SELINUS UNIVERSITY
OF SCIENCES AND LITERATURE

THE IMPACT OF COLLABORATIVE APPROACHES ON STUDENTS' PERFORMANCE IN HYDROCARBONS IN PUBLIC SENIOR HIGH SCHOOLS IN CENTRAL REGION OF GHANA

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A DISSERTATION

Presented to the Department of Chemistry
Program at Selinus University

Faculty of Life and Earth Science
in fulfillment of the requirements
for the degree of
Doctor of Philosophy in Chemistry

2022

Supervisor's Declaration

I hereby declare that the preparation and presentation of this dissertation is in accordance with the guidelines on supervision of dissertation laid down by Selinus University of Sciences and Literature.

Supervisor's name: Dr. Salvatore Fava (PhD)

Signature……. Date……

DEDICATION

The work is dedicated to God Almighty.

ACKNOWLEDGEMENT

The successful completion of this research would never have been possible without the contributions from certain individuals. I would like to profoundly express my appreciation to my general supervisor Dr. Salvatore Fava (PhD), Selinus University of Science and Literature for his time and contribution to the success of this study. Again, Prof. Ruby Hanson, (Ph.D.), Dean, Faculty of Science Education, University of Education, Winneba, who spent time and energy to read through the write-up, and whose constructive criticisms, advice, comments and suggestions led to the success of this study.

I wish to offer my sincere gratitude to all administrators of Winneba and Apam Senior High Schools for their support, as well as students of the above mention senior high schools who were sampled to respond to the research instruments for their maximum cooperation during the gathering of data for the research. My deep appreciation also goes to Mr. Baba Moro Seku of Winneba Secondary School who devoted part of his busy schedule to proof read this work. I am also grateful to Mr. Isaac Gaisie and all friends of Winneba Secondary School for their moral support.

I also express my profound gratitude to Miss Vestra Ephraim, Winneba for her moral support. It will be sheer gross disrespect if I fail to acknowledge the support of my parents, wife and children for their prayers and support.

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ABSTRACT

This study investigated the impact of collaborative instructional approaches on form three students' understanding of the topic; hydrocarbons. The sample for this study consisted of 106 science students from Winneba Senior High School and Apam Senior High School. The sample was selected from two intact classes in the both schools. After a pre-test organized for both classes, the class with the lower average score was assigned as the experimental group and the other class assigned the control group. Students were given an individual identification number to check students cross-over from one group to the other. Interviews, questionnaires and tests were used as the main instruments to collect data for the study. The reliability of the questionnaire, pre-test and post-test items were determined using Cronbach-Alpha ranged from 0.78 to 0.86. A collaborative learning text-oriented instruction was applied in teaching the experimental group whereas traditional approach was used in teaching the control group. It was also found that a good number of the students who took part in the study had wrong notions about hydrocarbons. The findings showed that there was a statistically significant difference in performance between the experimental and control group. The experimental group performed better in the post-test than the control group. The implication is that chemistry teachers in Winneba Senior High school and Apam Senior High should employ the collaborative learning approach in teaching chemistry to enhance the students' learning.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This is an initial chapter that looks at the background to the study, statement of the problem and the purpose of the study. It also covers the research questions as well as the significance of the study. This chapter ends with the provision of abbreviations and synonyms of some terms mentioned in the report.

1.1 Background to the study

Science is at the midpoint of many successful careers and an influence on all human activities. Good Scientific Literacy (SL) is the bedrock upon which the development of every country depends. The acquisition and application of scientific knowledge is the panacea for the elimination of social and economic problems such as diseases, hunger and unemployment in the developing countries. In fields such as engineering, medicine, and agriculture, science and technology play crucial roles in the production of goods and services for the benefit of mankind. Countries such as the United States of America, China, Japan, Britain, Germany, Korea, India and a host of others have attained economic breakthrough through the efficient use of science and technology, especially information technology thus scaling the poverty obstacle. For this reason, the relevance of science cannot be over stressed. For Ghana to develop at a fast pace, the quick development of science and technology through literacy among its members is principal. It is therefore in the right direction that the curriculum research development division of the ministry of education has put in place an organized syllabus to develop understanding of scientific concepts, principles, literacy and

scientific way of living. The syllabus places emphasis on the development of scientific attitudes towards an effective scientific life. The aim is to generate interest, critical thinking and appreciation of interaction between science and technology. Other interventions that have been presented by the government aimed at increasing and sustaining the interest of students in science and technology. These have been through interventions such as the Science, Technology and Mathematics Education (STME) Clinics, and the creation of girls' education units within districts, municipal and regional educational units. The STME project is a collaborative project by the GES and the Japan International Cooperative Agency (JICA). Generally, the project trains districts, municipal directors of education, circuit supervisors who supervise teaching and learning among others at the basic level on how to use the best practices in teaching and learning of science, technology and mathematics.

Also, selected teachers are sent to Japan for about eight weeks to study how to use science and technology, and teaching and learning materials more effectively in teaching. During vacations girls from the senior high schools across the country are camped for weeks to undergo extra tuition in science, mathematics and technology in STME Clinics. The Ghana Association of Science Teachers (GAST) and the Ghana Science Association (GSA) are augmenting the government's efforts in promoting science education. The aim is to effectively promote the teaching of science at all pre-tertiary level through the concept update and the development of resources for science teachings through workshops. This objective is achieved by bringing science teachers from different backgrounds in the country together to share ideas and promote the teaching of science.

The Ghana Science Association (GSA) is focused on the co-ordination of research activities in both science and science education. The main objective of the GSA is to inspire, endorse and

commercialize the study and applications of science and technology in Ghana. Furthermore, some colleges of education have been selected to purposely train teachers in science. The University of Education, Winneba was established in 1992 for training of graduate teachers in various fields of learning including science. In spite of the above interventions, science seems to be one of the academic subjects that students appear to dislike most (Adu-Gyamfi, 2013). Most students hold misconceptions on one aspect of science or the other and tend to discard or distance away from school science, regardless of the major influence it has on their lives (Aikenhead, 2002). African leaders tend to drop science for other subjects or courses perceived to be easier in their school or as part of their tertiary study in spite of the vast opportunities that science offers in terms of further studies in science (Naidoo, 2005).

Teacher-centered methods such as lecturing, demonstrations, memorizing, reviewing and questioning are often used. These approaches do not stimulate or improve students' understanding of science. Student-centered learning methods such as collaborative learning could be used in shifting the focus of activity from teacher to the learner. Collaborative learning is based on the Constructivist Model in which students construct rather than receive or assimilate knowledge (Puntambekar, 2006). Constructivist learning models also require intellectual effort by students and aids in the retention of knowledge and generate interest in science. The role of the teacher in the student-centered learning is to facilitate the students' learning by providing a framework of activities for the students to complete. Constructivists believe that for higher level of cognition to occur, students must build on their own knowledge through activities that engage them in active learning (Cooperstein & Kocevar-Weinger, 2004). Effective learning takes place when students take stock of what they already know and then move beyond it. If students actually

constructed their own framework scheme through experimenting, they are most likely to retain the facts they learn in chemistry. Despite the application of hydrocarbons in technological development and everyday life, both students and teachers of chemistry consider the concept difficult (Udu, 2018). Studies have shown that the performance of students in hydrocarbons in most West African countries has generally and consistently been poor over the years (WAEC, 2018; Adu-Gyamfi & Ampiah, 2019).

According to Acker and Armenti (2007), the instructional method which is right for a particular lesson depends on many factors. Among these are the age and developmental levels of the students, what the students already know and what they need to know to succeed in a lesson, the subject matter content, the objective of the lesson and class size. Other factors are time, space, materials, resources and the physical setting. A more difficult problem is to select an instructional method that best suits one's particular teaching style and the lesson to be taught.

Flores (2016) also suggested that resources that also assist teachers teach better are typically a lesson plan or practical activity that involves learning and acquisition of skills. Also, students working in groups is yet one other way a teacher can organize a better constructivist lesson. Many educators seek to apply the strategies that help students collaborating to complete course work (Reigeluth, 2009). Reigeluth explained further that active or participatory learning by the students within the classroom environment has recently been recognized as an effective, efficient, and superior instructional technique. Yet, only a few teachers in basic and senior high schools appear to employ this pedagogical strategy (Akyeampong & Lewin, 2002). Collaborative or peer learning is one of the most widely discussed teaching methods according to Marjan and Seyed (2012). According to researchers (Darling-Hammond, 2006) collaborating in learning allows

students in smaller groups to work on the same task; talk among themselves and to the viewpoints of one another during discussions or assignment. Evidence from Puntambekar's (2006) research shows that collaborative learning approaches increase opportunities for learners to practice concepts they have been taught, and provides opportunities for learners to be problem solvers rather than information receivers. It also provides opportunities for meaningful interactions between peers and teachers. Hence, the need for a study of the effect of collaborative instructional approaches on the academic performance of students in chemistry at Winneba Senior High School and Apam Senior High School. Below is the extract of chief examiner's report on students' performance in hydrocarbons, 2018

4. SCIENCE SUBJECTS

The Chief Examiners noted that, candidates performed woefully in the following topics of the respective subjects;

Biology (Biological drawing, Causes and consequences of variation, and Process photosynthesis). General Agriculture (Agribusiness, Chemical Weathering and Agricultural development). Crop Husbandry and Horticulture (Establishment of potted plant enterprise, Crop pests and diseases). Chemistry (Electronic configuration, Partition coefficient and chromatography, and Redox titration). Physics (Heat transfer, Semi-conductors, and Nuclear physics). Integrated Science (Hydrocarbons, Animal production, and Magnetism). Animal Husbandry (Marketing of animal products, and Animal nutrition). Forestry (Forestry sector structure, and Forestry estate). Fisheries (Roles of extension services in fisheries development, and Maintenance of fish landing sites)

In addition to the above, the following weaknesses were noted:

- Inadequate preparation;
- Poor language use;
- Lack of understanding of the demands of the questions;
- Inability to explain simple scientific terms;
- Inability to assign proper units to figures;
- Inability to draw and interpret graphs.

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Source: www.waecgh.org

1.2 Statement of the Problem

In Ghana, teaching of science in senior high schools seems to be teacher-centered through giving and taking of notes and demonstration methods which do not enable students to form mental models of the concepts presented to them. Also, absent in the teacher-centered method is the enthusiasm to learn since the method is boring, and monotonous, with only the teacher doing the talking. Effective science teaching does not result from teacher-centered approaches. Even though in Ghana, chemistry is taught in senior high schools with the intention of enabling students to follow instructions, perform experiments, record observations, evaluate and draw conclusions, these noble intentions are not achieved in reality. Students therefore go through their chemistry courses with a deficiency in these important process skills. The Chief Examiner's Report on science for 2018 stated that the students' performance was poor and that the students lacked answering skills and the understanding of topics in chemistry. Science subjects in general and chemistry in particular, tend to be disliked by most students since most of the concepts are abstract. Although the students' deficiencies in the knowledge and practical skills aspects of chemistry have been the subject of concern for some time now at the SHS level, there appears to be no immediate solution.

For this reason, this study was designed to determine whether or not the utilization of collaborative instructional approaches will help the students in the research area to improve upon their understanding of selected chemistry concepts.

1.3 Purpose of the Study

The main purpose of this study was to evaluate the impact of collaborative learning on the academic performance of selected Winneba Senior High School and Apam Senior High School students in their study of the concept of hydrocarbons.

1.4 Objectives

The objectives for this study were as outlined below:

- To explore the causes of poor performance of students in hydrocarbons.
- To examine the effect of collaborative instructional approaches on students' understanding and academic performance in their study of hydrocarbons.
- To find the statistical difference in the academic performance between students exposed to collaborative instructional approach and those exposed to traditional approach of teaching.

1.5 Research Questions

The study was guided by the following research questions.

- What are the main causes of students' poor performance in their study of hydrocarbons?
- To what extent will the use of collaborative learning improve the students' understanding and academic performance in their study of the topic, hydrocarbons?
- Are there any differences in the performance of students exposed to collaborative instructional approach and those exposed to traditional approach of teaching hydrocarbons?

