AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT

COMPARATIVE EFFECT OF REACT TEACHING STRATEGIES AND CONVENTIONAL TEACHING APPROACH ON SENIOR HIGH SCHOOL CHEMISTRY STUDENTS' ACADEMIC PERFORMANCE IN ALKENES

BAWA NLANBITABINI MOSES

DECEMBER, 2023

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BY

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DECEMBER, 2023

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree at this university or elsewhere.

Bawa Nlanbitabini Moses

Signature: …………………………………. Date:…..……………………………

Supervisor's Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the Akenten Appia-Menka University of Skills and Entrepreneurial Development.

Dr. Charles Amoah Agyei (Principal Supervisor)

Signature: …………………………………. Date:…..……………………………

Professor Kofi Sarpong (Co-Supervisor)

Signature: …………………………………. Date:…..……………………………

ABSTRACT

The study examined the comparative effect of REACT teaching strategies and conventional teaching approach on Senior High School (SHS) students' performance in the concepts Alkenes in Chemistry in Lambussie District, Upper West Region, Ghana. By adopting the embedded mixed method approach, the research design employed in this study was the quasi-experimental using pretest and posttest non-equivalent control group design. Sample population of eighty-seven (87) SHS 3 students drawn from two intact classes (all the students in the class) were used for the study. Instruments known as Alkenes Concepts Test (ACT), as well as an interview guide were used to gather data for the study. Mean, standard deviation, frequencies, percentages, mean differences, independent sample t-test, and thematic analyses were used to answer the research questions, while independent sample t-test was used to test the hypotheses. The results showed that students taught using REACT teaching strategies obtained higher marks in the Alkenes Concepts Test (ACT) than those taught using conventional teaching method. Also, there was no gender distinction in overall performance on the use of REACT teaching strategies, but gender differences existed in performance by using the conventional teaching method. Students taught using REACT teaching strategies, therefore perceived that REACT teaching strategies helped them to understand alkenes concepts better by relating concepts to previous knowledge, participate fully during lessons, and retain concepts well. Based on the results obtained, it was therefore recommended amongst others that SHS teachers in Lambussie, are encouraged to use REACT teaching strategies when teaching Alk

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DEDICATION

To the entire Bawa family, my lovely wife, Bonyeh Jennifer and my daughter Esther Bawa

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CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter contains the background to this study, problem statement, main objective, specific objectives of the study and research questions. It also emphasizes on significance of the study, delimitations, and limitations. The terms used in the study is also defined operational, and the study's organizational structure are all captured.

1.1 Background to the Study

As explained by ladejo, A. I., Nwaboku, N. C., Okebukola, P. A., & Ademola, I. A. (a). (2021) and corroborated by Anim-Eduful & Adu-Gyamfi (2022), it is a reality that the fields of Science, Technology, Engineering, and Mathematics (STEM) play a widespread position in the socio-economic growth of most regions of the world. Therefore, without doubt, investments in STEM education are essential for a country' monetary, competitiveness, progress, and high well-known of residing as the globe become extra and greater globalized. One of the biggest investments, any country can make in STEM, according to Vivian (2018) is ensuring that her citizens are well trained to be well equipped with knowledge and skills needed for a fast-growing technological world, of which Chemistry is no exception. As a result, researchers and educators are constantly looking for ways to make sure that facilitating and mastering Chemistry at various levels of schooling is advantageous in order to improve students' mastering effects in Chemistry.

According to the Ministry of Education (2010), Chemistry is involved with the find out about matter and its changes. Hence, it is about us humans and the whole things around us.

Chemistry continues living matters alive via the numerous adjustments that take place in our bodies around us for instance, there is chemistry in clothing, food, shelter, medicine and transportation system. Chemistry also exists in the outer space. Household items like plastics, soap, radio, TV, video and computers would not exist without chemistry. Chemistry allows us to explain, understand, control and stop phenomena like bush fires, industrial pollution, corrosion of metals and the depletion of the ozone layer. Chemistry is consequently a challenge of crucial importance for life Ministry of Education (2010).

