe, 1994). The new paradigm in teaching science in higher education today emphasizes that students must "construct" their knowledge themselves:

> *"A college's purpose is not to transfer knowledge but to create environments and experiences that bring students to discover and construct knowledge for themselves, to make students of communities of learners that make discoveries and solve problems"* (Millis & Cottell, 1998; 23).

Cooperative learning also provides a sound basis for developing mutual respect, interpersonal communication, conflict resolution and group decision making skills required for success in students' future careers and lives (Michaelsen, 1994; Millis & Cottell, 1998).

Many techniques for cooperative learning have been utilized in teaching chemistry in higher education. Smith, Hinckley and Volk (1991) conducted an experimental study to test the effectiveness of a cooperative learning technique termed "Jigsaw" in a laboratory course. This technique involves a "division of tasks so that each student in a group is assigned a particular part of a lesson or unit and acts as a resource, helping the other members of the group learn that section of the material"(P: 413). The results established that students in the experimental group engaged in cooperative learning had significantly higher grades than students in the control group.

Basili and Sanford (1991) used cooperative learning in problem solving focused on concepts in chemistry. They found that students who engaged in conceptual tasks in cooperative learning had a lower proportion of misconceptions than students in the control group. Deeply examining students' verbal behaviours when they were studying in small groups, Basili and

Sanford indicated that students in the group with more interaction and mutual help made more conceptual changes than students in groups with less interaction.

Also, Dinan and Frydrychowsky (1995) applied team learning (group learning) to cover course content in an organic chemistry course. Their finding showed that students who studied within team learning environment had significantly higher mean scores in the final exam than students who had been taught by the lecture method in three prior years. They noticed that in the team learning method, course content was covered much more than in lecture method. Students in the study reported that team learning was an effective way to learn organic chemistry; team learning built better relationships among students than lecture method, and they felt responsible for their learning and team tasks.

Wright (1996) used a series of cooperative activities outside class to move students out of passive learning. For example, cooperative take-home-exams which permitted students to discuss a problem together but with their own answers, as well as, students working together in small groups over a long period of time to accomplish open-ended laboratory projects were used. The question about whether students moved to active learning, however, was not answered in the study, but students reported that group work increased their understanding of the subject matter, and they enjoyed the format of cooperative learning more than traditional learning methods.

In contrast with Wright's work, Towns and Grand (1997) devoted time for small group discussions and presentations in a graduate physical chemistry course and found out that cooperative learning moved students from rote learning strategies towards more meaningful learning strategies involving active learning and integrated thinking. Students in the study reported that they spent more time studying and studied more frequently, and that they had opportunities to develop their communication skills and build better relationships with peers through cooperative learning. Roon and friends used cooperative learning groups in a biochemistry laboratory course for first year students and reported that the faculty was positive about cooperative learning impact (Roon, Van Pilsum, Harris, Rosenberg, Johnson, Liaw, & Rosenthal, 1983).

A classical implementation of cooperative learning in chemistry is that of Hanson & Wolfskill (2000), who used a "process workshop" format in the general chemistry class at SUNY-Stony Brook. Students worked in teams of three or four on activities that involved guided discovery, critical thinking questions that help provide the guidance, solving context-rich and sometimes open-ended and incompletely defined problems, and metacognitive reflecting. Most activities focused on a single concept or issue and could be completed in a 55-minute session. Following each workshop, students completed an individual quiz on the workshop content, thus promoting individual accountability. The use of this approach led to substantially improved examination grades relative to the previous year, in which the course was conventionally taught, as well as increased attendance at recitation and tutorial sessions and improvements in student self confidence, interest in chemistry, and attitudes toward instruction

Generally, the effectiveness of cooperative learning in higher education in chemistry was found to be similar to applications of cooperative learning techniques in elementary and secondary schools. However, cooperative learning in higher education has appeared differently from the strategies used in elementary and secondary schools. While group scores or group rewards based on individual performances were emphasized in cooperative learning in elementary and secondary schools, group work in higher education required more individual accountability. In the five reports concerning chemistry education cited above, Wright (1996) used group projects in which each group handed in a single report and was scored as a group, while Smith et al. (1991) used the average score of the group members to build interdependence among members in the group. The others either did not give a grade for group learning (Towns & Grant, 1997) or used peer grading processes (Basili & Sanford, 1991; Dinan & Frydrychowsky, 1995) in which members in the group scored each other on preparation tasks and helpful behaviours to stimulate students learning and mutual help among group members.

But some teachers in higher education argued that, the purpose of grading was to indicate students' mastery of a given subject and that, when grades are used for other reasons, such as to motivate or communicate with students, they lose their meaning. They argued that, "rewarding students by putting a price tag on their efforts undermined the altruistic desire to help them" (Kohn, cited in Millis & Cottell, 1998).

Although most students in higher education are accustomed to individualistic and competitive environments, it seems easier for them to accept cooperative learning conditions when they are assured that "their own final course grades will be based on their own efforts" (Millis & Cottell, 1998, 12).

2.4 Benefits of Group Learning as an Instructional Approach

There are numerous social, psychological, academic and assessment benefits that can be derived from cooperative learning; according to Panitz (1996).

Cooperative learning promotes social interactions, thus students benefit in a number of ways socially. As students explain their reasoning and conclusions in cooperative learning, they develop oral communication skills. Also appropriate structuring for cooperative learning can be used to model the appropriate social behaviors and develop leadership, decision-making, trust building, communication and conflict-management skills necessary for employment situations and functioning in society.

Students also benefit psychologically from cooperative learning. Johnson and Johnson (1989) believe, "cooperative learning experiences promote more positive attitudes" toward learning and instruction than other teaching methodologies. Because students play active role in the learning process in GL, student satisfaction with the learning experience is enhanced. The approach also helps to develop interpersonal relationships among students. The opportunity to discuss their ideas in smaller groups and receive constructive feedback on those ideas helps to build student self-esteem. Cooperative learning creates a safe, nurturing environment because solutions come from the group rather than from the individual. Errors in conclusions and thought processes are corrected within the group before they are presented to the class.

During cooperative learning process, students tend to be inspired by instructors who take the time to plan activities which promote an encouraging environment (Janke, 1980). Receiving encouragement in a cooperative setting from both the instructor and peers helps to develop higher self-efficacy. As a result of higher self-efficacy, student grades tend to increase;

thus, providing several academic benefits for students. Research indicates that students who were taught by cooperative methods learned and retained significantly more information than students being taught by other methods. Requiring students to verbalize their ideas to the group helps them to develop more clear concepts; thus, the thought process becomes fully embedded in the students' memory. Vygotsky supports this concept in his research on egocentric speech by claiming that verbalization plays a significant role in task solution (Bershon, 1992). Discussions within the groups lead to more frequent summarization because the students are constantly explaining and elaborating, which in turn validates and strengthens thoughts.

Students also benefit from cooperative learning academically. This is so because, individuals tend to give up when they are unable to progress with a task, whereas a group of students is more likely to find a way to keep going (Johnson & Johnson, 1990). Cooperative learning calls for self-management from students because they must come prepared with completed assignments and they must understand the material which they have put together. As a result, a more complete understanding of the material is developed.

By assessment, group learning provides instant feedback to the students and the instructor because the effectiveness of each class can be observed. As instructors move around the room and observe each group of students interacting and explaining their views, they are able to detect misconceptions early enough to correct them. A few minutes of observation during each class session can provide helpful insight into students' abilities and growth.

Cooperative teaching methods make use of a variety of assessments. Instructors can use more authentic assessments such as observation, peer assessment and writing reflections.

Johnson and Johnson (1975) identified that group learning promoted mutual liking, better communication, high acceptance and support, as well as demonstrating an increase in a variety of thinking strategies among individuals in the group.