1.6 Null Hypotheses

The following null hypotheses were formulated for the study:

H_{01}: There is a statistically significant difference between the experimental group's interpretation of concepts in hydrocarbons and that of the control group before and after teaching them using collaborative learning approach.

H_{02}: There is no significant difference between the test scores of the experimental group and the control group before teaching them hydrocarbons.

H_{03}: There is a statistically significant difference between the means in the performance of students taught of hydrocarbons using collaborative learning approach and those taught using traditional approach.

1.7 Significance of the Study

The findings and recommendations of this study will be beneficial to students studying chemistry in Winneba Senior High School and Apam Senior High School. It will be of immense benefit to teachers teaching chemistry in Winneba Senior High School and other Senior High Schools in Central Region of Ghana. It will provide insight into the need for teachers to select appropriate methods which will be useful in arousing and sustaining the students' interest in chemistry. Furthermore, this study will serve as a reference document for the Ministry of Education (MOE), Ghana Education Service (GES), the Curriculum Research and Development Division (CRDD) and other stakeholders associated with science education to effect desirable changes in the teaching and learning of chemistry. Finally, and more importantly, it will serve as the basis for further research work.

1.10 Organization of the Thesis

This write-up is divided into five chapters. The first chapter provides an introduction to the study. It also includes the problem of the study, purpose of the study, research questions, and significance of the study. The second chapter consists of the bibliography of the study. The third chapter outlines the detailed information of research methodology and materials employed in the study. The fourth chapter presents the data collected and their analysis. The fifth chapter presents the discussion of the results, summary of the study, conclusions and recommendations.

Abbreviations and synonyms

CRDD: The Curriculum Research and Development Division

MOE: Ministry of Education

GSA: Ghana Science Association

GES: Ghana Education Service

GAST: Ghana Association of Science Teachers

JICA: Japan International Cooperative Agency

SHS: Senior High School

STME: Science, Technology and Mathematics Education

WAEC: West Africa Examination Council

CHAPTER TWO

BIBLIOGRAPHY

Abbey, T. K., Aihassan, M. B., Ameyibor, K., & Wiredu, M. B. (2008). *Integrated Science for Senior High Schools*. (4th edition), Accra: Unimax MacMillan Ltd.

Acker, S., & Amenti, C. (2007), Sleepless in Academia, *Gender and Education*, 16, (1), 3-24

Aikenhead, G.S (2000a). Cross-cultural science teaching: Rekindling traditional for Aboriginal Students. *Canadian Journal of Science, Mathematics and Technology Education*, 306-425.

Aikenhead, G.S (2000b). Renegotiating the culture of school science. In R. Millar, J. Leach, & J. Osborne (Eds), *Improving science education: The contribution of research*. Birmingham, UK: Open University Press, pp. 245-264.

Ajaja, O. P., & Eravwoke, O. U. (2010). Effects of cooperative learning strategy on junior Secondary school students' achievement in integrated science. *Electronic Journal of Science Education*, 14(1), 1-18.

Akyeampong, K., & Lewin, K. (2002). From student teacher to newly qualified teachers in Ghana: Insights into becoming a teacher. *International Journal of Educational Development*, 22, 339-352.

Amedahe, F. K. (2002). *Review of continuous assessment: guidelines for identifying critical Instructional objectives for designing continuous assessment*. Cape Coast: SEASCAPE Project.

Bain, K. (2004). *What the best college teachers do*. Cambridge, MA: Harvard University Press.

Bandura, A. (1986). *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice-Hall

Belland, B. R., Kim, C., & Hannafin, M. J. (2013). A framework for designing scaffolds that improve motivation and cognition. *Educ. Psychol*. 48, 243-270.

Bermudez, J. L. (2010). *Cognitive Science: An Introduction to the Science Of the Mind. Cambridge*: Cambridge University Press.

Best, J. W., & Kahn, J. V. (1991). *Research in education*. Englewood Cliff, New Jersey: Prentice Hall.

Berg, B. L., & lune, H. (2017). Qualitative research methods for the social sciences (9^{th}) Pearson, Harlow-England.

Blaxler, Dodd, Tight. *How to research*. Buckingham: Open University Press, 1991

Bogdan, Biklen. *Qualitative research for education: An introduction to Theory and methods*. Boston: Allyn & Bacon, 1998

Brufee. *Collaborative learning: Higher education, interdependence, and the Authority of knowledge*. Baltimore: John Hopkins University Press, 1993

Busia, K. A. (1994). *Purposeful education for Africa*. London: Mouton.

Chin, C. (2007). Teacher questioning in science classroom: Approaches that stimulate productive thinking. *Journal of Research in Science Teaching*. 44 (6), 815-845.

Chin-min, H. (2013). The effectiveness of cooperative learning. *The Research Journal for Engineering Education*, 101 (1), 119-137.

Chiu. C. (2008). A Statistical discourse analysis. *Journal of the Learning Science*, 17(3), 415-463.

Chiu. C. (2004). Adapting teacher interventions to students need during cooperative learning. *America Educational Research Journal*, 41, 365-399.

Cohen, L., Manion, L., & Morrison, K. (2017). *Research methods in education*. London: Routledge Publications.

Conway, Jako. A meta-analysis of interrater and internal consistency Reliability of selection interviews. *Journal of Applied Psychology*, 80(5), 567-579, 1995

Cooperstein, E. & Kocevar-Weindinger, E. (2004). Beyond active learning: A constructivist approach to learning, *Reference Service Review*, 32 (2)

Cooper, J., & Robinson, P. (1998). Small group instruction in science, mathematics, Engineering and technology. *Journal of College Science Teaching*, 383-388.

Cuseo, J. (1992). Cooperative learning versus small group discussions and group projects. *Cooperative Learning and College Teaching*, 5-10.

Darling-Hammond, L. (2006). *Powerful teacher education lesson for exemplary programs*. San Francisco, CA: Jossey- Bass

Dillenbourg, P. (1999). *Collaborative Learning: Cognitive and Computational Approaches. Advances in learning and institutional series*. New York NY: Elsevier Science Inc.

Easterby-Smith, M., Thorpe, R., & Love, A. (1991). *Management research: An introduction*. London: Sage Publications.

Flores, M. A. (2016). *International Handbook of Teacher Education*. SpringerLink. pp 187-230

Floria-Ruane, S. (2001). *Teacher education and Cultural imagination*. Mahwah, N J, US: Lawrence Erlbaum Associates Publishers.

Forman, E. A., & Cazden, C.B. (1985). *Exploring Vygotskian perspectives in education. The Cognitive value of peer interaction*. Cambridge: Cambridge University Press.

Friedenberg, J., & Silverman, G. (2015). *Cognitive Science: An Introduction to the Study of Mind*. Beverly Hills: Sage Publications.

Gall, M. D., Borg, W. R., & Gall, J. P. (1993). *Educational research: An introduction*. New York: Longman.

Gerlach, J. M. (1994). "Is this collaboration?" In K. Bosworth, & S. J. Hamilton, *Collaborative learning: Underlying processes and effective techniques* (pp. 50-60). New York: McCraw Hill Inc.

Good, T. L., & Lavigne, A. L. (2017). *Looking in classroom*. NY: Routledge Publications.

Griffin, P., Care, E., & McGaw, B. (2014). "The changing role of educational and schools" in *Assessment and Teaching of 21st century skills*, eds P. Griffin, B. McGaw and E. Care. (New York, NY: Springer), 1-15.

Guion, R. M. (2011). *Assessment, Measurement and prediction for personnel decisions* (2nd ed) NY: Routledge-Taylor & Francis.

Hadwin, A., Jarvela, S., & Miller, M. (2017). "Self-regulation, co-regulation and shared regulation in collaborative learning environments" in *Handbook of Self-Regulation of learning and Performance*, eds D. H Schunk and J. F. Grene (London: Routledge), 83-106.

Harding-Smith, T. (1999). *Learning together: An introduction to collaborative learning*. New York NY: HarperCollins College Publishers.

Harasim, L. (1990). *On-line education: Perspectives on a medium*. New York: Praeger-Greenwood.

Helmo-Silver, C. E., Chinn, C. A., Chan, C., & O'Donnell, A. M. (2013). "Information processing approaches to collaborative learning" in *The international Handbook of Collaborative Learning*, eds C. E. Hmelo-Silver, C. A. Chin, C. Chan, and A. M. O'Donnell (New York, NY: Routledge), 31-52.

Helmo-Silver, C. E. (2004). Problem-based learning: what and how do students learn? *Educational Psychology Rev*. 16, 235-266.

Hiltz, S. R., & Turoff, M. (1993). *The Network nation: Human Communication via computer*. Cambridge MA: MIT Press.

Hwong, N., Caswell, A., Johnson, D., & Johnson, R. (1993). Effects of cooperative an Individualistic learning on prospective elementary teachers' music achievement and Attitude. *Journal of Social Psychology*, 53-64

Johnson, D. W. (1981). Student-student interaction: The neglected variable in education *Educational Research*, 5-10.

Johnson, D. W., & Johnson, R. (1989). *Cooperation and competition: Theory and research*. Edina, MN: Interaction Book Company.

Johnson, D. W., & Johnson, R. (1981). Effects of cooperative and individualistic learning Experiences on interaction. *Journal of Educational Psychology*, 454-459.

Johnson, D. W., & Johnson, R. T. (1992). *Interaction in cooperative groups: Theoretical Anatomy of group learning.* Edina, MN: Interaction Book Company.

Johnson, D. W., Johnson, R. T., & Smith, K. (2007). The state of comparative learning in post-secondary and professional settings. Educational Psychology Review. Pg. 15-19

Johnson, D. W., Johnson, R. T., & Holubec, E. J. (1986). *Circles of learning*. Edina, MN: Interaction Book Company.

Joppe, M. (2000, January 2). *The research process*. Retrieved December 6, 2022, from http://www.htm.uoguelph.ca/pagefiles/MJResearch/Research Process/home.htm

Kellogg, R. T. (2007). *Fundamentals of Cognitive Psychology*. Beverly Hills: Sage Publications.

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

Krapp, A. & Prenzel, M. (2011). Research on interest in science: Theories, methods, and findings. *International Journal of Science Education*, 33 (1), 27-50.

Kuhn, D. (2015). Thinking together and above. *Educ. Res*, 44, 46-53.

Laurillard, D. (2012). Teaching as a design science: Building pedagogical patterns for learning and technology

MacGregor, J. (1992). Collaborative learning: Shared inquiry as a process of reform. In M. D. Svinicki, *The changing face of college teaching, New Direction for Teaching and Learning* (pp. 40-45). New York: Routledge.

Makitalo-Siegl, K., & Fischer, F. (2013). "Help seeking in computer-supported collaborative science learning environments" in *Advances in Help-Seeking Research and Applicants: The Role of Emerging Technologies*. eds S. A. Karabenick and M. Puustinen (Charlotte, NC: IAP), 99-120

Martyn, S. (2001). *Pretest-Posttest Designs*. Retrieved June 20, 2022, from Experimental Resources: http://experiment-resources.com/pretest-posttest-designs.html.

Miller, M., & Handwin, A. (2015). Scripting and awareness tools for regulating collaborative learning: changing the landscape of support in CSCL, *Comp. Hum. Behav*. 52, 573-588

Miyake, N. (1986). Constructive interaction and the iterate process of understanding. *Cogn. Sci*. 10, 151-177

Nagata, K., & Ronkowski, S. (1998). *Cooperative learning strategies for university students*. Retrieved fromhttp://idwww.ucsb.edu/IC/Resources/Collab-L/strategies.html

Naidoo, V. (2005). *Bridging the gap between anecdotal and empirical evidence in the international education market*. New York: Longman.