One of the major areas studied in the Ghanaian SHS Chemistry curriculum is Organic Chemistry (Ministry of Education, 2010) due to its vital role it plays in the life of man according to Anim-Eduful and Adu-Gyamfi (2021). It is not possible to undervalue importance of organic chemistry. According to Adu-gyamfi and Asaki (2022), its influence on contemporary science and technology, as well as on our ideas, lives, and the state of the planet, cannot be overemphasized. Everything we consume, including the carbohydrates, proteins, fats, and oils, as well as the clothing we wear, plastics, and medications we take, has its origins in organic chemistry. Due to the numerous benefits of organic chemistry in our lives as well as the requirement for scientific advancement, organic chemistry education must always be given priority. To understand chemical interactivity in living creatures and products that are produced from them, organic chemistry examines properties, structure, and reactivity of organic compounds that contain carbon atoms in covalent bonds (Adu-Gyamfi & Asaki, 2023). Adu-Gyamfi and Asaki (2023) claim that the study of structure identifies an object's chemical formula and composition; the study of properties examines an object's physical and chemical characteristics; while the study of chemical reactivity is to comprehend its behavior. However, the knowledge will come to light when a concept introduced in organic chemistry called "functional group" is understood (Anim-Eduful & Adu-Gyamfi, 2021). Functional groups, according to Petrucci et al. (2011) These structures give organic molecules their characteristic properties by attaching individual atoms or groups of atoms to carbon chains or rings . According to Petrucci et al.(2011) generally, compounds with similar functional groups exhibit similar chemical and physical properties. Wade (2013) also added that Chemical functional groups include double bonds (C=C), triple bonds (C≡C), hydroxyl groups (–OH), carboxyl group (–COOH), etc. that are reactive (P. 73). To Wade (2013), functional groups are commonly used to describe and classify organic compounds. Hence, examining the properties associated with specific functional groups is a convenient way to study organic chemistry as agreed by Petrucci et al. (2011).

From the Ghanaian Senior High School (SHS) syllabus, one major functional group which Chemistry students are exposed to during organic chemistry teaching and learning in chemistry is alkenes (Ministry of Education, 2010). A double bond between two carbon atoms is one of the characteristics of alkenes, a type of hydrocarbon that is, C=C (Wade, 2013). However, Petrucci et al. (2011) suggest that these double bond could be one or more in a particular organic compound . In this scenario, the double bond is hence referred to as the alkene's functional group. Some concepts which are studied under the alkene functional group according to the Ministry of Education (2010) are various structures of alkenes, naming of alkene compunds, reactions involves alkene double bond , physical and chemical properties of alkenes, isomerism of alkenes, as well as preparation and uses of alkenes.

Notwitstanding, various researchers have reported that Chemistry students generally encounter diverse difficulties in alkenes. For instance, Adu-Gyamfi et al. (2012) reported that IUPAC names were difficult to write correctly by the majority of Chemistry students .To Adu-Gyamfi et al.(2012), 75.1% of the students were unable to write the correct structural formula for 4-ethyl-2,3-dimethylhex-2-ene. Şendur (2012) also revealed that aspiring science educators were having misapprehension about a number of subjects, including the creation of alkenes from alcohols and alkyl halides, geometric and structural isomerism, the use of Markovnikov's and Markovnikov's anti-rules, Markovnikov's nomenclature for cycloalkenes, polymerization reactions, and nomenclature for cycloalkenes. Again, in a study by Nartey and Hanson (2021), it was found that students perceived preparation and Alkene chemical reactions challenging to comprehend. Adu-Gyamfi et al. (2017) revealed that most chemistry students had trouble naming any alkenes or dienes(that is an alkene compund with two double bonds) with branched or substituted chains.These students' difficulties have been reflected in their final external examinations as the Chief Examiners of the West African Examination Council (WAEC) revealed that the majority of candidates were unable to create the proper diagram to show how an alkene forms a C=C double bond. (WAEC, 2017). Also, according to the chief examiners report, candidates' did exhibit inadequate knowledge of organic chemistry concepts (WAEC, 2018). Further, the inability of candidates to select organic compound that could be cracked, undergo substitution reactions from a list of compounds was also stated as major difficulties by candidates in Chemistry (WAEC, 2021).

In an attempt to solve this major problem, researchers sought to ascertain the possible causes of students' conceptual challenges encountered when teaching organic chemistry. For instance, Anim-Eduful and Adu-Gyamfi (2022) stated that students consider the organic chemistry concepts to be too abstract, which they could not relate to their real worlds. Appiah-Twumasi (2020) and Sibomana et al. (2021) also found out that educators use ineffective instructional strategies to deliver content throughout the science concept teaching and learning process, including organic chemistry. This results in students memorizing concepts which needed not to be memorized, thus, creating a shallow understanding of the subject, and students tending to see the content not having meaning to the lives. This challenge has been investigated to be mitigated when teachers employ effective teaching strategies which will help them deliver meaningful contents to students, thereby expanding their understandings Appiah-Twumasi (2020) and Sibomana et al. (2021).