2.5 General Characteristics of Group Learning

Johnson and Johnson (1994) proposed positive interdependence, individual accountability, face-to-face interaction, social skills, and group processing as essential elements for effective group learning. These, they believe could enhance achievement, and acquisition of higher-order social, personal and cognitive skills such as problem solving, reasoning, decision-making, planning, organizing, and reflecting. They explained that, in:

- **Positive interdependence -** Team members are obliged to rely on one another to achieve the goal. If any team members fail to do their part, everyone suffers some consequences.
- **Individual accountability -** All students in a group are held accountable for doing their share of the work and for mastery of all of the material to be learned.
- **Face-to-face promotive interaction -** Although some of the group work may be parceled-out and done individually, some must be done interactively, with group members providing one another with feedback, challenging reasoning and conclusions, and perhaps most importantly, teaching and encouraging one another.
- **Appropriate use of collaborative skills -** Students are encouraged and helped to develop and practice trust-building, leadership, decision-making, communication, and conflict management skills.

- **Group processing -** Team members set group goals, periodically assess what they are doing well as a team, and identify changes they will make to function more effectively in the future.

A learning exercise only qualifies as cooperative learning to the extent that the five listed elements are present.

2.6 Types of Group Learning

Johnson *et al.* (1998) proposed three types of CL groups as follows:

Formal CL Groups (FCLG) - under this, groups last from one class period to several weeks. It may involve structuring an academic assignment or course requirement. FCLGs ensure that students involved in the intellectual work of organizing material, explaining it, summarizing it and integrating it into existing conceptual structures.

Informal CL Group (ICLG)-these are ad-hoc groups that last from a few minutes to one class period. It may be used during direct teaching to focus student attention on the material they are to learn, set a mood conducive to learning, set the expectations regarding what the class will cover, and provide closure to an instructional session.

Cooperative Based Groups (CBGs)-these are long-term heterogeneous groups with stable members whose primary purpose is for members to give each other the support, help, encouragement and assistance each needs to progress academically. CBGs provide students with long-term relationship and commitment to one another.

2.9 Forms of Group Learning Methods

Slavin (1995) has discussed some of the most researched and widely used group learning methods as follows:

Student-Team Learning Methods (STLM)-most of the studies of practical group learning methods involve this. Here the students learn as a team. Team rewards, individual accountability, and equal opportunities for success are central to this approach. There is a focus on the activities of team members to ensure that they help prepare one another for a quiz or any assessment that would be taken individually. By ensuring equal opportunities for success, high, average and low achievers are equally challenged to do their best, making the contribution of all team members valuable. Every single person's achievement contributes to the group's success. Here there is no competition among groups.

Student Team–Achievement Divisions (STAD)–under this method, students are grouped heterogeneously by ability, gender, race and ethnicity. Students learn materials in team and take quizzes as individuals. Individual scores contribute to a group score. The points contributed to the group are based on a student's improvement over previous quiz performance. Slavin considers this method appropriate for a variety of subjects, including science (Slavin, 1988).

Teams-Games-Tournaments (TGT)-this method involves the same heterogeneous teams, instructional format, and worksheets, as does the STAD. For the tournament, students from different teams are placed in groups of three students of comparable ability. Here the academic game replaces quizzes. Tournament table composition changes weekly, although the study teams stay together for about six weeks.

Slavin suggests that, TGT can be used two to three days a week in science to learn basic concepts, with laboratory activities taking place on the other two days. It is also possible to alternate TGT with STAD on a weekly basis. Students appear to enjoy the challenge of the tournaments and, because they compete with others of comparable ability, the competition is fair (Slavin, 1988).

Jigsaw–this method was developed by Aronson (1975). In this model, each student in a

five–member group is given a different piece of information that comprises only one part of the lesson. However, all students need to know all information to be successful. Students leave their original group and form an "expert group", in which all persons with the same piece of information get together, study it, and decide how best to teach it to their peers in the original group. After this is accomplished, students return to their original groups, and each teaches her/his portion of the lesson to the others in the group. Students work cooperatively in two different groups; their group and the expert group. Grades are based on individual examination performance and there is no specific reward for achievement or for the use of cooperative skills (Knight & Bohlmeyer, 1990).

Structured Dyadic Methods (SDM)–this is a structured method in which pairs of students teach each other. Students take turns as teacher and learner to learn procedures or extract information from a text, and it can be very effective in increasing student learning (Dansereau, 1988). Tutors and tutees switch roles as they present and provide solutions to a problem. Dyads earning the most points are the recognized in class each day.

Cooperative Review (CR)–mostly this approach is used prior to an assessment such as exam. Student groups make up review questions and take turns to ask the other groups the questions. The group asking the question gets a point for the question while the group initially called on, gets a point for a correct response. Then a second group can receive a point if it can add any important information to the answer.

Group Projects (GP)–here the essence is to make sure that each group member participates in the group activity. The project is planned such that every member of the group has a well defined part of the task, so that all the work does not fall on the shoulders of one person or a few. Usually a group leader is chosen who ensures that every member participates equitably. Most science teachers use cooperative laboratory/project groups.

2.7 Group Knowledge Construction and Negotiation Processes

When students interact during GL, there is intersubjectivity among the members. Rogoff, (1990) defines intersubjectivity as a shared understanding among individuals whose interaction is based on common interests and assumptions that form the ground for their communication.

Communications and interactions entail socially agreed-upon ideas of the world and the social patterns and rules of language use (Ernest, 1999). Construction of social meanings, therefore, involves intersubjectivity among individuals. Social meanings and knowledge are shaped and evolve through negotiation within the communicating groups (Gredler, 1997). Any personal meanings shaped through these experiences are affected by the intersubjectivity of the community to which the people belong. Intersubjectivity also supports people to extend their understanding of new information and activities among the group members (Rogoff, 1990; Vygotsky, 1987).

Also, a closer look at the research outcomes of group learning appears to suggest that, students in groups are engaged in the process of co-construction of meaning. That is, they are engaged in the process of making a common meaning out of their individual experiences. For instance, a study by Heller, Keith, and Anderson (1992) supports co-construction of a physics problem solution by college students. Students solving physics problems in cooperative groups produced better physics descriptions than the best student in the group working as an individual on a matched problem. It was clear that the superior group product was not the work of the best individual in the group. Indeed, even the lower ability student appears to have contributed to a problem solution (Heller & Hollabaugh, 1992).

Tobin, Tippins and Gallard (1994) believe that, in collaborative processes within groups, there is negotiation of meaning while Brown and Palinscar (1989) say the superior product of a group come from "distributed thinking" and a "joint management of argument construction" in cooperative groups. Brown and Palinscar defined argument as a logical, thought-out conceptual statement which has a structure. Construction implies the students "build" or "construct" their argument out of prior knowledge and ideas that surface in the course of the discussion. Co-construction therefore means the group members (students) are doing this together. Cooperative learning therefore provides a better environment for consensus building, negotiation of meaning and co-construction of knowledge for students.

2.8 The Influence of Group Learning on Retention

Improving college students' learning and retention is highly paramount and this can be achieved through effective involvement of the students in the learning process. According to Alexander Astin, student involvement is "the amount of physical and psychological energy that the student devotes to the academic experience" (Astin, 1999b). He said, the amount that a student learns and develops as a result of an academic program is directly related to the quality and quantity of involvement that the student has invested in the program. According to him, the effectiveness of any educational policy or program lies in its ability to increase the level of student involvement in the learning process. Astin therefore recommends that students be given more opportunity for CL activities that would increase their involvement with faculty and peers inside and outside the classroom (Astin, 1999a).

Kuhn's work, "The Effects of Student-Faculty Interaction" in the 1990s, supports Astin's theory when he stated that, student-faculty interaction motivates students to devote more effort and energy toward educationally purposeful activities.

Therefore by using group learning, the students get much involved in the learning process, argue and debate over views, refine them, and finally arrive at a consensus which is a group product. The knowledge thus becomes much internalised and then retained.