National Urban League. (1999). *Science opens door sand it's fun too: Who needs science*? Retrieved September 20, 2009, from http://eripts.cr5c.uiuc.edu/npin/respar/texts/parschool/sciencedoor.html

Omosewo, E. O. (1999). The level of participation of in science and technology. *Journal of Educational Media and Technology*, 8(1), 1-6.

Osborne, J., Simon, S., & Collins, S. (2010). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education*, 25 (9), 1049-1079.

Penick, J. E., & Krajcik, J. (1985). Focus on excellence: Middle School/Junior High Science. *National Science Teachers Association Journal*, 12-22.

Perreault, R. J. (1983). *An experimental comparison of cooperative learning and their effects on cognitive achievement in junior high industrial arts laboratories*. Maryland: A Doctoral dissertation presented to the university of Maryland.

Perry, N. E. (1998). Young Children's self-regulated learning and contexts that support it. *J. Educ. Psychol*. 90, 715-729.

Piaget, J. (1954). *Intelligence and affectivity: Their relation during child development*. Palo Alto: MacCraw Hills Inc.

Pinar, W. F. (2012). What's curriculum theory? (2nd). Routledge Publications, NY.

Putnam, J. W. (1998). *Cooperative learning and strategies for inclusion: Celebrating diversity in the classroom*. New York: Paul H. Brookes Publication Co. Inc.

Puntamberkar, S. (2006). Analysis collaborative interactions: Divergence, shared understanding and construction of knowledge. *Computer and Education*, 47 (3), 332-351.

Putnam, J., Markovchick, K., Johnson, D. W., & Johnson, R. T. (1996). Cooperative learning and peer acceptance of students with learning disabilities *The Journal of social Psychology*, 741-752.

Reid, J., Forrestal, P., & Cook, J. (1989). *Small group learning in the classroom*. Sydney: Chalk face Press.

Reigeluth, C. M. (2009). *International design theories and models*. Routledge Publications, NY.

Rennie, L. J., & Punch, K. F. (1991) The relationship between effect and achievement in science. *Journal of Research into Science Teaching*, 28, 193-209.

Rixse, J. S. & Pickering, M. (1985). Freshman chemistry as predictors of future academic success. *Journal of Chemical Education*, 62(4), 313 – 315.

Rockwood, H. S. (1995a, 1995b). Cooperative and collaborative learning. *The National Teaching and Learning Forum*, 5(1), 8-9.

Roschelle, J., & Teasely, S. D. (1995). The construction of shared knowledge in collaborative problem solving, *Camp. Support, Collab. Learn*, 128, 69-97

Sawyer, K. (2014). "Introduction: the new science of learning science, 2nd Edn, eds K.R Sawyer (New York, NY: Cambridge University Press), 1-18.

Schnaubert, L., & Bodemer, D. (2019). Providing different types of group awareness information to guide collaborative learning. *Int. J. Comp. Support. Collab. Learn*, 14, 1-15

Silva, W. D. (2002). *A Guide to Modern Science: Science and Technology in Today's World*. Fog: Fog City Press.

Slavin, R. (1983). *Cooperative learning*. New York: Longman.

Smith, B. L., & MacGregor, J. T. (1992). What is collaborative learning? In A. S. Goodsell, M. R, Maher, & V. Tinto, *Collaborative learning: A sourcebook for higher education* (pp.15-27). New York: Syracuse University.

Stahl, R., & Vansickle, R. (1992). *Cooperative learning as effective social study within the social Studies classroom*. Washington: National Council for the social studies.

Thorpe, R., & Easterby-Smith, M. (2012). Research as detective work. In J. Billsberry, J. Charlesworth, & P. Loenard. *Moving images: Effective teaching and film and television in Higher Education*. Pg. 37-47

Totten, S., Sills, T., Digby, A., & Russ, P. (1991). *Cooperative learning*: A guide to research New York: Garland.

Vygotsky, L. S. (1978). *Mind and society*: The development of higher mental processes. Cambridge, MA: Harvard University Press.

Van Leeuwen, A., & Janssen, J. (2019). A systematic review of teacher guidance during collaborative learning in primary and secondary education. *Educ. Res. Rev*. 27, 71-89.

Wang, X., Kollar, L., & Stegmann, K. (2017). Adaptive scripting to foster regulation processes and skills in computer-supported in collaborative small. *J. Educ. Psychol*, 87, 406-423.

Webb, N. M., Troper, J. D., & Fall, R. (1995). Collaborative activity and learning in collaborative small. *J. Educ. Psychol*, 87, 406-423

Weimer, M. (2002). *Learner-centered*. San Francisco: Wiley.

Wertsch, J. V. (1991). *Vygotsky and the formation of the mind*. Cambridge: Cambridge Press.

Winne, P. H. (2018). Theorizing and researching levels of processing in self-regulated learning. *Br. J. Educ. Psychol*, 88, 9-20.

WAEC (West African Examination Council, 2018). *Chief examiner's report-science programme: May/June West African Senior High School Certificate Examination*. Accra.

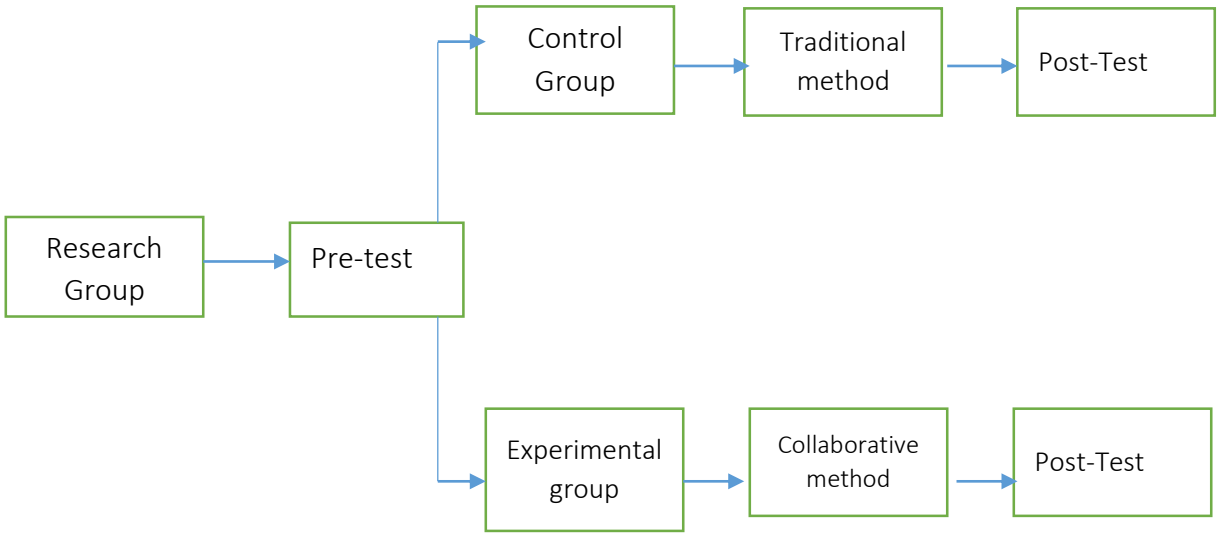
CHAPTER THREE

METHODOLOGY AND MATERIALS

3.0 Overview

This chapter describes the methodology of the study. It covers the research design, population sample and sampling procedures, the interventions as well as research instruments (observation, interview and questionnaire, and performance test implementation) for data collection. Other issues considered in this chapter are reliability and validation of the research instruments, data collection as well as educational materials of the study.

3.1 Research Design



The research design used in this study was quasi-experimental. In this type of design, two groups are used with one as the experimental group and the other, as the control group. Both groups were assessed with the same test item (Pre-test) to establish their entry knowledge. Both groups were then assessed again with post-test to ascertain the impact of the treatment. The research design is possibly useful in that it controls all threats to validity and all sources of bias such as history and maturation. Lee and Chwen (2017), research design allows the researcher to compare the final post-

test results between the two groups, giving the researcher an idea of the overall effectiveness of the intervention or treatment. Also, it enabled the researcher to find out how both groups changed from pre-test to post-test whether one, both or neither improved over time. If the control group also showed a significant improvement, then would permit the researcher to attempt to uncover the reasons behind this. Again, this design will enable the researcher to compare the scores in the two pre-test groups, to ensure that the randomization process was effective. These checks evaluate the efficiency of the randomization process and also determine whether the group given the treatment showed a significant difference in performance.

3.2 Treatment

All the students in form three science class (3SC1) and form three science class (3AG1) in Apam Senior High and Winneba Senior High School respectively were examined on hydrocarbons. This served as the pre-test. The intervention was in the form of a collaborative learning approach. Both groups of students were taught by the researcher in the course of the study. The students in the experimental group were administered the treatment and those in the control group were taught using the traditional method of teaching. Students in the treatment group were taught using a collaborative learning approach in the teaching and learning process. Each student in the group was assigned a different aspect of a given learning task to perform. The solution to the task allocated to each group was arrived on consensus. Students from each group then presented their findings in turns. The researcher then summarized the major points agreed on by all members in each of the groups in the class on the marker board. This approach was adopted for a period of six weeks in the experimental class.

The control groups however were taught using the traditional method of teaching which consisted of lecturing and teacher directed discussion. After the end of the four-week period, all the students in the two classes, 3C1 and 3AG1 were then assessed using the post-test to ascertain the impact of the collaborative learning approach.

The post-test for both the control and experimental was held at the same time in different classrooms under strict supervision. During the implementation of the intervention to the experimental group, the teacher observed the entire teaching and learning process in the class. According to Eastaby-Smith, Thorpe and Love (1991), observation offers more information which would not have been done with other methods. It also offers first-hand information without relying on reports of others. Observation, again also is useful to determine whether or not people do what they say they do behave in a way they claim to perform (Amedahe 2002).

3.3 Population and Sample

The population for this study consisted of all SHS students in Winneba Senior High School in the Winneba municipality and Apam Senior High School in Gomoa West District. The sample involved in the study comprised all form three 3SCI and 3AG students in Apam Senior High and Winneba Senior High School respectively. Apam Senior High and Winneba Senior High School were chosen for the study because both schools do science. Again, to enable the researcher to benefit from teachers and students for the cooperation of the research work. Finally, the researcher chose the schools in question because of the willingness of the students to partake in the study during the pre-study visits to the school.

3.4 Sample and Sampling Procedure

Purposive sampling technique was used to select the sample for the study. The sample for the study was selected from three-year complete classes at Winneba Senior High School and Apam Senior High School. One of the two classes, 3AG1 (Form three Agriculture 1 class) was chosen as the experimental group and the other class, 3SC1 (Form three science 1) the control group. The total sample size was one hundred and six (106) students. Out of this, fifty (50) were in the experimental group while the control group contained fifty-six (56) students. The control group was made up of twenty-three (23) females and thirty-four (33) males, while the experimental group was made up of twenty (20) females and thirty (30) males. After the pre-test, which was administered to all the students at the same time in their respective classrooms, the class that obtained the lower mean mark (i.e., low ability class) was chosen as the experimental group whiles the class that obtained the higher mean mark (i.e., high ability class) was chosen as the control group. This was done to find out whether the performance of the low ability class would improve from the collaborative learning approach than the high ability class.

3.5 Research Instruments

The instruments used for data collection in this study were observation, interview, questionnaire and performance test. The tests used were pre-test and post-test. Observations and tests are meant to provide reliable and inform measure, without disparities Amedahe (2002). Observation is a collection of data to provide information when other methods are not effective. It also offers straight information without relying on the reports of others and it is relatively inexpensive to run. Observation is again valued in particular to discover whether people do what they claim to behave. Throughout the entire three weeks when the treatment was being administered, the researcher

observed the behavior, responses and contributions of students in both control and experimental groups. This was to ascertain if there were any changes in behavior of students and also to find out the differences in attitude of students from each of the two groups. A Treatment Variation on the collaborative learning approach industrialized by Reid, Forrestal, and Cook (1989) was also accepted in the course of the treatment being administered. This was used to help determine the effectiveness of collaborative learning approach on students' behavior in class and attitude towards chemistry. The pre-test named Base Line Survey test was used to undertake the pre-test. It consisted of 40 items covering hydrocarbons. The instrument was designed by the researcher and consisted of 20 multiple choice questions and 16 major answer type. These items were critically reviewed by a subject area expert. The instrument (test) was trial tested and the reliability coefficient of the pre-test and post-test were calculated to be 0.79 and 0.78 respectively, using the Cronbach Alpha Reliability Test. Samples of the pre-test and post-test can be found in Appendices A and B respectively. All assessments were made using these items. The tests were administered twice during the study; once before the administration of the interventions and once after the interventions. The purpose of the pre-test was to assess the students' prior knowledge level in the subject matter and to find out if there were any significant differences between the control and experimental groups. The post-test was aimed at assessing if a significant difference in terms of subject matter knowledge between the groups has emerged. The same questions were administered in both tests, however, the questions used for the pre-test were altered slightly in terms of arrangement and construction for the post-test.