These teaching strategies can be categorized into two approaches: learner-centered and teacher-centered (Cole-Onaifo, 2022). Lak et al. (2017) explain, "student-centered" puts the student at the core of the educational process, also the student is at the center of the process and the teacher in the classroom only takes on the role of the center of the process once it has begun. This is because, an active learning environment is produced by student-centered teaching, where teachers are seen as facilitators and students as active learners (Bekenova & Nygatayeva, 2017), whereas in the teacher-centered classroom, students become passive recipients of teachers' knowledge (Lak et al., 2017), and only listen to the teacher "talk and chalk" (Romanus & Ifenyinwa, 2020). By this approach, the teacher makes all the choices pertaining to the curriculum, instructional strategies, and various assessment formats. One indicator of the teacher-centered teaching approach is rote-memorization, where students learn by repetition so as to remember every word verbatim (Bekenova & Nygatayeva, 2017). Because of this, students soon forget concepts being taught since they learned it abstractly (Felder & Brent, 2017). One major example of the teacher-centered approach according to Felder and Brent, (2017) is the lecture method. The teacher-centered approach to teaching is frequently referred to as the "traditional" or "conventional" teaching style since it was widely adopted by teachers across the globe prior to the development of the modern, student-focused methodology (Lak et al., 2017). However, Chen et al.(2013) argue that conventional instructions do not focus on detecting and correcting learner misconceptions.

However, in a learner-centered classroom, students gain more control over what they learn, how they learn it, and when they learn it by actively engaging in the teaching and learning process. (Lak et al., 2017). That is, the teacher designs the lessons to suit the needs of the learners. This indicates that Students take responsibility for their education and actively participate in the learning process. A learner-centered teaching style places more of an emphasis on how students learn than on how teachers instruct (Lak et al., 2017). In a student-centered learning environment and the teacher's responsibility shift towards facilitation of learning rather than transmission of knowledge, hence the classroom teacher becomes a facilitator or guide, and not an instructor-which is associated with the teacher-centered teaching approach (Lak et al., 2017). Also, there is a shift in the balance of power in the classroom, that is the teacher assumes a democratic attitude and not see his transferred knowledge as unquestionable. Further, students develop positive attitudes towards the learning content and there is a facilitation of increased student responsibility for learning, thus students become autonomous in the learning process (Bekenova & Nygatayeva, 2017). When students become active in the learning process, their critical thinking skills – the process of questioning and challenging existing and long-held assumptions, creativity skills and higher-order thinking skills of learners – which according to the Ministry of Education (2010) are the objectives of science instruction– are developed. The REACT teaching strategies, which places much emphasis on context-based teaching is a student-centered approach. In Ghana, the teaching of Chemistry emphasizes the employment of such student-centered and activity-oriented strategies, where the learner is the focal point of the instructional process Ministry of Education (2010).This will give all students equal access to the understanding of the content.

Students' academic performance according to Husaini and Shukor (2022) is essential for determining a student's academic status during an instruction or a course. It enables decision-makers, academic staff, and educational administrators to accurately assess the efficiency of the teaching and learning process as well as the students enrolled in different courses throughout the course of a semester. Thus, a student, by knowing their performances in an instruction will serve as guide to make adjustments for subsequent improvements. According to Abanikannda (2016), student performance is essential to producing the greatest students who will make excellent leaders and provide labour for the country. These students are in charge of the nation's economic and social progress. This means that academic performance is seen as the most important outcome of formal educational experiences (Moore, 2019). One common indicator that affect student's academic performance in Chemistry is teaching strategies employed by teachers (Al-wari et al, 2013). Thus, it makes sense to adopt teaching tactics in the chemistry classroom that will enhance students' academic success. This calls for the use of a more student-centered teaching approach, which will enable students to better understand Chemistry ideas for enhanced academic performance.

Another factor that is documented in literature affects students' academic performance in Chemistry is gender (Ajayi & Ogbeba, 2017). Therefore, studies have looked into how gender affects students' academic performances in Chemistry. For instance, Busolo (2010), and Wrigley-Asante et al. (2023) reported that males perform better than females in Chemistry. Contrarily, Udousoro (2011) and Tambaya others. (2016) discovered no discernible difference in chemistry students' gender. Given the contradictory data in the literature regarding the performance of male and female students in Chemistry, Eya and Ezeh (2020) imply that by implementing proper teaching tactics like REACT (Relating, Experiencing, Applying, Co-operating and Transferring) teaching strategies, the long-standing science achievement gap between male and female students can be closed.