Johnson, Johnson and Smith (1991) stated: "more elaborative thinking, more frequent giving and receiving of explanations, and greater perspective taking in discussing material seems to occur in heterogeneous groups, all of which increase the depth of understanding, the quality of reasoning and the accuracy of long-term retention (P. 46). An important contemporary theory of learning within the learning sciences is the theory of knowledge building

(Bereiter, 2002; Scardamalia & Bereiter, 1996). This theory notes that knowledge in the discipline is typically constructed by ideas being made public, becoming successively refined and resulting in knowledge artifacts (technical terms, theories, documents, tools). The knowledge-building theory then suggests that students could effectively learn about a discipline by similarly engaging in group knowledge-building efforts. The processes, by which knowledge is shared, transformed, integrated, and even co-constructed through conversational interactions has been a fascination of the Learning Sciences (LS), Computer-Supported Collaborative Learning (CSCL) and Collaborative Knowledge Interoperability (CKI) communities for at least the past decade (Letsky *et al.,* 2009; Stahl, 2006; Resnick, Levine & Teasley, 1991).

2.9 The Challenges of Using Group Learning

Incorporating group learning in science and mathematics classroom is not without challenges. Initially, teachers and students have to face various challenges. The main problems which arise include the following:

- Need to prepare extra materials for class use

The need to prepare materials require a lot of work by the teachers, therefore, it is a burden for them to prepare new materials.

- There is also the fear of losing content coverage.

Group learning methods often take longer time than lectures. Thus, some teachers conclude that it is a waste of time and that, using it will affect content coverage.

- Also, some researchers argue that students cannot be trusted in acquiring knowledge by themselves. To them, teachers must tell their students what and how to learn. Only the teachers have the knowledge and expertise.
- Lack of familiarity with group learning methods is another challenge.

Group learning is new to some teachers, so they need time to get familiar with the new method. Intensive in-service course can be implemented to overcome the problem.

- Lack of skills to work in group is also a problem. (Zakaria, E., & Iksan, Z., 2006: 38)

Teachers are often concerned with students' participation in group activities. They think thatstudents lack the necessary skills to work in group. However, according to Ong and Yeam (2000) teachers should teach the missing skills and/or review and reinforce the skills that students need.

According to Sharan, (2010), due to the fact that group learning is constantly changing, there is the possibility that teachers may become confused and lack complete understanding of the method and also, teachers implementing group learning may be challenged with resistance and hostility from students who believe that they are being held back by their slower teammates or those who are less confident and feel that they are being ignored or demeaned by their teammates.

CHAPTER THREE

METHODOLOGY

3.0 Overview

The chapter discusses the research design, context of the study, population, sample size and sampling technique and research instruments. It also includes validity and reliability of the instruments, intervention, data collection procedure and data analysis.

3.1 Research Design

"The pre-test, post-test small group control experimental" and "descriptive survey design" was used for the study. Experimental design was considered because it was the best design to establish the true effect of group learning on students' understanding and retention of chemical concepts in science, since its central aim is to establish cause and effect. Also, since the design allows for control of variables, the outcome could be reliable and well suited for generalisation. The subjects were measured using a pre-test and after they had been taken through the intervention, a post-test was administered to them. Later, the descriptive survey design was used to enable the researcher investigate the impression of the students regarding group learning and their attitude towards learning of chemistry after using group learning.

3.2 Population of the Study

The aim of this study was to investigate the relative effectiveness of group learning on the academic achievement of college of education students in chemistry. Therefore, the population for the study consisted of all first year students studying integrated science in Bagabaga College of Education.

3.3 Context of the Study

The study was conducted during the first semester of the 2010/2011 academic year in the science department of Bagabaga College of Education, Tamale. The first year students were used for the study. Bagabaga College of Education pursues a 3-year diploma in basic education programme with integrated science as one of the core subjects. The first year, first semester science includes some aspects of inorganic chemistry, biology and physics. Also, the credit system is practised. Usually the first semester covers a period of 16 weeks, starting from September to February. Both continuous assessment (CA) marks of 40% and the end of semester examination mark of 60% were used to assess students. The post-test scores were computed as 25% of the 40% CA marks.

The study was carried out within a period of five weeks, starting from the 3rd week. The normal tutorial period was used. In fact a tutor from the English Department was made to administer the survey questionnaires to prevent the students from pretence and self-adjustment **(Hawthorne effect)**. "The **Hawthorne effect** is a form of reactivity whereby subjects adjust or modify an aspect of their behaviour being experimentally measured simply in response to the fact that they are being studied (Landsberger, 1950).

3.4 Sample Size and Sampling Techniques

Two first year classes, C (experimental group) and D (control group) containing 50 and 52 students respectively were selected through purposive sampling method for the study. The purposive sampling method was used because of the fact that, the students in those classes generally performed below their counterparts in the other classes.

Bagabaga College of Education trains Science, Mathematics, English and Social Studies teachers, as well as specialised Technical and French teachers for Primary and Junior High Schools. By the academic structure, all students study science, except those studying French. The technical students are selected based on the strength of their Mathematics and Science grades while the Social Studies classes are considered for all based on their passes in Mathematics and Science. As a result, students in those classes showed marked deficiency in science, especially, in chemistry related areas. A total sample size of 102 was used.

3.5 Research Instruments

Two main instruments were used for data collection. These included test and survey questionnaire. The test instrument consisted of Chemical Concepts Achievement Pre-test (CCAPrT) and Chemical Concepts Achievement Posttest (CCAPoT) and Chemical Concepts Retention Test CCRT developed by the author. The test items for the pre- and post-tests consisted of 40 selected chemical concept-oriented questions drawn from the Foundation Development Course (FDC 114) examinations past papers set by the Institute of

Education, University of Cape Coast for the past three years. The test items were closed multiple-choice test items and short-answered subjective type items.

A 5-point Likert-scale style survey questionnaire, consisting of 24 items, ranging from strongly agree to strongly disagree was used to examine the views and attitudes of the students before and after using group learning. These were called Chemical Concepts Pre-Attitude Test (CCPrAT) and Chemical Concepts Post-Attitude Test (CCPoAT) respectively. The scale was valued as follows: Strongly Agree (SA) = 4, Agree (A) = 3, Not Sure (NS) =2, Disagree (D) = 1 and Strongly Disagree (SD) = 0.

3.6 Validity of Research Instruments

Patton (2007) defines validity of an instrument as how well it measures the intended concepts. Two types of validity were addressed. These include face validity and content validity of the instruments. Face validity was achieved through inspection by the researcher's supervisor and the unit head of Science department in Bagabaga College of Education. The validators determined the suitability of the content material, clarity of the test items and instructions. The content validity of the instrument was achieved through pre-testing and weaknesses identified corrected. The CCAPoT was examined by the supervisors to identify and correct any inconsistencies between the test items.

3.7 Reliability of Research Instruments

According to Joppe (2000), reliability refers to the extent to which results are consistent over time, and becomes an accurate representation of the total population being considered. Internal consistency estimate of reliability technique was employed to determine the reliability of the instruments. The test instruments were pilot tested on a class of 40 first year students in Tamale College of Education, Tamale and Cronbach alpha Coefficient of CCAPrT, CCPoT and CCAT were found to be 0.71, 0.77 and 0.82 respectively. This agreed with Patton's model which says, for test instrument which measures cognitive abilities to be accepted, it should have Cronbach alpha Coefficient reliability exceeding 0.70 (Patton, 2007).

3.8 The Intervention

The author was the teacher in this exercise. The normal class session was used. Each class had 4 credit hours in a week for science, 2 for biology and 2 for chemistry. To have enough time, there was a negotiation with colleagues in the department to use 3 credit hours out of the 4, which they agreed.