The questionnaire also consisted of 5 items which sought the views and perceptions of students on chemistry. It was designed by the researcher and consisted of five responses ranging from strongly

disagree to strongly agree. Positive worded items in the questionnaire were scored on a scale of one to five. Negative worded questionnaire items were scored in the reverse manner. This was to ensure that all of the individual item scores lie on the same scale with regard to direction. For positive items, strongly agree was scored 5, agree was scored as 4, not certain 3, disagree 2 and strongly disagree 1. However, for negative statements, strongly agree was scored 1, agree 2, not certain 3, disagree 4 and strongly disagree 5. The mean value for each sub-scale was obtained.

3.6 Validity of the Main Instrument

The content validity of the Interview Schedules and questionnaire for students were ascertained by senior science educator in the Department of Science Education, UEW, with extensive knowledge and research experience in designing instructional strategies and curriculum materials for suggestions and comments for the improvement of the items. This expert vigorously analyzed various questions items in both the interview schedule and questionnaire. This led to correction of incorrect items.

3.7 Reliability of the instrument

Reliability is clarified by Cohen et al (2017) as the extent to which a procedure produces similar results under constant conditions on all occasions. In order to ensure the reliability and effectiveness of the instruments used, they were trial-tested with form three science students in Potin Senior High School. This school is chosen because it offers the elective science programme just as students at Winneba Senior High School and Apam Senior High School. Proximity is another reason why Potin Senior High School was chosen for the exercise. The internal consistency of the study was determined using the Statistical Package for Social Science (SPSS), version 20 for windows. The Cronbach alpha coefficient of reliability was measured. The reliability coefficient

of the questionnaire and tests are summarized and presented in Table 1: According to Berg and Lune (2017) coefficient of reliability values above 0.75 are considered reliable. Therefore, the above reliability indices gave an indication that the instruments were substantially reliable.

Table 1: The Reliability coefficients of the various instruments

Instrument	Reliability coefficient
Questionnaire	**0.80**
Pre-test	**0.79**
Post-test	**0.78**

The interview protocol was also piloted with the same sample used in piloting the test. The reliability of the interview was then assessed using inter-rater reliability. The transcriptions of the audio recordings of the interviews were given to different experts to determine the inter-rater reliability of the data. These experts agreed that the interview protocol could be used to undertake the substantive study. The reliability of the interview protocol was also enhanced by the fact that the interviewer held one-no-one interview sessions with the various respondents using almost the same questions. Agreeing to Guion (2011), one-on-one interviews with standardized questions appear to have the highest reliability.

3.7 Treatment of the Groups

3.7.1 The Control Group

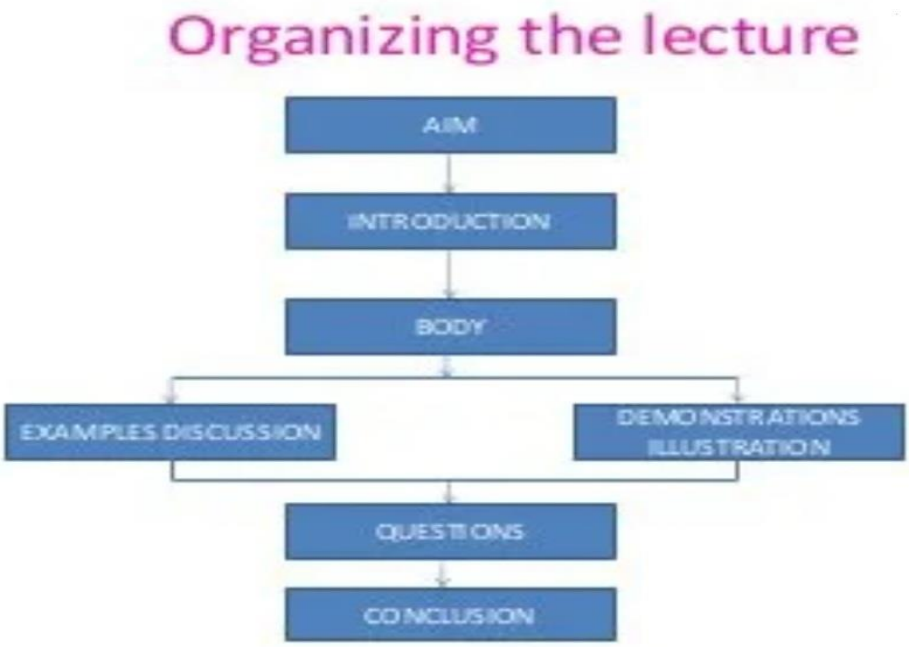


Figure 1: Traditional method classroom

The control group received traditional instruction which involves lessons using lecture/discussion methods to teach hydrocarbons. Teaching strategies relied on teacher's explanation and textbooks, with no direct consideration of the students' alternative conceptions. The students studied their handouts on their own before the class. The teacher structured the entire class as a unit, wrote notes on the marker board about the definition of concepts, and key points. The primary underlying principle was that knowledge resides with the teacher and that it is the teacher's responsibility to transfer that knowledge as a fact to students. The teacher described and defined the concepts and after teacher's explanation, some concepts were discussed, motivated by teacher-directed questions. The majority of instruction time (70-80%) was devoted to instruction and engaging in discussion stemming from the teacher's explanation and questions. The remaining time was spent on a worksheet study. Worksheets developed specifically for each lesson were used as practice activities; they required written responses and reinforced the concepts presented in the classroom

sessions. While the students were studying worksheet exercises, the teacher circulated and provided assistance if needed. The students had the opportunity to ask questions, and the teacher was available both to answer questions and make suggestions. The worksheets were collected and corrected by the teacher, and the students received their sheets after correction. This classroom typically consisted of the teacher presenting the right way to solve problems.

3.7.2 The Experimental Group

To promote change in the study of chemistry, collaborative learning model was prepared by the researcher and used with the experimental group lasting three (6) teaching weeks.

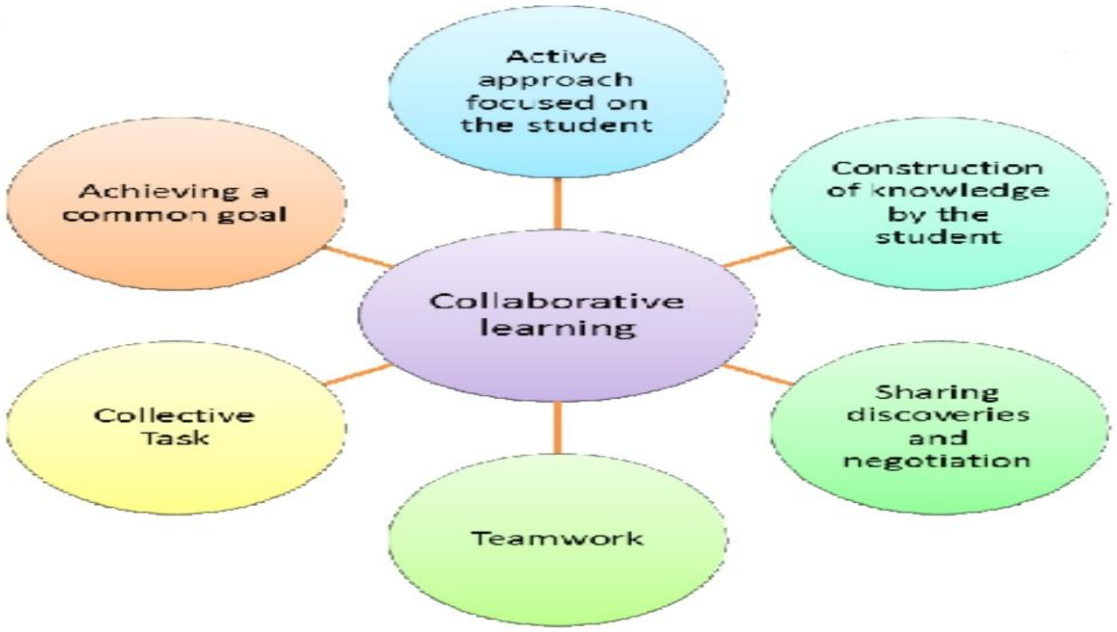


Figure 2: Collaborative learning model

Source: www.semanticscholar.org

Figure 3: Collaborative instructional approach classroom

3.8 Data Collection Procedure

The researcher obtained a permission from the Municipal and District Directors of Education to administer the instruments in the selected schools. The researcher sought permission from the headmistress to undertake the study. Permission was also sought from the teachers of the selected classes. The first visit was used to establish rapport with the students and to solicit their participation in the study and to select a date for administering the instruments. In the first week, the questionnaire and the pre-test were administered to the students in their respective classrooms by the researcher. This was done during their chemistry periods and the responses were collected immediately to ensure 100% collection. The hydrocarbons pre-test was administered by the researcher to both intact classes during the chemistry period of each class which lasted for 45 minutes to determine each student's level of performance in the topic prior to the start of intervention. Based on the mean performance of students out of a maximum score of 30 marks, experimental and control groups were designated. The class which obtained higher mean mark was designated the control group and one with the lower mean mark was designated experimental group. This was done to find out whether the performance of the class of ability might improve much more from collaborative learning approach instructions than the class of high ability. After the administration of the pre-test, collaborative learning model was prepared and the experimental group was taught the hydrocarbons by the researcher using the collaborative learning model whilst the control group was taught the same topic using the traditional method of teaching. Each class was taught for three weeks. Each classroom instruction was four periods of 60 minutes each per week (i.e., 240 minutes of contact periods per week in each class). After three weeks of instruction, post-tests (Appendix B) of comparable standards as the pre-tests were administered to the entire students in their respective classrooms. The test lasted for 45 minutes. This was done to compare

the performance of the students in the two groups after the instructional period. After the administration of the post-test in the last week, a 15-minute interview was also conducted with ten students from the treatment group to find out their views and perceptions about the collaborative learning model. The interviewees were assured of confidentiality and also given code names in order to prevent the exposure of their identities. Prior to each interview session, the interviewees and the researcher agreed on the time and venue of interview. Permission for each interview was also sought before the interview sessions were recorded.

3.9 Data Analysis Procedure

Both qualitative and quantitative methods of data analyses were employed by the researcher for analysis of data collected. Data from the interview sessions were analyzed qualitatively while the data from students' questionnaire and the test were analyzed quantitatively. Analyses of the results obtained from the study were carried out in three (3) phases. The statistical analyses of the tests (i.e., pre-test and post-test) and the students' scale questionnaire were carried out first. The mean, standard deviation and the T-test of the experimental and control groups were computed. The T-tests were used to compute. The T-tests were used to investigate whether any differences existed between the experimental and control groups' mean scores on the tests and the questionnaires. Also, the T-test was used to investigate whether there any significant differences between the groups' mean scores before and after the administration of the interventions. T-test was used to investigate any differences in performance of students in experimental in terms of gender. The inferential statistics were used by the researcher to determine the effectiveness of the collaborative learning approach in solving the learning needs of students. The second phase of the analysis was

done to find out the views of students about the collaborative learning method developed as provided on the interview schedule.