Contextual learning is developed through the REACT approach, which was put forward by Crawford (2001). Contextual learning includes learning from real-world experiences and making connections to academic knowledge. The abbreviation REACT refers to a group of instructional techniques that encourage student participation and active learning in the classroom. A distinct strategy is represented by each letter in REACT; these include cooperating, transferring, applying, experiencing, and relating. (Ültay et al., 2017).

The REACT teaching strategies have been found to improve students' academic performances. For example, According to Günter (2018), the REACT teaching strategies increased students' understanding of the concept of solubility equilibrium. Additionally, REACT method was proven to be effective at addressing alternate concepts in solution chemistry, according to Ültay et al. (2017). Again, teaching using the REACT technique has a favorable impact on students' attitudes and academic motivations for biology according to Kaya and Gül's study in 2021. However, it seems little or no literature work has been reported in Ghana, particularly in the field of Chemistry to determine its efficacy on students' academic performance and impact on gender. Therefore, this investigation was required.

1.2 Statement of the Problem

The study of organic chemistry is essential to human existence on a daily basis.This is because organic chemistry is the foundation of all the foods we eat, including the sugars, proteins, fats, and oils, as well as the clothes we wear, plastics, and medicines we take (Anim-Eduful & Adu-Gyamfi, 2021). Organic compounds, their structures, properties and reactions which are studied in organic chemistry, according to Petrucci et al. (2011) only be well understood when their "functional groups" are well grasped. One of these functional groups which is documented in the literature that students find difficult is alkene, it has a double bond (C=C) between two carbon atoms. Some of the reported challenges encountered by students vary. For example, from writing the correct structural formula of alkenes and naming of alkene compounds (Adu-Gyamfi et al., 2012, 2017) to challenges with comprehension chemical reactions, preparation (synthesis), isomerism (Nartey & Hanson, 2021), as well as general misconceptions in alkene concepts (Şendur, 2012). These students' difficulties have been reflected in their final external examinations as according to the examiners of the West African Examination Council (WAEC), most applicants were unable to create the correct diagram that would have shown how the C=C double bond in an alkene is produced (WAEC, 2017). Also, to the chief examiners, candidates' exhibited inadequate knowledge of organic chemistry concepts (WAEC, 2018). Furthermore, the inability of candidates to select organic compound that could be cracked, undergo substitution reactions from a list of compounds was also stated as major difficulties Chemistry candidates encountered in the area of alkenes (WAEC, 2021). But these are Chemistry students who are being trained to take over the medical and engineering fields of the economy in the future. As a result, it presents a great urgency for educators and various stakeholders to find solution to this problem.

The literature (Anim-Eduful & Adu-Gyamfi, 2022; Appiah-Twumasi, 2020; Sibomana et al., 2021) reports that such difficulties partly stem from the inappropriate instructional strategies employed by teachers during the instructional process, thereby rendering the concept learnt too abstract. Such teaching strategies, according to Cole-Onaifo (2022) and Lak et al. (2017) are classified as teacher- centered or learner-centered. But in Ghana, the teaching of Chemistry requires that teachers employ student-centered instructional strategies thereby creating more opportunities for the student to practice the content through diverse activities. Nevertheless, since the syllabus was not specific concerning which teacher-centered instructional strategies to employ, it therefore creates room to investigate the efficacy of the REACT teaching strategies, which is a learner-centered strategy, on students' academic performances in alkenes.

1.3 Purpose of the Study

This study's looks into the comparative effect of REACT teaching strategies and conventional teaching approach on senior high school chemistry students' acadamic performance in alkenes.

1.4 Objectives of the Study

The specific goals of the research are to:

1. identify SHS Chemistry students' difficulties in studying alkenes.
2. ascertain the impact of the traditional teaching (conventional approach) method and the REACT teaching strategy on the academic achievement of SHS Chemistry students studying alkenes.
3. ascertain the disparity in the academic achievement of male and female SHS Chemistry students in the alkenes subject taught utilizing the REACT teaching technique.
4. Ascertain the perception of SHS Chemistry students regarding the application of the REACT teaching approach in the instruction and comprehension of alkenes.

1.5 Research Questions

1. What difficulties exist among SHS Chemistry students studying alkenes.
2. What is the difference in the academic achievement of SHS Chemistry students who are taught using the REACT teaching strategy and those who are taught using the traditional way when it comes to studying alkenes?
3. What are the disparities in academic performance between males and females students taught using REACT teaching strategies?

4. What perceptions do SHS Chemistry students have about the use of the REACT teaching approach to the study and instruction of alkenes?