To establish the bases of the students, the teacher taught both the control and experimental groups some selected topics, namely elements; atomic structure; electronic configuration and isotopes, during the first and second weeks, without any group work. The two groups were then made to write a test which consisted of 25 multiple-choice and 15 fill-in type items. These were scored and used as the pre-test scores for the study. 5-point Likert-Scale student attitude survey questionnaires (appendices AI), consisting of 24 items were given to the students in the experimental group to complete before the treatment.

Treatment

The author used Student Team Achievement Division (STAD) model which was developed by Slavin (1988) in Formal Cooperative Learning Groups (FCLG) which last from one class period to several weeks (Johnson, Johnson, & Smith, 1998). Group learning using STAD consists of a regular circle of instructional activities as follows:

- Presentation of the lesson
- Students work on worksheets in their groups to master assigned materials
- Students take individual quizzes
- Team scores are computed based on group members' improvement scores and high scoring groups are recognised in class.

The experimental group was assigned to 10 heterogeneous groups of 5 by the teacher. The groups were formed randomly by assigning numbers 1-10 to each roll. The ones, twos, threes etc. were allowed to form groups. This was done to satisfy the heterogeneity principle of the groups. The lesson then proceeded in the following steps:

- the teacher presented the lesson using direct teaching approach
- the teacher provided the students with copies of worksheet which was previously developed by the teacher as guided discovery
- the students started working on the worksheets while the teacher moved round and watched the social skills, level of cooperation, level of interaction and participation.
- the teacher guided the students throughout the exercise
- the students were given assignment to do individually
- the individual scores were computed and the average scores taken as group scores. Performing groups were acknowledged in class.

This circle continued until the five topics were covered in five weeks as shown in the order below:

Week	**Topic**
1	Writing of chemical formulae

2	Naming of chemical compounds
3	Chemical bonding
4	Balancing of chemical equations
5	Mole concept

In each of these lessons, at least 2hour 20minutes of the 3 credit hours was used for small group discussion, sharing and solving of problems in the experimental class. Also some group assignments were given to students to do after classes. These were, however, excluded in the control class. The researcher monitored the students' involvement in the group activities and asked them to encourage and help one another to understand what the group was doing. The students were made to understand that both their individual and groups scores were to contribute to their Continuous Assessment (CA) marks and this made them serious with whatever they were doing. Also, for every group activity the average of individual scores in a group was computed and used as a single score for all.

After the last lesson in the 5th week, an achievement test (post-test), consisting of 25 multiple-choice items and 15 fill-in questions covering the treated topics was conducted for the two groups.

Also, 5-point Likert-Scale student attitude survey questionnaires (appendices AII), consisting of 24 items were given to the students in the experimental group to complete after the treatment. These were meant to assess the students' attitude toward teamwork, understanding of the course, perception about chemistry after using group learning as an instructional method and their level of co-operation.

After 4 weeks of the intervention, the same post-test was administered to the two groups to measure the level of retention of learnt chemical concepts.

3.9 Data Collection Procedure

A pre-test was administered to both the control and experimental groups before treatment. The rationale was to find out the level of students' understanding of the chemical concepts before the intervention. The experimental group was taught for a period of five weeks using group learning approach, while their control group counterparts were taught without group learning. After the treatment, a post-test was administered to the two groups. The purpose of this test was to determine the achievement of the two groups. The test consisted of 25 multiple choice test items and 15 fill-in type items. All the items were based on the selected first year, first semester chemistry topics that were taught. Same post-test was administered after four weeks as a surprise test to measure the retention of both the control and experimental groups.

Student attitude survey questionnaires (appendices AI & AII) were given to the students in the experimental group to complete before the treatment and at the end of the 5 weeks study period. To minimise "Hawthorne effect" (pretence and self-adjustment) as much as possible, a tutor from the English Department of Bagabaga College of Education was made to administer the questionnaires. The questionnaires were meant to assess the students' attitude toward teamwork, understanding of the course, perception about chemistry after been taught using group learning as an instructional method and their level of co-operation.

3.10 Data Analysis Procedure

Data were analysed according to the research questions. Mean scores and standard deviations were determined from the pre-test, post-test and retention-test. Research questions 1and 2 were formulated into hypotheses and analysed using Statistical Package for Social Sciences (SPSS) version 16.0. Paired t-test for dependent samples was used to investigate any differences that existed between the experimental and control groups in performance and retention at a confidence level of 0.05, while the Levene's test for equality of variances was used to investigate the differences in research question 3 at 0.05 confidence level. Most behavioural scientists agree that alpha significant level of 0.05 is reasonable to be used in a research (Vernoy & Kyle, 2002).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

The chapter presents the results of the study and discussions of findings in the light of available literature.

4.1 Results Presentation and Analysis

The results of the study were presented in the light of the research questions as follows:

Research Question 1: Are there any differences between the pre-test and post -test mean scores of students taught using group learning?

To determine if there were differences between the pre-test and post -test scores, mean scores and standard deviations for both tests were computed. The mean score for the control group pre-test was 55.21 (SD = 9.81) while the mean score for the experimental group was 55.10 (SD = 10.03). The mean score of the pre-test in the control group was slightly higher than that of the experimental group before the intervention. However, the post-test results showed that the mean score for the control group was 59.40 (SD = 12.06), while the mean score in the experimental group was 75.40 (SD = 12.06) as shown in table 1 below. Clearly the experimental group did better than the control group after the intervention.

Table 1: Paired t-test for dependent samples analysis according to pre- and post-tests scores of both control and experimental groups.

Groups Compared	Test	Mean Test Scores	Standard Deviation	t- Value	p- Value
Control	Pre-test	55.21	9.81	0.08	0.938*
Experimental	Pre-test	55.10	10.03		
Control	Post-test	59.40	12.06	-9.48	7.359×10^{-18}∞
Experimental	Post-test	75.40	12.06		

* = Not Significant; $p > 0.05$. ∞ = Significant; $p < 0.05$

Hypothesis Testing

To determine whether there was statistically significant difference in the enhanced performance of students taught using group learning strategy, research Question 1 was formulated into a null hypothesis as shown in page 4:

H_{O1}: There is no significant difference between the pre- and post-tests mean scores of students taught using group learning strategy.

The t-test for independent samples was used to determine whether differences between the two groups were significant. The t-test analysis of the pre-test mean scores of both groups showed no significant difference between the two groups at t = 0.08($t_{0.05}$ =1.984) and p=0.938 ($p > 0.05$) (table 1). This showed that there was no significant difference in performance between the two groups before the study and that the two groups were comparable on their initial level of understanding of chemical concepts. However, there was significant difference between the mean scores of both groups in the post-test. The t-test analysis of the mean scores gave t = -9.48 ($t_{0.05}$ =1.984) and $p=7.359\times10^{-18}$ ($p < 0.05$) at 0.05 significant level (table 1).

This indicates that the experimental group, after the intervention, had improved upon their understanding of chemical concepts better than the control group. The statistical significance of the differences in performance between the two groups was attributed to the use of group learning. Hence the null hypothesis could not be retained.

Research Question 2: Are there any differences between the post-test and retention-test mean scores of students after using group learning?

Mean scores and standard deviations of the post-tests and retention-tests for both the experimental and control groups were determined using descriptive statistics. The mean score for the control group in the post-test was 59.51 (SD = 12.01) while that of the experimental group was 75.40 (SD = 12.06) at 0.05 significant level (table 2). The mean score of the experimental group was higher than that of the control group. In the retention test, the mean score for the control group was 52.30 (SD = 10.12) while the mean score for the experimental group was 74.46 (SD = 12.02). The mean scores show a drop in both groups, however, the margin of drop indicates that the experimental group had better retention than the control group (table 2). While the margin of drop in the control group was 7.21, that of the experimental group was 0.94.