In the second phase, qualitative analysis was done on the data gathered through the interviews. The recorded conversations were transcribed, analyzed and summarized thematically after the interview sessions. Using the constant comparatively method of analysis, the researcher read through the transcript for each interview to get a sense of the uniqueness of that story. Each transcript was carefully reviewed, sentence by sentence, in order to identify words and phrases that were descriptive and represented a particular concept. Central themes were extracted as the transcript was read and re-read several times.

3.10 Ethical consideration

Ethical consideration can be specified as one of the most important parts of research. Dissertation may even be doomed to failure if this part is missing (Bryman & Bell, 2007). The researcher therefore employed the following principles.

- Research participants were not subjected to any harm.
- Respect for dignity of research participants was prioritized.
- Full consent was obtained from the participants prior to the study.
- The protection of the privacy of research participants was assured.
- Anonymity of individuals and organisations participating in the research was assured

3.11 Educational Materials

The educational materials for this study were based on the collaborative learning theory rooted in Lev Vygotsky's idea, Zone of Proximal Development and constructivist learning theory. Thus,

learners rely on one another to accomplish tasks that they otherwise would not be able to complete individually. Hence, students explain concepts perfectly in an orderly manner. Collaborative learning is key for developing critical thinking skills, with it suggested that students retain more information when working in groups. Collaborative learning theory involves peer-to-peer learning that foster deeper thinking in the classroom. Collaborative learning theory suggests that group learning helps students develop their higher -level thinking, oral communication, self-management and leadership skills.

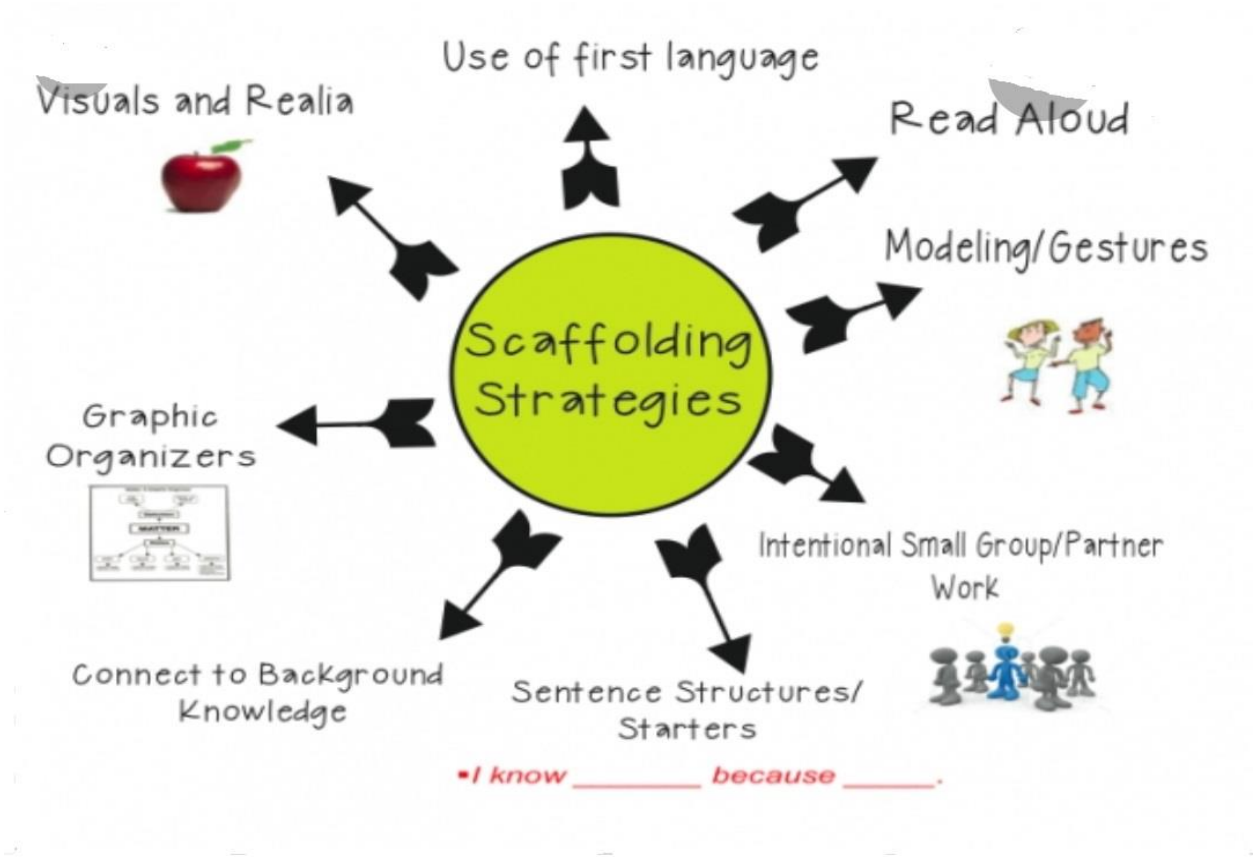


Figure 4: Scaffolding strategies for collaborative learning

Source: www.mshouser.com

Figure 5: Scaffolding instructional approach for collaborative learning approach

Source: learn.canvas.net

Figure 6: Constructivist learning design for collaborative learning

Source: www.researchgate.net

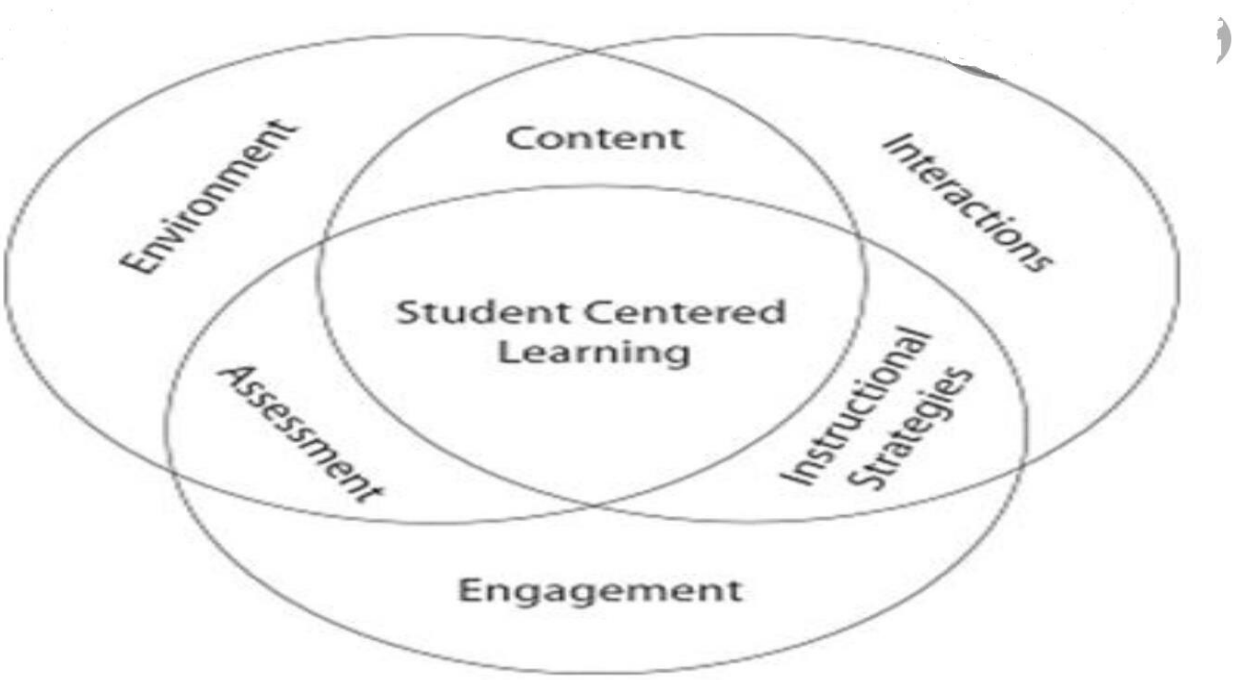


Figure 7: Student-centered learning approach for collaborative instruction

source: wordpress.com

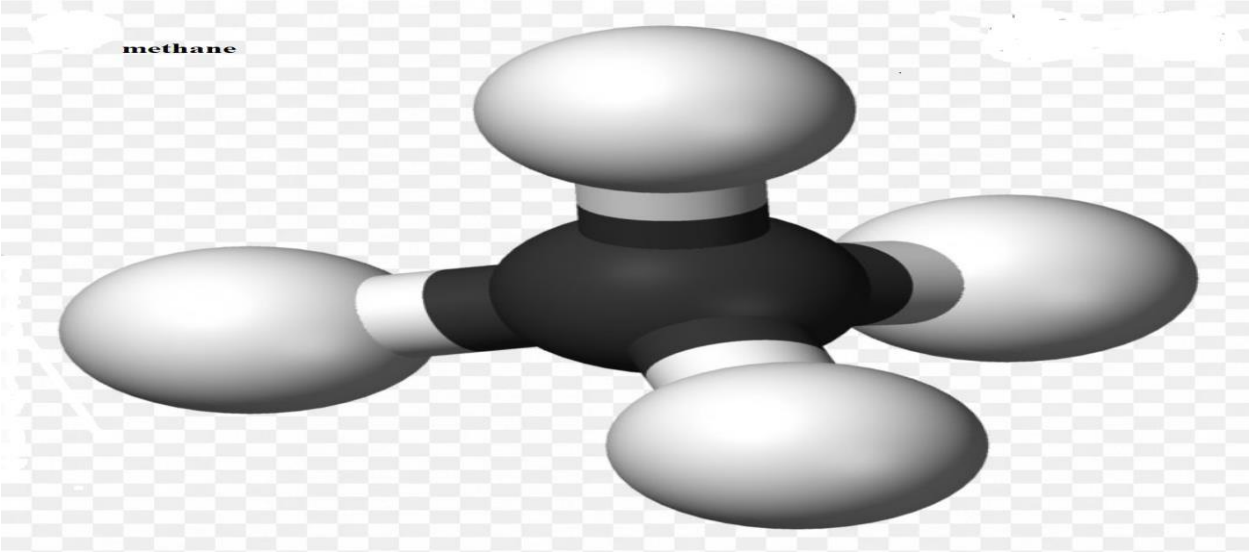
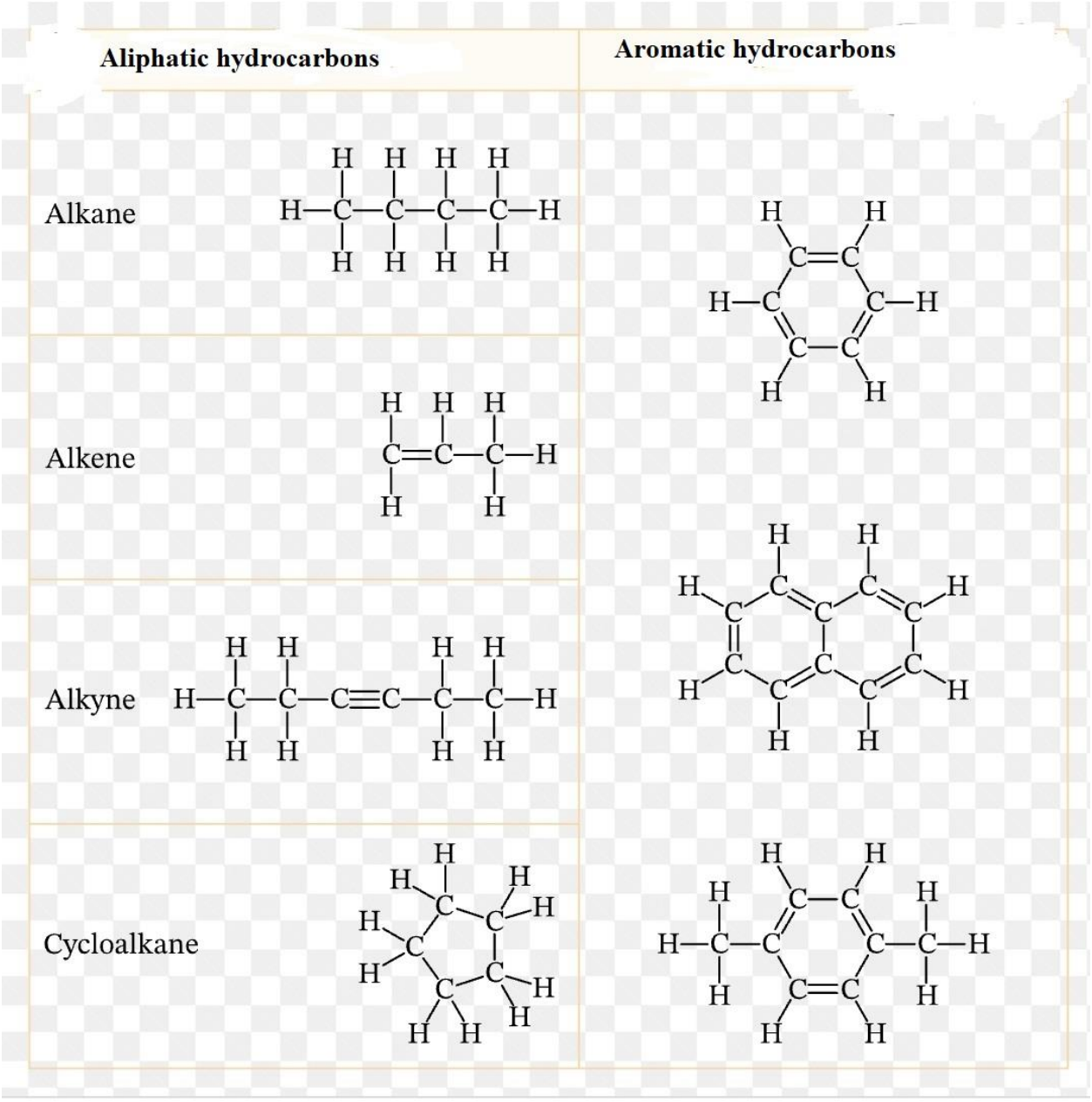