1.6 Significance of the Study

In order to improve students' academic performance, this project will first educate Chemistry teachers in Lambussie district on the value of implementing suitable student-centered teaching methodologies. Secondly, the instructional plan developed in this study will help educate teachers about h ow to use the REACT teaching technique to teach. Also, it will inform teachers about the importance of REACT which involve relating concepts to the contexts of students, cooperation, transferring, applying, experiencing.

1.7 Justification of the Study

Many studies have been done on the REACT teaching methods, but it appears that not much study has been done in Ghana in particularly in the field of chemistry and on gender, Adu-Gyamfi and Asaki (2022)

1.8 Delimitation of the Study

The study considered structures, nomenclature, reactions and isomerism in alkenes. As a result, not all concepts under alkenes were considered. These topics were taken into consideration because they are the common concepts that students encounter difficulties as reported in the literature. Also, they appear almost yearly in WASSCE and because WAEC and other researchers have found that these are the concepts that students struggle with the most. Again, only SHS three elective chemistry students within the Lambussie District could participate in the study, because organic chemistry, where alkenes are studied, is treated in SHS three according to the Ministry of Education (2010). Another restriction was that while a quasi-experimental approach was used, not all Upper West Region schools were able to take part in the research. Schools in one district were chosen to take part in this investigation.

1.9 Limitations of the Study

The researcher's own bias may also be introduced by the design employed, because researcher was the same person that taught both the experimental and control group and also conducted the semi structured interview.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

A review of the literature that is relevant to this topic is presented in this chapter. The theoretical review is presented in this chapter. This chapter also highlighted the empirical review of the study, which analyzed earlier research that was relevant to the current investigation. A summary of the reviewed literature closes the chapter.

2.1 Theoretical Review of the Study

Constructivism theory forms the basis of this investigation. Constructivist theory, commonly known as constructivism, is a theory of learning that maintains that learners combine newly acquired information with previously learned knowledge to produce new meanings and understandings (Gupta, 2013). Even physical laws, according to a constructivist, exist because they have been created by individuals based on data, observation, and logical or intuitive reasoning. More essential, however, is the fact that specific communities of individuals (in this example, scientists) have mutually agreed upon what constitutes valid knowledge. Therefore, the constructivist perspective asserts that knowledge is created by people or groups making meaning of their experiential realities rather than passively being acquired from the outside world or from reliable sources (Gupta, 2013).

Students actively participate in the learning process and the teacher functions more as a facilitator in a constructivist classroom. According to this concept, a teacher who serves as a "facilitator" who mentors, directs, and coaches students to interpret the course material independently (Umida et al., 2020). In order to work together to create new information, students are encouraged to interact and share their thoughts.(Herlina & Ilmadi, 2022), as it occurs in the “cooperating” stage of the REACT teaching strategies. This means that the students are increasingly becoming or assuming the center of instruction instead of the teacher. Today’s learners, according to Umida et al. (2020), are not passive sponges waiting to be filled with knowledge by their knowledgeable teacher in the classroom. Constructivism, according to Gupta (2013) is not a unitary theoretical position; rather, it is a continuum. However, the two most well-known constructivist approaches are cognitive constructivism (propounded by Jean Piaget) and sociocultural constructivism, which was propounded by Lev Vygotsky (Begg, 2015; Efgivia et al., 2021).

In opposition to conventional behaviorist ideas, Piaget created his cognitive constructivist theory. The basic tenet of his theory is that children’s intellect varies as they mature and that environmental factors and biological maturation are responsible for cognitive growth (Schunk, 2012). Piaget believed that the human mind developed through interaction with its surroundings, but in sequentially essential physiological stages that resulted in knowledge and abilities that were adaptively structured. These cognitive phases evolve in a complex, natural way that is important for adaptive functionality, along with other changing behavioral and emotional traits (Hruby & Roegiers, 2013). These developmental stages, according to Piaget (1976), are attained by the acquisition of specific schemas, also defined by Hruby & Roegiers (2013) as "regimens, skill sets, or procedures," which initially address the needs of present development but can thereafter be analogously applied to new experiences, circumstances, or scenarios. Significant structural alterations to the knowledge base of the type that denote a behavioral stage-shift are necessary when previously adaptable schemas prove to be inadequate for a child's needs. The cognitive dissonance brought on by this inadequacy facilitates the next stage in the developmental process by motivating the kid to explore in order to have a more satisfying engagement with the world. However, for an individual to develop cognitively, Piaget assumed that one must “adapt” to an evolving body of knowledge (Piaget, 1976). The process of adapting or resolving the conflict which the individual experiences in the face to this new knowledge is called “equilibration”. The biological desire to create the best possible condition of equilibrium (or adaptation) between cognitive structures and the environment is known as equilibration (Schunk, 2012).