Table 2: Paired t-test for dependent samples analysis according to post- and retention-tests scores of both control and experimental groups

Group	Test	Mean Score	Standard Deviation	t-value	p-value
Control	Post-test	59.51	12.01	6.61	$1.802\times10^{-9\infty}$
Control	Retention test	52.30	10.12		
Experimental	Post-test	75.40	12.06	0.52	0.604^{*}
Experimental	Retention test	74.46	12.02		

* = not significant at 0.05; $p>0.05$ ∞ = significant at 0.05; $p<0.05$ $t_{0.05}=1.984$

Hypothesis Testing

To determine whether there was statistically significant difference in the retention of chemical concepts after using group learning, research Question 2 was formulated into a null hypothesis as shown in page 4:

$H_{O\,2}$: There is no significant difference between the post-test and retention-test mean scores of students after using group learning.

By facial observation of the mean scores, the experimental group appeared to have done better than their control group counterparts in the retention-test (table 2). Paired t-test was used to determine whether there was significant difference between the two groups in the retention-test. The t-test analysis of the post-test scores and retention test scores for the control group showed significant difference, given $t = 6.61 (t_{0.05}=1.984)$ and $p = 1.802\times10^{-9}$ $(p < 0.05)$ (table 2). However, analysis of the post- and retention-tests scores for the experimental group showed no significant difference, given $t = 0.52$ $(t_{0.05}=1.984)$ and $p = 0.604$ $(p > 0.05)$ (table 2). This indicates that the margin of drop in the control group was significantly higher than that of the experimental group, meaning the experimental group's level of retention was higher than that of the control group. It was therefore concluded that the use of group learning resulted in the differences in retention of chemical concepts among the two groups. Hence the null hypothesis could not be retained.

Research Question 3: Are there any differences in the attitude of students toward the learning of chemistry before and after using group learning?

To answer this question, the mean scores and standard deviations of the pre- and post-attitude tests scores of the students were computed and analysed (table 3). The mean score of the pre- attitude test of the experimental group was 92.08 (SD = 20.10) while the post-attitude test results gave a mean score value of 136.54 and 16.93 SD (table 3). Hence the mean score of the post-attitude test was higher than the pre-attitude test.

Using the t-test for independent sample, differences between the attitudes of the students towards the learning of chemical concepts before and after the intervention were assessed. The result of the analysis is presented in the table below:

Table 3: Paired t-test for dependent samples analysis according to pre- and post-attitude tests scores of the experimental group.

Group	Test	Mean Score	Standard Deviation	t-value	p-value
Exp.	Pre-Att. test	92.08	20.10	-16.71	$2.33788 \times 10^{-14\infty}$
Exp.	Post-Att. test	136.54	16.93		

∞ = significant at 0.05 ($p<0.05$); $t_{0.05}=2.07$

H_{O3}: There is no significant difference in the attitude of students toward the learning of chemical concepts before and after using group learning.

In testing this hypothesis, the pre- and post-attitude test scores of the students were analysed using Paired t-test. The analysis showed that there was statistically significant difference between the two test scores at $t = -16.71$ ($t_{0.05} = 1.984$) and $p = 2.33788 \times 10^{-14}$ ($p<0.05$). This implies that the use of the group learning to teach the chemical concepts showed positive change with regard to the attitude of the students towards the learning of chemical concepts after the intervention. It was therefore concluded that the use of group learning resulted in the positive change of the students' attitudes towards the learning of chemical concepts. Hence it was tenable to reject the null hypothesis.

4.2.0 Discussion of Results

The discussion is divided into 3 main sections and was done in the light of existing literature. The first and second sections discuss the statistical findings related to research questions one and two respectively while the third section discusses the findings of research question three. The third section is discussed in the light of the respondents' perspective on teamwork, cooperation among group-mates, level of involvement, understanding of the subject, knowledge retention, motivation to learn, attitudes of students towards learning of chemistry and thinking together. It also discusses the statistical analysis of the general attitude test scores.

4.2.1 Research Question 1

The t-test analysis for the pre-test mean scores of both the control and experimental groups showed no significant difference ($t = 0.08$; $p > 0.05$) (table 1). This means that the two groups were comparable on their initial level of understanding of chemical concepts. However, the analysis of the post-test mean scores for both groups showed significant difference in favour of the experimental group, ($t = -9.48$; $p < 0.05$) at 0.05 significant level (table 1). This indicates that the experimental group, after the intervention, had improved upon their understanding of chemical concepts better than the control group. This agreed with an experimental study conducted by Smith, Hinckley and Volk, (1991) to test the effectiveness of a cooperative learning technique termed "Jigsaw" in a laboratory course. The results established that students in the experimental group engaged in cooperative learning had significantly higher grades than students in the control group. Also, Basili and Sanford (1991) used cooperative learning in problem solving focused on concepts in chemistry and found that students who engaged in conceptual tasks in cooperative learning had a lower proportion of misconceptions than the students in the control group. Dinan and Frydrychowsky (1995) conducted similar study by applying team learning (group learning) to cover course content in an organic chemistry course and their finding showed that students who studied within team learning environment had significantly higher mean scores in the final exam than students who had been taught by the lecture method in three prior years.

4.2.2 Research Question 2

The mean score for the control group in the post-test (M=59.51; SD = 12.01) and that of the experimental group (M= 75.40; SD = 12.06) showed that, the mean score of the experimental group was higher than that of the control group. In the retention test, the mean score for the control group was 52.30 (SD = 10.12) while the mean score for the experimental group was 74.46 (SD = 12.02). Again, the mean score of the experimental group was slightly higher than that of the control group (table 2). However, the mean scores showed a drop in both groups. The margin of drop appeared to suggest that the experimental group had better retention than the control group. Whilst the margin of drop in the control group was 7.21, that of the experimental group was 0.94.

The t-test analysis of the post-test mean score and retention-test mean score for the control group showed significant difference at $t = 6.61$($t_{0.05}$=1.984) and $p = 1.802\times10^{-9}$ ($p < 0.05$)

(table 2). However, t-test analysis of the post- and retention-tests mean scores for the experimental group showed no significant difference at $t = 0.52$ ($t_{0.05}=1.984$) and $p = 0.604$ ($p > 0.05$) (table 2). This indicates that the margin of drop in the control group was significantly higher than that of the experimental group. This means that, the experimental group's level of retention was higher than that of the control group and this was attributed to the use of group learning. Hence the null hypothesis that, "there is no significant difference between the post-test and retention-test mean scores of students after using group learning", could not be retained.

This finding is in line with that of Dougherty, Bowen, Berger, Rees, Mellon, and Pulliam (1995) which reported that group learning had a positive impact on student retention and student performance in general chemistry. Johnson, Johnson and Smith (1991) stated: "more elaborative thinking, more frequent giving and receiving of explanations, and greater perspective taking in discussing material seems to occur in heterogeneous groups, all of which increase the depth of understanding, the quality of reasoning and the accuracy of long-term retention" (P. 46).

4.2.3 Research Question 3

This section is discussed in the light of the respondents' perspective on teamwork, cooperation among group-mates, level of involvement, understanding of the subject, knowledge retention, motivation to learn, attitudes of students towards learning of chemistry and thinking together. It also discusses the statistical analysis of the general attitude test scores.

4.2.3.1 Views of respondents on teamwork

The category related to teamwork consisted of two statements (Appendices AI & AII). Analysis of the data collected showed that, an average of 71.5 (35.8%) of the responses agreed with the statements in the pre-attitude test. This however increased to 139.0 (69.5%) in the post-attitude test (Appendices BI and BII), showing that, after the intervention students had improved and that, majority of them see group learning as positive. The finding is supported by Morgan and Bobbette (2003), who found out that 100% of the students he surveyed, described the group learning as less stressful than individual learning and the students also expressed feeling of support by their teammates.

30.5% of the responses showed that some of the students did not agree or simply not sure about the statements. Similar finding was found by Morgan and Bobbette (2003) who concluded that, though the students were doing all the work, they did not trust their partners. This could be due to the fact that, although they prefer to work in a team, they also preferred to work independently as well.