Figure 8: Model of methane

Source: www.shutterstock.com



Source: sites.google.com

The purpose of these materials in the collaborative learning is to give learners an opportunity where they learn the skills of active listening, positive conflict resolution, acceptance of others' views, and effective communication. The teacher's task is to be a facilitator of learning process through

the use of collaborative learning models to help learners discover themselves the meaningful way of learning which promotes a better understanding of hydrocarbons.

CHAPTER FOUR

RESULTS

4.0 Overview

In this chapter, the results of analyses of documents and data collected through interviews, questionnaire and tests are presented. The chapter opens with a description of characteristics of the actual sample. The presentation of results is organized according to the research questions. Results pertaining to the first research question are presented first, followed by the other research questions one after the other.

4.1 Demographic description of the research participants

Demographic description may be referred to as how people are classified into groups using common characteristics such as race, gender, income level or age. Demographic information provides data regarding research participants and it is necessary for the determination of whether the individual in the study is a representative sample of the target population for generalization purpose. The profile of the respondents in this study was presented in terms of their age and gender. There was a total of 106 students involved in the study. Out of this number, 56 formed the control group. The remaining 50 students formed the experimental group. The sample is presented graphically shown in Figure 6.

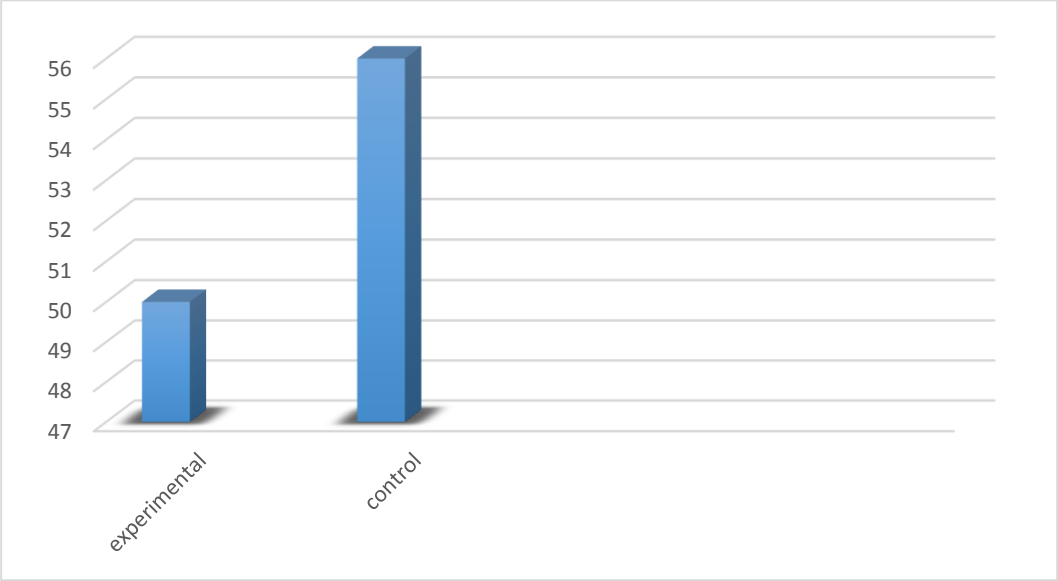


Figure 9: Distribution of students in the experimental and control groups

Research Question One: What are the main causes of students' poor performance in their study of hydrocarbons?

This question was answered using data from items in the questionnaire designed for the study as well as the interview data of random selections of students from both the experimental and control groups. Table 2 gives a summary of the responses provided by the students to the questionnaire items designed to answer the research question. A vast majority of the students agreed that the conditions in school inhibited the smooth study of chemistry. Only 29 out of the 106 students disagreed with the above assertion as seen in Table 2.

Table 2: Views of students on the causes of their poor performance in hydrocarbons

Item		SA	A	NC	D	SD
1.	Conditions in the school are not conducive for the study of chemistry	52	21	5	22	6
2.	The attitude of my chemistry teacher discourages me from studying chemistry	29	27	2	26	22
3.	I am discouraged from studying chemistry by my peers	33	30	0	28	15
4.	There are no relevant equipment and laboratory apparatus in the school to help me study chemistry	40	37	4	18	17
5.	I am not motivated to study chemistry because of conditions at home and the attitude of my parents towards chemistry	15	15	6	36	34

The students gave diverse responses to item two which sought to ascertain the impact of a chemistry teacher on the students' attitude and achievement in the subject. Whereas 56 of the students said they were discouraged from studying chemistry by the attitude of their chemistry teacher, 43 of them disagreed with the students. From Table 2, it is evident that the peer influence had an impact on the students' attitude toward the study of chemistry. A total of 63 students admitted to being discouraged from studying the subject due to the influence from peers. Only 35 students disagreed with the statement that there was no relevant equipment for studying chemistry at school. The total number of students who admitted to being influenced adversely by the conditions at home as far as

the study of chemistry is concerned was 30. Seventy of the students stated that their study of chemistry was not adversely influenced by the attitudes of their parents' and conditions at home.

In the complimentary data collected through interviews in this question, students indicated that the factors responsible for their poor performance include: congestion in the chemistry laboratory, absence of logistics, lack of comprehension of concepts, outdated nature of equipment and logistics, teaching method of the teacher and improper supervision by teachers and technicians.

Research Question Two: To what extent will the use of collaborative learning improve the students' understanding and academic performance in their study of hydrocarbons?

To ascertain the initial performance level of the students, a pre-test was conducted on the students. The test items are shown in Appendix C. The frequency distribution of marks attained by students in the experimental group during the pre-test is displayed in Table 3. From Table 3, none of the 50 students scored above 50%. Eight students had marks between 10 and 20. Thirty-four percent of students scored between 20 and 30. It can also be observed from the table that many students scored between 31 and 40 marks. Only 5 students representing 10% of the total number of students in the experimental group had marks above 40.

Table 3: Frequency Distribution of Pre-test Scores of Students in the Experimental Group.

Scores	Frequency	Percentage (%)
10-20	8	16
21-30	17	34
31-40	20	40
41-50	5	10
51-60	0	0.0
61-70	0	0.0
71-80	0	0.0
81-90	0	0.0
91-100	0	0.0
Total	**50**	**100**

To determine the effect of the collaborative learning on students' performance, a post-test was conducted after the intervention procedure. The frequency distribution of post-test scores of students in the same group (experimental) is displayed in Table 4. Table 4 indicates that only six percent of students scored marks less than 51. Twelve percent of students had marks ranging between 51 and 60. Twenty-four percent of students scored between 71 and 80. The total number of students who had marks above 80% was 22 as displayed in Table 4.

Table 4: Frequency Distribution of Post-test Scores of Students in the Experimental Group

Scores	Frequency	Percentage (%)
10-20	0	0.0
21-30	0	0.0
31-40	0	0.0
41-50	3	6
51-60	6	12
61-70	8	16
71-80	12	24
81-90	11	22
91-100	10	20
Total	**50**	**100**

It is observed from Table 4 that there was a remarkable improvement in the scores of the students after the treatment.

From Table 5, the average mark of the students in the experimental group during the pre-test was 35.73. However, this mark increased to 79.43 during the post-test. Observably, there had been a tremendous improvement in the performance of students after the treatment.

Table 5: Analysis of Pre-test and Post-test Scores of the Experimental Group

Compared Group	N	Mean Score	SD	d.f	p-Value
Pre-test	50	35.73	4.33	48	0.002
Post-test	50	79.43	11.21		

*$p < 0.05$

Hypothesis One

H_{01}: There is no significant difference between the experimental group's understanding of hydrocarbons before and after teaching them using the collaborative learning approach.

A paired sample T-test result conducted to determine the extent of difference between the performance of students in the pre-test and post-test is also shown in Table 4. The generated p-value of 0.002 was less than the probability level of 0.05, thus indicating that there was a significant difference in the performance of students in the experimental group in the pre-test and post-test.

Research Question 3: Are there any differences in the performance of students exposed to the collaborative instructional approach and those exposed to the traditional approach of teaching hydrocarbons?

This research question sought to establish the impact of collaborative learning approach on students' understanding of various concepts in redox reaction as compared to the traditional method of teaching. The scores attained by both groups of (control and experimental) in both the pre-test and post-test were tabulated, compared and analyzed to come out with inferences and conclusions. Twenty-five (25) students scored below fifty marks for the post-test for the control group whiles only three students scored below fifty marks for the post-test for the experimental group. Only six students scored above sixty (60) in the post-test for the control group. After the post-test, forty-one students scored above sixty (60) marks for the experimental group. Hence, there is a significance difference in the performance between students exposed to the collaborative learning approach and those exposed to the traditional learning approach.

The frequency distribution of both pre-test and post-test scores of students in the control group is shown in Table 6.

Table 6: Frequency Distribution of Pre-test and Post-test Scores of students in the control Group

Scores	10-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
Pre-test	4	16	15	15	6	0	0	0	0
Post-test	0	13	12	13	11	5	2	0	0

The frequency distribution of pre-test and post-test of scores of students in the experimental group is seen in Table 7.

Table 7: Frequency Distribution of Pre-test and Post-test of the Experimental Group

Scores	10-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
Pre-test	8	17	20	5	0	0	0	0	0
Post-test	0	0	0	3	6	8	12	11	10

To find out whether there were significance differences in the performance between those exposed to collaborative learning approach (experimental group) and those exposed to the traditional approach (control group) of teaching, the means, standard deviations and t-tests for both pre-test and post-test scores were calculated as shown in Table 8.