Therefore, youngsters use the adaption processes of "assimilation" to increase their knowledge of the environment and help them make sense of it. “Assimilation” means fitting new information to match current knowledge; and “accommodation”, which means changing preconceived notions in response to new information. Put another way, the integration of less complex knowledge concepts with more complex ones is the means by which cognitive mental progress is attained at every developmental stage. In light of this, Piaget believed that growth would occur organically as a result of repeated interactions with the natural and social contexts. There are internal variables that trigger developmental change. Environment and other extrinsic factors can influence growth, but they cannot direct it. As a result, Schunk (2012) emphasized the significance of providing children with rich environments that support active learning and hands-on activities. Knowledge construction that is active is made easier by this design. Furthermore, the content should be neither too easy nor too hard to accommodate. Even though Piaget's theory maintains that social interaction is necessary for development to progressed, (Schunk, 2012), Nonetheless, Vygotsky (1994) asserts that the social environment is a crucial source for cognitive growth. Thus, Vygotsky highlighted that the key to human development in the learning process is the combination of interpersonal (social), cultural–historical, and individual elements. He denied Piaget's assertion that learning can be separated from context and claimed that culture had a major influence on the development of cognitive ability. In other words, learners' interactions with the people, things, and institutions in their environments change the way they think. The social environment's "tools," or cultural artifacts (such vehicles and machinery), language, and social structures, have an impact on cognition (e.g., schools, churches). Therefore, applying cultural skills in social interactions and internalizing and cognitively changing these encounters lead to cognitive transformation. Concepts get new meanings as they become connected to the outside world. For instance, according to Schunk (2012), "School" is an institution that aims to advance citizenship and learning, not just a term or a physical building. Accordingly, first stage of the REACT strategies assumes that the subject matter should be linked with the context of the learner for the learner to make a concrete meaning of the content.

Also, the social constructivism theory gives relationships and small groupings a lot of attention. According to Vygotsky, learning is limited to what a person already knows without interactions with others. While teachers encourage and assist talk by utilizing the organic flow of discourse in the classroom, students learn largely via interactions with their peers, teachers, and parents. According to Vygotsky, social interactions produce language, writing, and concepts that stimulate higher order cognitive processes.

The zone of proximal development, or ZPD, is a central idea in Vygotsky's theory of social constructivism. It highlights the importance of the teacher in a student's education. The ZPD outlines the tasks that a pupil can complete on their own and those that they require assistance from a teacher or more experienced classmates to complete. According to the ZPD, pupils can comprehend and acquire knowledge and abilities that they would not be able to do on their own with the assistance of an instructor. Students are capable of finishing a task on their own once they have mastered it. As a result, rather than acting as a passive figure, the instructor actively contributes to the learners' knowledge gain. Cognitive development in the ZPD is brought about by the instructor and learner sharing cultural tools, and when this culturally mediated interaction is internalized by the learner, it also brings about cognitive change. Although there is a lot of focused engagement required for ZPD work, Schunk (2012) asserts that children do not automatically or accurately reflect events when they learn about culture through these encounters. As an alternative, students approach social interactions with their own conceptual frameworks and give them significance by combining them with their personal experiences. In contrast to representing a gradual accumulation of information, learning typically happens all at once in the sense of gestalt comprehension.

There are various approaches to assist learners in developing cognitive mediators through their social environment. The idea of instructional scaffolding, as defined by Schunk (2012), is frequently used in applications. It is the practice of limiting task aspects that are difficult for learners to complete so they may concentrate on and become proficient in the task's easier components. In an instructional setting, the majority of the work may first be completed by the teacher, and then the learners and the teacher will share responsibilities. This is evident in the "Experiencing" and

"Transferring" stages of the REACT teaching strategies. The teacher progressively removes the scaffolding as students gain proficiency so they can work on their own. Making sure the scaffolding keeps students in the Zone of Proximal Development (ZPD), which rises as students gain skills, is crucial. It is a struggle for the students to learn inside the ZPD. Peer collaboration is a significant application area that embodies the concept of collaborative activity. The shared social interactions that occur when peers collaborate on projects might have an educational purpose. As a result, the REACT teaching strategies houses in themselves the "Cooperating stage" to help learners interact among themselves and the teacher during the instructional process.

2.2 The Concept of Teaching Strategies

According to Dorgu (2015), The phrase "teaching strategies" describes a range of methods that educators use to introduce their material to students in a way that aligns with a set of learning objectives and fosters understanding. But a teacher will have an affiliation for a teaching method based on their philosophy of imparting knowledge. It is by this philosophy that will make a particular teaching strategy effective to the teacher.