4.2.3.2 Responses on cooperation among group-mates

This category is related to cooperation among group-mates. It consisted of four statements (Appendices AI & AII). Analysis of the data showed that an average of 89.0 (44.5%) of the responses agreed or strongly agreed to the statements in the pre-attitude test. The figure increased to 131.8 (65.9%) in the post-attitude test after the intervention (see Appendices BI and BII). This is supported by Felder (1996), who observed that the students studied together, partied together and complained with unusual unanimity when they were unhappy about something in the curriculum. Similarly, research by Gupta (2004) showed that 89% of the students "agreed" that their group members provided support and encouraged their efforts in learning.

4.2.3.3 Views of respondents on level of involvement

The category related to students' level of involvement in the learning process consisted of four statements, (Appendix AI & AII). Analysis of the data collected showed that an average of 86.5 (43.3%) of the responses agreed or strongly agreed to the statements in the pre-attitude test. The figure, however, increased to 131.8 (65.9%) in the post-attitude test after the intervention (see Appendices BI and BII). This showed that majority of the respondents supported the accession that group learning increased their level of involvement in the teaching and learning process.

Alexander Astin, defined "student involvement" as "the amount of physical and psychological energy that the student devotes to the academic experience" (Astin, 1999b). He said, the amount that a student learns and develops as a result of an academic program is directly related to the quality and quantity of involvement that the student has invested in the program. According to him, the effectiveness of any educational policy or program lies in its ability to increase the level of student involvement in the learning process. Astin therefore recommended that students be given more opportunity for group learning activities that would increase their involvement with faculty and peers inside and outside the classroom (Astin, 1999a). Thus, his recommendation agrees with the results obtained above.

4.2.3.4 Views of respondents on understanding of the subject

This category consisted of three statements (Appendices AI & AII). The data obtained showed that an average responses of 83.7 (41.9%) agreed or strongly agreed to the statements in the pre-attitude test. However, the figure increased to 133 (66.5%) in the post-attitude test after the intervention (see Appendices BI and BII). This finding is supported by Ross and Fulton (1994), who concluded that the students' confidence in their ability to understand complex concepts was more effective in cooperative groups. Research by Mourtos and Allen (2000) also showed that the cooperative learning has helped the students in the understanding of their lesson. Finding by Mohd Zaki and Talib (2003) and Gupta (2004) showed that cooperative learning could increase the students' understanding of materials and effectively helped the students to learn.

4.2.3.5 Views of respondents on knowledge retention

The category related to "knowledge retention" consisted of one statement (Appendices AI & AII). Analysis of the data collected showed that, 106 (53.0%) of the responses agreed or strongly agreed with the statements in the pre-attitude test. This however increased to 138 (69.0%) in the post-attitude test (Appendices BI and BII), showing that, after the intervention students had improved and that, majority of them believed group learning could increase their retention rate. This is in line with the finding of Iqba, M. (2004) that, CL is a potent contributor to enhance the retention of low achievers.

4.2.3.6 Views of respondents on motivation to learn

The category related to students' "motivation to learn" consisted of four statements (Appendices AI and AII). Analysis of the data collected showed that, an average of 107.5

(53.8%) of the responses agreed or strongly agreed with the statements in the pre-attitude test. This however increased to 145.8 (72.9%) in the post-attitude test (Appendices BI and BII), showing that, after the intervention students had improved and that, majority of them were motivated to learn chemistry. Johnson, Johnson, & Holubec, (1986) reported that cooperative learning increases student motivation to do academic work. According to Von Glasersfeld (1989), sustaining motivation to learn is strongly dependent on the learner's confidence in his or her potential for learning. These feelings of competence and belief in potential to solve new problems are derived from first-hand experience of mastery of problems in the past and are much more powerful than any external acknowledgment and motivation (Prawat and Floden 1994).

4.2.3.7 Responses on attitudes of students towards learning of chemistry

This category consisted of three statements. The analysis of the data obtained showed that an average response of 92.3 (46.2%) agreed or strongly agreed to the statements in the pre-attitude test. However, the figure increased to 134.7 (67.4%) in the post-attitude test after the intervention (see Appendices BI and BII). This indicates that the students' attitudes towards learning of chemistry improved positively after the intervention. This finding is supported by Ross and Fulton (1994), who concluded that the students' confidence in their ability to understand complex concepts were more effective in cooperative groups.

4.2.3.8 Views of respondents on thinking together

This category consisted of three statements. The data obtained showed that an average responses of 100.3 (50.2%) agreed or strongly agreed to the statements in the pre-attitude test. However, the figure increased to 140.3 (70.2%) in the post-attitude test after the intervention (see Appendices BI and BII). Johnson and Johnson (1975) identified that cooperative learning promoted mutual liking, better communication, high acceptance and support, as well as demonstrated an increase in a variety of thinking strategies among individuals in the group. A study by Heller, Keith, and Anderson (1992) supports co-construction of a physics problem solution by college students. Students solving physics problems in cooperative groups produced better physics descriptions than the best student in the group working as an individual on a matched problem. Tobin, Tippins and Gallard (1994) believe that, in collaborative processes within groups, there is negotiation of meaning while Brown and Palinscar (1989) say the superior product of a group come from "distributed thinking" and a "joint management of argument construction" in cooperative groups.

Hypothesis Testing

In testing the hypothesis that "there is no significant difference in the attitude of students toward the learning of chemical concepts before and after using group learning", the overall pre- and post-attitude test scores of the students were analysed using t-test. The analysis showed that there was statistically significant difference between the two test scores ($t = -16.71$; $p>0.05$) at 0.05 significant level (see table 3). This implies that the use of the group learning to teach the chemical concepts showed attitudinal differences with regard to the attitude of the students towards the learning of chemical concepts before and after the intervention. It was therefore concluded that the use of group learning resulted in the differences in the students' attitudes towards the learning of chemical concepts. Hence it was tenable to reject the null hypothesis.

4.3 Conclusion

Overall, the findings of the research showed that the effects of group learning on students' understanding of chemical concepts were positive. For example, the group learning benefited students in many ways. From the 5-point Likert-scale questionnaires used in this study, the findings showed that group work is effective in improving students' understanding of chemical concepts in science; promotes better retention of chemical concepts and develops positive attitudes of students towards the learning of chemistry. Difficult materials and concepts can be taught and learned effectively in groups. Group work helped the students to learn and care about others. Teamwork helped the students to feel less stressful and motivated them to work harder to score points for themselves and for their teammates. There was mutual liking, better communication, high acceptance and support, as well as demonstrated increase in a variety of thinking strategies among individuals in the group (Johnson & Johnson, 1975). Within groups, there was negotiation of meaning (Tobin, Tippins & Gallard, 1994) which resulted in the superior product.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Overview

This chapter presents the summary of the study, conclusion and the recommendations/ suggestions for further research.

5.1 Summary

The pre-test, post-test small group control experiment with an element of descriptive survey study was used to examine the effects of group learning on college students' understanding of chemical concepts in science. Chemistry is an 'enabling science' as. Chemistry is also a highly conceptual discipline which requires an ability to deal with symbols at all levels. Its core concepts are essential for the understanding of almost every aspect of science (Rao & Lakshmi, 2009). Thus, the aim and professional obligation of a chemistry teacher is to make the subject accessible in such a way that maximum meaningful learning can take place. The objectives of this study included: (1) to determine the effectiveness of group learning on first year colleges of education students' understanding of some selected chemical concepts in science; (2) to examine the effectiveness of group learning on the retention of chemical concepts learnt; (3) to examine the attitudes of students toward learning of chemistry before and after using group learning.

This study was conducted in Bagabaga College of Education, Tamale. The students of two first year classes, C and D containing 50 and 52 students respectively, were selected through purposive sampling method for the study. The C class was the experimental group while the D class was the control group.