Table 8: Means, Standard Deviations and t-test of Pre-test and Post-test Scores of the Experimental and Control Groups

Groups compared	Test	Mean Test Scores	Standard Deviation	t-value	p-value
Experimental	Pre-test	35.73	4.33	0.134	.254
Control	Pre-test	41.22	5.64		
Experimental	Post-test	79.43	11.21	5.465	.004
Control	Post-test	57.17	8.61		

*$p < 0.05$

Testing of Null Hypothesis Two

The first null hypothesis, H_{02}, said that there is no significant difference between the achievement of the experimental group and the control group before they were taught hydrocarbons using the collaborative learning approach and the traditional learning approach respectively. From Table 7, the mean test score of the experimental group (35.73) in the pre-test was smaller than for the control group (41.22) counterparts. The t-test analysis of the pre-test mean score of the two groups shows no significant difference ($t = 0.134$; $p > 0.05$). This showed that there was no significant difference in the performance between the two groups at the beginning of the study. This indicates that the two groups were comparable on the initial understanding of hydrocarbons. Thus, we fail to reject the null hypothesis.

Testing of Null Hypothesis Three

$H_{03:}$ There is no significant difference between the means in the performance of students who were taught hydrocarbons using the collaborative learning approach and those taught using the traditional approach.

As shown in Table 8 above, the mean test score of the experimental group (79.43) was higher than their control group (57.17) counterparts in the post-test. The T-test analysis of the mean score on the post-test shows a significant difference between the two groups ($t = 5.465$; $p < 0.05$). There is statistically significant difference between the performance of students exposed to the collaborative learning approach and their counterparts exposed to the traditional approach. The experimental group performed better than the control group in the post-test. This indicates that the experimental group had better conceptual understanding of hydrocarbons than the control group after the treatment. Thus, the null hypothesis was rejected.

CHAPTER FIVE

DISCUSSION AND CONCLUSIONS

5.0 Overview

This chapter summarizes the research findings and provides a conclusion to the study. Recommendations and suggestions for further research are also provided.

5.1 Summary

The purpose of this study was to scrutinize the effect of the collaborative learning on the performance of students in some selected chemistry concepts. Instruments such as questionnaire, interview guide, pre-test and post-test were used. The use of the various instruments ensured that the researcher gathered adequate data to carry-out the study and came out with valid deductions and findings. The responses provided by students to the various research questions are summarized below.

5.1.0 Causes of poor performance of students in their study of hydrocarbons

The main factors mentioned by students as being responsible for their poor performance in hydrocarbons were as follows: congestion with respect to class size, abstract nature of the topic, absence of logistics such as laboratory equipment, charts and models, lack of comprehension of concepts, poor teaching methods adopted by teachers, same laboratory for all subjects, not much practical work as is required and improper supervision by teachers and technicians. The statistical analysis of the experimental group's pre-test and post-test results showed that there were statistically significant differences in students' performance before and after the treatment. The experimental group showed tremendous improvement in their performance after teaching them hydrocarbons using the collaborative learning approach.

5.1.1 Differences in the performance between students exposed to the collaborative learning approach and those exposed to the traditional approach of hydrocarbons

The statistical analysis of the pre-test of the control and experimental groups showed that there was no statistical significance in the performance between the two groups at the beginning of the study. This indicates that the groups had about the same entry performance in their initial understanding of hydrocarbons. However, there was a statistically significant difference in the performance between the experimental group and their control group counterparts in the post-test. The experimental group performed better than the control group in the post-test. This indicates that the experimental group had better conceptual understanding of hydrocarbons than the control group after treatments. Thus, there was a significant improvement in the performance of the experimental group over the control after the treatments. This also means that the students who were exposed to the collaborative learning approach retained significantly more of the scientific concepts taught in the study than those who were taught using the traditional approach.

5.2 Discussion

This study has exposed some of the reasons why students might lose interest in chemistry, and particularly hydrocarbons, in the course of their secondary schooling. It, thereby, highlights ways in which we might attempt to enhance students' interest in the topic. In terms of the content of the chemistry curriculum, some topics appear to attract some students but deter others. As such, emphasis or reduction of such subjects might, overall, prove ineffective. This suggests that science should be taught using topic study instead of selected sub-topics. Another major effect on whether students find a subject interesting appears to reside in whether they perceive it as 'relevant' (Woolnough, 1994). Interviews with students in the present study revealed that

‘relevance’ was a reason for finding redox reaction interesting, and ‘lack of relevance’ as a reason for finding it boring. This idea was reinforced by the specific curriculum areas that students raised in the context of finding the subject interesting. However, a few also raised the notion of degree of relevance of the topic to other parts of the formal school curriculum.

Science teachers must place more emphasis on interdisciplinary links, perhaps by raising, for example in physics lessons, circumstances in which chemistry is relevant to popular areas in physics. For instance, nuclear physic. Perhaps, the most obvious factor raised by students was the link between the poor teaching methods employed by the teacher and perceiving a topic as being abstract. Indeed, there is evidence that the method of teaching adopted in teaching a particular topic tends to result in the development of a general negativity to that topic. Additionally, students tended to choose for further study those subjects in which they anticipate they will be able to perform well (Rennie & Punch, 1991). The challenge here, then, is to make hydrocarbons less daunting to school students while retaining its essential nature. The issue of which subject areas are of inherent interest to students, especially girls, is worth exploring further if such information has the potential to contribute to increasing an overall interest in chemistry, and science in general. The superiority of the collaborative learning method over the traditional method can be explained on the basis of several mechanisms. In traditional classrooms, individual competition exists where failure of an individual plays an important role in the success of another. So, instead of helping others, students try to take advantage of their peers, so as to enhance their own chances of success. Competition also exists in collaborative learning set up but unlike the traditional set up, there is inter-group competition. In collaborative learning an individual is not the winner. It is the group which loses or wins. The members of a particular group help each other to promote the success of their group

members. Additionally, collaborative learning emphasizes rewards. The rewards are given on the basis of the sum-total of the performances of individual members in the group. Thus, individual accountability is ensured. Individual accountability ensures that each member puts their maximum effort for the group rewards. For this, members try to make sure that all have understood the assigned material. Collaborative learning structures produce a situation in which the only way group members can get their personal goals is if the group is successful (Johnson & Johnson, 1992; Slavin, 1983). Students in collaborative learning situations value the success of the group so they encourage and help one another to achieve. This factor is absent in traditional classrooms. This might have been the reason for the significantly greater achievement for the knowledge level and the total achievement in chemistry in the collaborative learning group.

A significant difference in the attainment of scores by students in chemistry was found in the study. This result is in partial agreement with the findings of Perreault (1983) who found that cooperative learning resulted in significantly higher achievement in students at the knowledge and comprehension levels of Bloom's taxonomy. The main challenge faced in cooperative and collaborative learning is group conflict. Students need to learn to work together. It is not always something that comes naturally. Also, teachers who have previously not used cooperative or collaborative learning might also need to get used to the increased noise level in the classroom, during class activities. Some teachers may also feel that cooperative learning takes too much time for planning and might also take longer to cover the required portion of the curriculum. With all these challenges studies have shown that once teachers start to use this tool, they continue to use it and make it the foundation for teaching. One fear many instructors have about collaborative learning is that when students' grades are affected by the achievement of their group-mates,

students will believe that the grading practices are unfair (Hwong N., Caswell A., Johnson & Johnson 1993). When positive outcome interdependence is structured within learning groups, achievement is greater than when students work individually. Again, collaborative experiences resulted in more positive attitudes toward classical music and own musical skills and no change in desire to teach music to elementary school students (Hwong N., Caswell A., Johnson & Johnson 1993). In agreement with the present study, research work done by Putnam, Markovchick, Johnson & Johnson (1996) on a group of fifth graders showed that cooperative and individual concept mapping conditions promoted the use of effective learning strategies more than traditional teaching.

Again, Nagata and Ronkowski (1998) explained again that the use of collaborative learning groups has shown to increase students' ownership of learning and improve outcomes for students who gain most for collaborative learning. A study conducted by Putnam (1998) emphasized that collaborative learning is aimed at producing academically stronger students. It was claimed in that study that pedagogical concepts have been widely researched, practiced and endorsed by many professionals. Bruffee (1993) insisted that knowledge is built by talking together and reaching agreement.

5.3 Conclusion

From the findings gathered in this research, it was observed that the research objectives were achieved as there was a statistical difference in the academic performance between students exposed to collaborative instructional approach and those exposed to the traditional approach teaching. Students in the experimental group performed better than those in the control. For this, it can be concluded that collaborative learning brings about higher academic achievement. Collaborative learning is an important tool that can be used to improve students' achievement in

any classroom. It fosters tolerance and acceptance in the classroom which improves the students' academic performance in chemistry. Students who work individually must compete against their peers to gain praise or other forms of rewards and reinforcement. In this type of competition, many individuals attempt to accomplish a goal with only a few winners. The success of these winners can mean failure for others. Thus, in a collaborative classroom, there is healthy competition which brings about higher academic achievements.

Collaborative learning brings about improvement in the academic achievement of students with low performance as was observed in this current study. It improved communication skills among the learners. The collaborative approach set the stage for students to learn social skills. These skills helped them to build stronger cooperation among group members. Students in this study also gained leadership skills and trust-building as they learned collaboratively.

5.4 Recommendations

The following recommendations have been put forward based upon the findings of the study.

- Teachers in the Public Senior High Schools in the Central Region of Ghana should be well educated on the relevance of adopting collaborative learning methods during chemistry lessons. This would faster comprehension of topics by students.
- During teaching and learning, chemistry teachers in the Public Senior High Schools should endeavor to make sure that their students play more prominent roles in their own learning by giving more group tasks and assigning each student a particular role in the group.
- Students in Public Senior High School in Central Region of Ghana should be empowered by their teachers to assume responsibility for their own learning. This can be done when

teachers use more innovative teaching methods such as small group discussions and dialogue to empower them to learn. This can be done for instance, if a problem is raised or an idea is introduced and the instructor supervises an intellectual discussion, where students discuss such ideas to arrive at a solution.

- Survey of the educational provisions for teaching science should be conducted among senior high schools offering science within the Effutu Municipality and Gomoa West District to equip teachers with the requisite science materials.
- The Curriculum Research Development Division (CRDD) in planning the curriculum should also take into account, the learners' prior knowledge but not only the structure of the subject. This can be done, for instance, by providing opportunities for students to make their own ideas explicit; encouraging the generation of a range of conceptual schemes; introducing discrepant events.
- School authorities of Ghana Education Service must consider splitting large classes into smaller and more controllable units which will enable teachers to be able to conduct lessons more effectively and easily. Consequently, more teachers must also be recruited to handle these new classes.
- The Municipal Director of Education in the Winneba municipality and other related bodies in education should regularly and periodically be organizing workshops or in-service training (INSET) for teachers teaching chemistry at the various second cycle institutions in the country. Such training should cover innovative and collaborative ways of teaching and learning. This will undoubtedly upgrade the teachers' knowledge and ensure that effective means

of instructions are used in teaching science.

- The agencies associated with science education in the Winneba Municipality and Gomoa West District should make certain structural changes in the field of science education in school to encourage the use of collaborative learning approach in the teaching and learning chemistry.
- Researchers and the curriculum developers should focus on the students' prior knowledge and misconceptions since it is well recognized that most students are unable to effectively learn all of the materials in their lessons.

APPENDICES

APPENDIX A

QUESTIONNAIRE FOR THE STUDENTS

Dear student,

This study is purely for academic purpose. You will be contributing to its success, if you answer the items as frankly and honestly as possible. Your response will be kept confidential. Kindly read through each of the items carefully and indicate the opinion that is the nearest expression of your view on each of the issue raised.

General instruction: Please tick [√] the appropriate bracket or column.

Section A: Bio Data

Class: Science one [ ] Agriculture 2 [ ]

Statement	Strongly Agree	Agree	Not Certain	Disagree	Strongly Disagree
1.The method of teaching adopted by teacher prevents me from understanding hydrocarbons					
2. Hydrocarbons as a topic is too abstract					

3. I am discouraged from studying hydrocarbons because there no textbooks on hydrocarbons.					
4. There are not many prospects in the study of hydrocarbons.					
5. There are relevant equipment and laboratory apparatus in the school to help me study hydrocarbons.					