The use of effective teaching strategies helps pupils learn and receive information and acquire new skills. In the classrooms, there are a variety of teaching techniques that can be applied; it is up to the instructor to choose those that are most suited for the lesson. When effectively applied, these techniques will improve instruction and learning while also affecting pupils in the way that is intended. Different teaching methods can be used in combination with each other or in different combinations throughout a lesson or course. Selecting the best teaching method for the unique learning objectives and student demands is crucial. The method a teacher uses to teach a subject can either make it engaging or tedious (Assem et al., 2023)

2.2.1 Learner-Centered Teaching

Montessori education in 1917, Dewey's progressive education in 1938, and Carroll and Bloom's mastery learning in 1963 and 1968 are some of the early educational movements that paved the way for learner-centered education (An & Mindrila, 2020). Instruction that centers on the student and their actions is known as learner-centered instruction. In other words, it sees learners as active agents. The knowledge, experiences, culture, and beliefs that each student brings to the classroom have an impact on how they learn and assimilate new material (Olugbenga, 2021). The instructor's job is to create conducive learning environments, push students to collaborate and learn from one another, and create engaging real-world assignments that stimulate engagement (Ochieng, 2020). Students build knowledge in a learner-centered classroom by acquiring and synthesizing information, which includes explicit skill instruction. As a result, students develop the critical thinking, problem-solving, decision-making, teamwork, evidence-evaluation, argument analysis, and hypothesis-development skills that are essential for mastering the curriculum of the discipline (Olugbenga, 2021). An and Mindrila (2020) noted five characteristics of learner-centered teaching that can be commonly seen in classrooms. Personalized learning activities and support, social and emotional support, self-regulation, collaborative learning, and real-world learning experiences are a few of these qualities. According to McCombs (2015), there is also a benefit to fostering a pleasant learning environment and relationships, adjusting to the demands of the class, supporting the learning process, promoting personal accountability and challenge, and meeting social and individual learning needs.

2.2.2 Teacher-Centered Teaching

Conventional teaching, another name for teacher-centered instruction, describes established methods that have been used in classrooms throughout history (Shuchi, 2017). According to Dimitrios et al. (2013), the syllabus, the teaching materials, and the student assessments are decided by the teacher and communicated to students in numerous lectures, complimented by standard text books and notebooks, which are the main media for learning content (Dutta, 2010; Li, 2016). Thus, this teaching method uses didactic lectures and discussions while the problem-solving component is delivered by and/or discussed with the instructor.

The characteristics of conventional curriculum are subject-matter expert providing learning objectives and assignments, lectures, structured laboratory experiments. In conventional schools, individual department decides about the content coverage of that subject (Dutta, 2010). This means that, in a conventional classroom, instruction is more regimented and monotonous, which does not involve students much, as a result it is more teacher-centered. That is, when the instructor is speaking and writing on the board, some of the pupils will be fidgeting and taking naps, and others will be transcribing what they see into their notebooks.

For a large class of students, the traditional method of teaching is typically used. However, the teacher might not be able to comprehend each student's perspective on their understanding of the material (Bloomfield et al., 2010). As a result, the diverse learning needs of students are not accommodated.

According to Dutta (2010), this teaching method is important for learners who lack self-awareness since it offers a more structured method of instruction. Begum (2018) further argues that it may be used to introduce students to new ideas, and that the instructor can guide the class in an efficient manner by summarizing the main ideas of a chapter or lesson and emphasizing some of the most important and remarkable components. Furthermore, a lot of material can be covered in a short amount of time (Sobirova & Karimova, 2021). As a result, teachers cling to this method of teaching.

But Shuchi (2017) argues that, as knowledge is presented in traditional teaching, it is uncertain if the right information is getting to every student or not. This results from the teacher controlling the majority of the teaching and learning activities without the students' active involvement. As a result, it will be difficult to ascertain whether students grasp the main concepts or not. This can only be known when students have undertaken a “paper-and-pencil test”, since Dutta (2010) explains that the conventional teaching method’s most important component is holding frequent exams. This implies that the students absorb the information passively before reviewing it in preparation for the test.