Two main instruments were used for data collection. These included test and survey questionnaire. The test instrument consisted of Chemical Concepts Achievement Pre-test (CCAPrT); Chemical Concepts Achievement Post-test (CCAPoT) and Chemical Concepts Retention Test CCRT. The test items for the pre- and post-tests consisted of 40 selected chemical concept-oriented questions drawn from the Foundation Development Course (FDC 114) examinations past papers set by the Institute of Education, University of Cape Coast for the past three years. The test items were closed multiple-choice test items and short-answered subjective type items.

A 5-point Likert-scale style survey questionnaire, consisting of 24 items, ranging from strongly agree to strongly disagree was used to examine the views and attitudes of the students before and after using group learning. These were called Chemical Concepts Pre-Attitude Test (CCPrAT) and Chemical Concepts Post-Attitude Test (CCPoAT) respectively (Appendices AI and AII).

Paired t-test was used to determine the significant differences that existed between the experimental and control groups in terms of performance and retention at 0.05 confidence level, while the Levene's test for equality of variances was used to investigate the differences in research question 3 at 0.05 confidence level. The t-test analysis of the results provided the following finding:

1. There was no significant difference in the students' level of understanding of chemical concepts between the control and experimental group in the pre-test ($t = 0.08$; $p > 0.05$). However, there was significant difference between the two groups in the post-test ($t = -9.48$; $p < 0.05$) in favour of the experimental group after the group learning.

2. The analysis of the post-test and retention-test mean scores of the control group showed significant difference [$t = 6.61 (t_{0.05}=1.984)$; $p < 0.05$]. However, the analysis of the post- and retention-tests mean scores for the experimental group showed no significant difference [$t = 0.52 (t_{0.05}=1.984)$; $p > 0.05$] showing that the experimental group's level of retention was higher than that of the control group.

3. There was statistically significant difference between the pre-attitude test and post-attitude test mean scores ($t = -16.71$; $p < 0.05$) showing attitudinal differences with regard to the attitude of the students towards the learning of chemical concepts before and after the intervention.

5.2 Conclusion

Based on the statistical analysis and the findings of the study, the researcher concluded that:

- Group learning is effective as a technique for enhancing students' understanding of chemical concepts in science.

- Group learning promotes better retention of chemical concepts when it is used as a technique for teaching science, especially chemistry.
- Students' attitude towards the learning of chemistry was positive after using group learning as a teaching strategy.
- Group learning encouraged perspective sharing and negotiation of meaning among the students which resulted in higher performance and retention in the study.
- Since the results of this study have shown that the students prefer group learning in the classroom, tutors should be motivated to use the group learning techniques in the classroom.

5.3 Recommendations/Suggestions for further Research

Based on the outcome of the study and conclusion drawn, the researcher made the following recommendations:

1. That, group learning is effective as a technique for enhancing students' understanding and retention of chemical concepts in science. Therefore science tutors in Bagabaga College of Education could apply same to improve students' understanding and performance in science.
2. The study examined only the academic achievement and retention of students in selected chemical concepts, as well as attitude and motivation towards the subject. Thus, further studies are needed to examine the effectiveness of group learning on much content coverage of science.

3. This study was carried out in Bagabaga College of Education, Tamale. A larger scale should be carried out to compare the effectiveness of group learning on students' understanding of chemistry from other colleges in Ghana.
4. During the study, both the control and experimental groups stayed together after classes and it is possible that they shared some ideas among themselves. Therefore further research would require that the two groups are considered on separate grounds to avoid this possibility which could affect the reliability of the results.
5. Using group learning as a teaching technique requires much preparation and commitment. Therefore it is appropriate to organize some in-service training for tutors on how to use group learning in classroom.

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APPENDIX A (I)

Survey Questionnaire for Students-(Pre-Attitude Test)

This instrument is designed to solicit your views concerning group learning and its effects on the learning of chemistry. Using the 5 point Likert-Scale below, tick the appropriate number on the right which corresponds to your view about the statement on the left. Please be objective as much as possible.

Strongly Agree (SA) = 4, Agree (A) = 3, Not Sure (NS) =2, Disagree (D) = 1 and Strongly Disagree (SD) = 0

STATEMENT	SA	A	NS	D	SD	
Views on Group Learning						Total
1. I like group learning because it gives me the opportunity to share ideas with my colleagues	4	3	2	1	0	
2. I like group learning because it is better than individual learning	4	3	2	1	0	
Cooperation among Group-Mates						
3. I often ask for help or assist my colleagues who ask me for help	4	3	2	1	0	

4. I don't feel isolated during group activities	4	3	2	1	0	
5. I do tolerate my colleagues' views during group activities	4	3	2	1	0	
6. I learn a lot from my friends during group activities	4	3	2	1	0	
Level of Involvement						
7. I take active part in whatever my group does	4	3	2	1	0	
8. Group activities and group assignments make me learn almost all the time	4	3	2	1	0	
9. We meet regularly to study and solve group problems	4	3	2	1	0	
10. Group work makes me active	4	3	2	1	0	
Understanding of the Subject						
11. Group learning makes me understand chemistry better	4	3	2	1	0	
12. Questions from group-mates help me to think more deeply about the problem	4	3	2	1	0	
13. When I get confused in group work my friends correct me	4	3	2	1	0	
Knowledge Retention						
14. Group learning helps me to remember what I learn	4	3	2	1	0	
Motivation to Learn						
15. Group work encourages me to study always	4	3	2	1	0	
16. I feel happy whenever my group score high mark	4	3	2	1	0	

17. With the help of my friends I am able to solve some problems I couldn't solve alone and I feel happy	4	3	2	1	0	
18. I like to always learn chemistry in groups	4	3	2	1	0	
Attitudes of Students toward Learning of Chemistry						
19. I think I can learn and understand chemistry very well	4	3	2	1	0	
20. Chemistry is not too difficult to understand	4	3	2	1	0	
21. learning chemistry in group makes it easier for me	4	3	2	1	0	
Thinking Together						
22. We argue a lot in group work before we agree one answer	4	3	2	1	0	
23. I am always convinced that the answers we agree on are correct	4	3	2	1	0	
24. I try to convince my group mates to agree with my views	4	3	2	1	0	

APPENDIX A (II)

Survey Questionnaire for Students--(Post-Attitude Test)

This instrument is designed to solicit your views concerning group learning and its effects on the learning of chemistry. Using the 5 point Likert-Scale below, tick the appropriate number on the right which corresponds to your view about the statement on the left. Please be objective as much as possible.

Strongly Agree (SA) = 4, Agree (A) = 3, Not Sure (NS) =2, Disagree (D) = 1 and Strongly Disagree (SD) = 0

STATEMENT	SA	A	NS	D	SD	
Views on Group Learning						Total
1. I like the group learning because it gave me the opportunity to share ideas with my colleagues	4	3	2	1	0	
2. I like group learning because it is better than individual learning	4	3	2	1	0	
Cooperation among Group-Mates						

3. I often asked for help or assisted my colleagues who asked me for help	4	3	2	1	0	
4. I did not feel isolated during group activities	4	3	2	1	0	
5. I did tolerate my colleagues' views during group activities	4	3	2	1	0	
6. I learnt a lot from my friends	4	3	2	1	0	
Level of Involvement						
7. I took active part in whatever my group did	4	3	2	1	0	
8. Because of the group activities and group assignments, I learnt almost all the time	4	3	2	1	0	
9. We met regularly to study and solve group problems	4	3	2	1	0	
10. Group work made me work hard	4	3	2	1	0	
Understanding of the Subject						
11. Group learning made me understand chemistry better	4	3	2	1	0	
12. Questions from group-mates helped me to think more deeply about the problem	4	3	2	1	0	
13. I get confused when I am learning chemistry with my friends	4	3	2	1	0	
Knowledge Retention						
14. Group learning helped me to remember what I learned	4	3	2	1	0	
Motivation to Learn						
15. Group work encouraged me to study always	4	3	2	1	0	
16. I was happy whenever my group scored high mark	4	3	2	1	0	