APPENDIX B

INTERVIEW PROTOCOL FOR STUDENTS

1. Do you share the view that chemistry as a subject is difficult to study?
2. What are some of the topics in chemistry that pose the greatest challenge to you?
3. Can you mention any factors that inhibit your study of chemistry in the school?
4. Can you shed more light on the factors you have mentioned?
5. How do you rate chemistry in relation to other science subjects you study?
6. Are there any factors or aspects of chemistry that you like?
7. If yes, what are they?
8. Would you consider your teacher as a contributing to attitude towards chemistry?
9. How exactly, does your teacher influence your attitude towards the study of chemistry?
10. Do you intend to pursue chemistry further after senior high school?

APPENDIX C

Pre-Test for students on hydrocarbons

This exercise is being conducted for research purposes only. Its main objective is to find out your knowledge about hydrocarbons. Because of this, marks obtained on the test will be treated confidentially. It is hoped that the information gathered from your responses will be of much benefit to chemistry teachers as it will provide them with a guide in planning and teaching of this topic in schools.

Thank you for your cooperation.

Bio data of respondent.

Please, write your name, age, sex, class and date in the spaces provided below.

Name: …….. Age: …… Sex: …… Class: …….

Date: ……..... Time allocated: …….

Instructions: Answer all the questions on this paper.

1. The organic compounds that contain the elements hydrogen and carbon only are termed…….
2. The general molecular formula of alkanes is ……
3. The formula of methane is
   A. CH
   B. CH_2
   C. CH_3

D. CH_4

4. Alkanes are referred to as …….

5. Alkenes are referred to as ……...

6. The formula of ethane is

   A. C_2H_2 B. C_2H_4 C. C_2H_6 D. C_2H_8

7. Alkanes are also called……...

   A. Paraffins

   B. Olefins

   C. Saturated

   D. Cyclic

8. The general formula of alkynes is ……

9. Which of the following is a gas?

   A. C_4H_{10}

   B. C_5H_{12}

   C. C_6H_{14}

   D. C_7H_{16}

10. Hydrocarbons that contain at least one double bond are called……

11. Hydrocarbons that a single bond are called……

12. Which of the following is called acetylene?

    A. C_3H_4

    B. C_2H_4

    C. C_2H_6

D. C_2H_8

13. Which of the following is not a saturated hydrocarbon?

A. C_3H_4

B. C_4H_8

C. C_4H_{10}

D. C_5H_8

14. The first member of alkenes….

A. pentylene

B. Butylene

C. propylene

D. ethylene

15. Give one source of alkanes…….

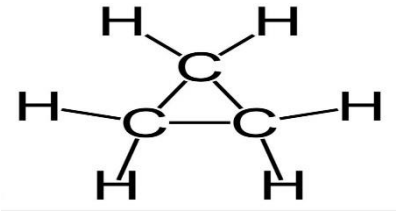
16. Give the IUPAC name of the following structures. (A) $C(CH_3)_4$, (B) CH_2CHCH_3, (C) $CHCCH_3$

A. ……..

B. ……..

C. …….

17. The IUPAC name of the structure below is …….



18. The first member of alkynes is called……...

19. Aromatic hydrocarbons are also called……...

20. Straight chain hydrocarbons are called……...

21. Ring chain hydrocarbons are called……...

22. Benzene is …...

    A. Aliphatic

    B. Alicyclic

    C. Heterocyclic

    D. Aromatic

23. Any atom or group of atoms except hydrogen which is bonded to the longest continuous carbon chain is called……

24. …….. is an atom or group of bonded atoms which give an organic compound its chemical properties.

25. The series of compounds with similar structural features and which differ from adjacent members by fixed number of atoms is called……

26. The number which indicates the position attachment of groups is known as ……

27. In a molecule in which there is more than one functional group, the dominant or the most important functional group is called……

28. The IUPAC name of the structure below is……...

$CH_3CHBrCH_3$

A. 1-bromopropane

B. 2-bromopropane

C. 3-bromopropane

D. 4-bromopropane

29. The IUPAC name of $CHCC(CH_3)_3$ is

A. 1,1-diamethyl-1-propyne

B. 2,2-dimethyl-1-propyne

C. 3,3-dimethyl-1-propyne

D. 4,4-dimethyl-1-propyne

30. The structure of 2-chloropropane is

A. $CH_3CHBrCH_2CH_3$

B. $CH_3CHBrCH_3$

C. $CH_3CHBrCH_2CH_3$

D. $CH_3C(Br)_2CH_2CH_3$

31. The structure of benzene is ……...

32. The functional group of the structure below is ……

CH_3CCCH_3

33. The cooking gas is mainly a mixture of the following gases

A. Methane and Ethane

B. Ethane and Propane

C. Propane and Butane

D. Butane and Pentane

35. Which of the following products is used for construction of roads?

A. Coke

B. Bitumen

C. Paraffin

D. Naphthalene

36. Which of the following substances is not an aromatic compound?

A. Benzene

B. Naphthalene

C. Anthracene

D. Hexene

37. Petroleum is a mixture of ……

A. Hydrocarbon

B. Salts

C. Polymer

D. Element

38. Which of the following carbon compounds will not give a sooty flame?

A. Benzene

B. Hexane

C. Naphthalene

D. Anthracene

39. What is the molecular formula of Butyne?

A. C_2H_2

B. C_4H_{10}

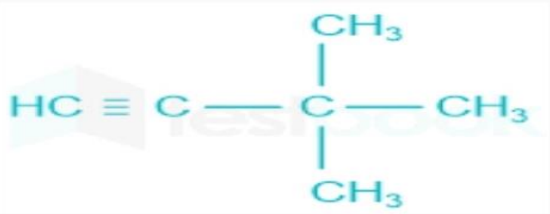
C. C_3H_4

D. C_4H_6

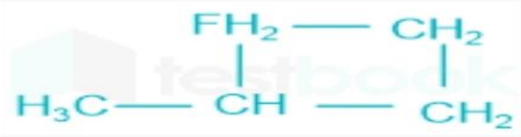
40. Which of the is an unsaturated compound?

A

B



C



D

APPENDIX D

Post-Test for students on hydrocarbons

This exercise is being conducted for research purposes only. Its main objective is to find out your knowledge about hydrocarbons. Because of this, marks obtained on the test will be treated confidentially. It is hoped that the information gathered from your responses will be of much benefit to chemistry teachers as it will provide them with a guide in planning and teaching of this topic in schools.

Thank you for your cooperation.

Bio data of respondent.

Please, write your name, age, sex, class and date in the spaces provided below.

Name: …….. Age: …… Sex: …… Class: …….

Date: ……..... Time allocated……...

Instructions: Answer all the questions on this paper.

1. Alkanes undergo which of the following reactions?
    A. Halogenation
    B. Chlorination
    C. Substitution
    D. hydrogenation
2. The structure of cis-2-butene is ……
3. Which of the following can decolourised bromine water?

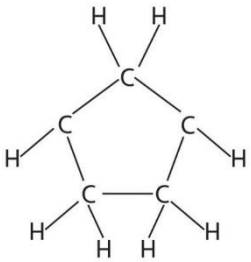
A. CH_4

B. C_2H_4

C. C_2H_6

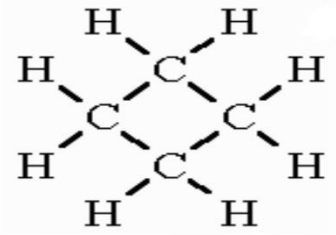
D. C_3H_8

4. Give the IUPAC name of the following.

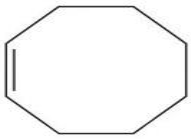


A

B



C



D

5. The structure of trans-2-butene is…….

6. CH_3 is called

A. Methene

B. Methane

C. Methyl

D. Methene

5. CH_3CH_2 is called

A. Ethylene

B. Ethyl

C. Ethane

D. Ethel

6. An example of an aliphatic hydrocarbon is …….

7. The structure of 2-butyne is

A. $CHCCH_2CH_3$

B. CH_3CCCH_3

C. $CH_3CH_2CH_2CH_3$

D. $CH_2CHCH_2CH_3$

8. Arrange the following compounds in order of increasing boiling point.

C_2H_6, C_4H_{10}, C_3H_8, CH_4

9. What is observed when potassium permanganate reacts with unsaturated hydrocarbons?

10. Distinguish between propene and propyne.

11. Hydrocarbons with triple bond is called…….

12. Which of the following compounds is not saturated?

A. CH_4

B. C_2H_6

C. C_3H_4

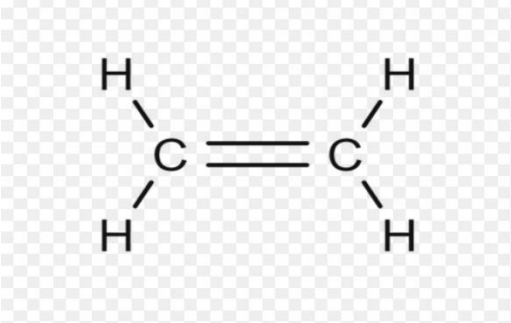
D. C_4H_{10}

13. The phenomenon in which more than one compounds have the same chemical formula but different chemical structures is called……...

14. Arrange the following compounds in order of increasing boiling points

C_2H_4, C_4H_8, C_3H_6, C_5H_{10}

15. The structure below is called



15. Cracking is the……

16. The two types of cracking are ……... and

……

16. Resonance occurs ……...

17. The isomers of propane are

A. 1

B. 2

C. 3

D. 4

18. The molecular formula of propane is ……...

A. CH_4

B. C_4H_{10}

C. C_3H_8

D. C_2H_6

19. A hydrocarbon in which two carbon atoms are joined by double is called as an …

A. Alkane

B. Alkene

C. Alkyne

D. Ionic bond

20. Cycloalkanes are……

SECTION B

Answer all the questions on this paper

1. Describe a simple test to distinguish between saturated hydrocarbons and unsaturated

hydrocarbons

2.Give the IUPAC name of the following compounds.

(a) $CH_3CH(CH_3)CH(CH_3)CH_3$

(b) $CH_2BrCHBrCH_2Br$

©. $CHCCH_2C(CH_3)C(CH_3)2CH_3$

3. Give the product and its IUPAC name of the following reactions

(a) $CH_2CH_2 + Br_2 \rightarrow$

(b) $CH_3CH_3 + Br_2 \rightarrow$

© $C_5H_{12} + O_2 \rightarrow$

(d) $CH_2CH_2 + HCl \rightarrow$

4. Give the major products of the following reactions and its IUPAC name.

(a) $CH_3CHCH_2 + H_2O \rightarrow$

(b) $CH_3CHCH_2 + H_2O \rightarrow$

5. Give the structure of the following IUPAC names.

(a) 2-bromo-2-metdimethylbutane

(b) 2-chloro-2-fluoro-3,3-dimethylhexane

6. Give two isomers of the following compounds

(a) C_4H_{10}

(b) C_4H_8

© C_4H_6

7. Why do alkenes prefer to undergo electrophilic addition reaction while arene prefer electrophilic substitution?

8. Name two reagents that can be used to distinguish between ethene and ethyne.

9. How will you detect the presence of unsaturation in an organic compound?

10. What are the sources to obtain LPG?

11. Arrange the following in the decreasing order of acidic character.

C_2H_4, C_2H_6, C_2H_2

12. Name two industrial sources of hydrocarbons

…….

…….

13. Arrange the following in the increasing order of c-c bond strength

C_2H_6, C_2H_4, C_2H_2

14. When acetylene is treated with HBr, the product is ……

15. Liquid hydrocarbons is converted into gaseous hydrocarbons by …….

16. Chlorination of alkanes is an example of …….

APPENDIX E

RELIABILITY COEFFICIENTS OF QUESTIONNAIRE

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Item	N of Items
.780	.761	8

Case Processing Summary

	N	%
Cases valid	106	100.0
Excluded [a]	0	0
Total	106	100.0

a. List wise deletion based on all variables in the proceed

INDEX