17. With the help of my friends I was able to solve some problems I couldn't solve alone and I was happy	4	3	2	1	0	
18. I will like to always learn chemistry in groups	4	3	2	1	0	
Attitudes of Students toward Learning of Chemistry						
19. I used to fear chemistry but now I think I can learn it	4	3	2	1	0	
20. Chemistry is not too difficult to understand.	4	3	2	1	0	
21. I enjoyed learning it because group ideas made it easier for me	4	3	2	1	0	
Thinking Together						
22. We argued on items but at the end, we agreed on one thing	4	3	2	1	0	
23. I was convinced that the answers we agreed on were correct	4	3	2	1	0	
24. I tried to convince my group mates to see sense in my views	4	3	2	1	0	

APPENDIX B (I)

Pre-Attitude Test Results for the Experimental Group

	SA(**4**)	A(**3**)	NS(**2**)	D(**1**)	SD(**0**)	Total Freq./per. of response
ITEM	Frequency and Percentage of Response					
	Views of respondents on group learning					
1	3(6.0%)	17(34.0%)	10(20.0%)	12(24.0%)	8(16.0%)	95
2	0(0.0%)	7(14.0%)	4(8.0%)	19(38.0%)	20(40.0%)	48
Average						71.5(35.8%)
	Responses on cooperation among group-mates					
3	5(10.0%)	18(36.0%)	15(30.0%)	10(20.0%)	2(4.0%)	114
4	0(0.0%)	7(14.0%)	10(20.0%)	27(54.0%)	6(12.0%)	68
5	1(2.0%)	6(12.0%)	6(12.0%)	25(50.0%)	12(24.0%)	59
6	7(14.0%)	14(28.0%)	17(34.0%)	11(22.0%)	1(2.0%)	115
Average						89.0(44.5%)
	Views of respondents on level of involvement					
7	5(10.0%)	11(22.0%)	18(36.0%)	15(30.0%)	1(2.0%)	104
8	3(6.0%)	9(18.0%)	10(20.0%)	17(34.0%)	8(16.0%)	76
9	2(4.0%)	10(20.0%)	22(44.0%)	10(20.0%)	6(12.0%)	92
10	0(0.0%)	3(6.0%)	16(32.0%)	23(46.0%)	8(16.0%)	74
Average						86.5(43.3%)
	Views of respondents on understanding of the subject					
11	8(16.0%)	14(28.0%)	11(22.0%)	11(22.0%)	6(12.0%)	97
12	3(6.0%)	10(20.0%)	20(40.0%)	10(20.0%)	7(14.0%)	92
13	1(2.0%)	8(16.0%)	5(10.0%)	24(48.0%)	12(24.0%)	62
Average						83.7(41.9%)
	Views of respondents on knowledge retention					
14	6(12.0%)	15(30.0%)	17(34.0%)	15(30.0%)	8(16.0%)	106(53.0%)
	Views of respondents on motivation to learn					
15	3(6.0%)	13(26.0%)	18(36.0%)	15(30.0%)	1(2.0%)	102
16	12(24.0%)	14(28.0%)	10(20.0%)	8(16.0%)	6(12.0%)	118
17	5(10.0%)	16(32.0%)	22(44.0%)	12(24.0%)	5(10.0%)	124

18	1(2.0%)	11(22.0%)	15(30.0%)	19(38.0%)	4(8.0%)	86
Average						107.5(53.8%)
	Responses on attitudes of students towards learning of chemistry					
19	4(8.0%)	14(28.0%)	26(52.0%)	4(8.0%)	2(4.0%)	114
20	6(12.0%)	9(18.0%)	3(6.0%)	28(56.0%)	4(8.0%)	85
21	1(2.0%)	7(14.0%)	19(38.0%)	15(30.0%)	8(16.0%)	78
Average						92.3(46.2%)
	Views of respondents on thinking together					
22	2(4.0%)	8(16.0%)	25(50.0%)	14(28.0%)	1(2.0%)	96
23	5(10.0%)	12(24.0%)	20(40.0%)	10(20.0%)	3(6.0%)	106
24	1(2.0%)	15(30.0%)	18(36.0%)	14(28.0%)	6(12.0%)	99
Average						100.3(50.2%)

N=50

APPENDIX B (II)

Post-Attitude Test Results for the Experimental Group

	SA(**4**)	A(**3**)	NS(**2**)	D(**1**)	SD(**0**)	Total Freq./per. of response
ITEM	Frequency and Percentage of Response					
	Views of respondents on group learning					
1	11(22.0%)	30(60.0%)	6(12.0%)	2(4.0%)	1(2.0%)	148
2	9(18.0%)	23(46.0%)	9(18.0%)	7(14.0%)	2(4.0%)	130
Average						139.0(69.5%)
	Responses on cooperation among group-mates					
3	12(24.0%)	32(64.0%)	4(8.0%)	1(2.0%)	1(2.0%)	153
4	8(16.0%)	20(40.0%)	11(22.0%)	4(8.0%)	7(14.0%)	118
5	3(6.0%)	15(30.0%)	14(28.0%)	8(16.0%)	10(20.0%)	93
6	17(34.0%)	28(56.0%)	2(4.0%)	7(14.0%)	0(0.0%)	163
Average						131.8(65.9%)
	Views of respondents on level of involvement					
7	11(22.0%)	30(60.0%)	6(12.0%)	3(6.0%)	0(0.0%)	149
8	14(28.0%)	21(42.0%)	5(10.0%)	7(14.0%)	3(6.0%)	136
9	10(20.0%)	25(50.0%)	10(20.0%)	5(10.0%)	1(2.0%)	140
10	4(8.0%)	15(30.0%)	15(30.0%)	11(22.0%)	5(10.0%)	102
Average						131.8(65.9%)
	Views of respondents on understanding of the subject					
11	11(22.0%)	30(60.0%)	6(12.0%)	2(4.0%)	1(2.0%)	148
12	12(24.0%)	22(44.0%)	5(10.0%)	8(16.0%)	3(6.0%)	132
13	6(12.0%)	18(36.0%)	18(36.0%)	5(10.0%)	3(6.0%)	119
Average						133(66.5%)
	Views of respondents on knowledge retention					
14	11(22.0%)	26(52.0%)	6(12.0%)	4(8.0%)	3(6.0%)	138(69.0%)
	Views of respondents on motivation to learn					
15	9(18.0%)	31(62.0%)	6(12.0%)	3(6.0%)	1(2.0%)	144

16	20(40.0%)	25(50.0%)	4(8.0%)	1(2.0%)	0(0.0%)	169
17	15(30.0%)	20(40.0%)	8(16.0%)	6(12.0%)	1(2.0%)	142
18	13(26.0%)	19(38.0%)	5(10.0%)	9(18.0%)	4(8.0%)	128
Average						145.8(72.9%)
	Responses on attitudes of students towards learning of chemistry					
19	13(26.0%)	23(46.0%)	7(14.0%)	7(14.0%)	0(0.0%)	142
20	18(36.0%)	14(28.0%)	4(8.0%)	9(18.0%)	5(10.0%)	131
21	10(20.0%)	21(42.0%)	10(20.0%)	8(16.0%)	1(2.0%)	131
Average						134.7(67.4%)
	Views of respondents on thinking together					
22	12(24.0%)	26(52.0%)	8(16.0%)	3(6.0%)	1(2.0%)	145
23	10(20.0%)	25(50.0%)	8(16.0%)	5(10.0%)	2(4.0%)	136
24	9(18.0%)	29(58.0%)	5(10.0%)	7(14.0%)	0(0.0%)	140
Average						140.3(70.2%)

N=50