2.3 The Concept of REACT Teaching Strategies

According to Özbay and Kayaoğlu (2015), REACT teaching strategies are a context-based learning experience that facilitates learners' discovery of information in their own unique worlds, and help them interpret the meaning of teaching and learning materials to create their own understanding. A paradigm of teaching and learning known as contextual teaching and learning pushes educators to relate the material they teach to actual or real-world circumstances. By doing this, students are motivated to put in the time and effort required for learning, as well as, to make connections between information and its applications to their lives as workers, citizens, and family members (Oktavia & Alwasilah, 2017).The REACT teaching strategies proposed by Crawford (2001) consist of five main stages ,where the learner is put at the center of the instructional activity at every stage. They are Cooperation, Transferring, Applying, Experiencing, and Relating. The following provides a quick explanation of each step.

2.3.1 Relating

During the "relating" phase of the REACT teaching process, students start learning within the context of their prior knowledge or experiences. That is, examples from everyday life are used to elicit the learners' interest before being linked to the new concepts that need to be mastered. Even though students may bring memories or existing information to a new learning scenario, they may not see its relevance. The teacher introduces the lesson by providing questions or problems that the students can address based on their past knowledge and experiences. This is known as the "relating stage". Rather of explaining an abstract concept or a phenomenon that is outside the range of the students' senses, comprehensions, and knowledge, the questions are typically related to events that are fascinating and familiar to the students (Crawford, 2001; Quainoo, 2019).

2.3.2 Experiencing

At this stage, as students learn in the framework of discovery, investigation, and creation, they have the chance to participate in activities that are connected to real-world events. As a result, this stage is characterized by hands-on activities, where they put into practice the subject matter through the manipulation of teaching and learning materials. Teachers thus set up an environment that encourages independent learning by giving pupils the tools they need. Students will benefit from having any misconceptions about the subject dispelled in the classroom, which will also boost their motivation and attitude toward learning it (Crawford, 2001; Marlan, 2017).

2.3.3 Applying

During the applying stage, students put the novel ideas or knowledge they have gained in a practical context through class activities, labs, and project work. Teachers can encourage students to understand concepts by giving them exercises that are practical and pertinent, even though they can also use hands-on problem-solving activities, like in the "experience stage". Hussien (2017) claims that the application stage gives pupils the ability to address the problem by putting the idea into practice through many activity answers. As a result, students can now look forward to success in their postsecondary education and professions. In contextual learning courses, applications are often based on job obligations; ideally, these tasks should be real, authentic, and from the real world (Crawford, 2001). These contextual learning opportunities might also include talks by outside speakers and hands-on learning opportunities like plant tours, mentorship relationships, and internships.

2.3.4 Cooperating

By using a contextual teaching technique, students are expected to respond, share, and communicate with one another. As stated by Crawford (2001), making significant progress on very challenging problems within a class period can occasionally be impossible for students working alone. If the teacher does not provide clear instructions, the students could become impatient. However, when they are working in small groups, students can frequently figure out these difficult problems on their own, with little assistance from the teacher. By paying attention to what others have to say, students evaluate and rephrase their own thoughts. Also, they learn to value other learners' viewpoints since sometimes a different solution to the problem may be more successful. Students are more driven and self-assured while working in groups than when working alone to complete a task Crawford (2001).

2.3.5 Transferring

Transferring is described as "applying knowledge in a new context" by Wahyuni (2013), that is, one that has not been discussed in class. Students thus use and build upon what they already know and understand. Acquiring the skill of adapting known knowledge to novel settings empowers students to confidently tackle unknown circumstances and challenges Musyadad and Avip (2020) affirm that the knowledge and abilities that learners already possess are not just memorized; they may also be applied in various situations. Therefore, according to Musyadad and Avip, a student's ability to master cognitive strategies or meet learning objectives is determined by how successfully they apply their newly acquired knowledge to solve fresh issues.

2.4 The Notion of Academic Achievement

The phrase "academic performance" refers to a student's accomplishment following the completion of a course or subject from an institution. It evaluates students' learning in a variety of academic subjects using formative and summative evaluations. It speaks of the results of pupils' efforts to meet certain learning objectives. Academic performance, according to Lamas (2015), is the degree of knowledge demonstrated in a subject or area relative to the norm. Grades, the result of an assessment that involves passing or failing specific tests, subjects, or courses, are used to symbolize this. According to Paudel (2021), a student's academic achievement is crucial because it is employed to increase their intellectual ability. That is, through their performances, teachers can identify learners who require further support and help them so that they can reach their full potential.

Even though academic performance is measured by grades or scores, according to Liem (2019) students' academic performance is a 'net result' of their cognitive and non-cognitive attributes. According to Suvarna and Bhata (2016), this means that academic performance should be considered as a multidimensional construct that covers several learning areas since it takes into account the learners' diverse abilities. These areas—cognitive, emotional, and psychomotor domains—are the "domains of learning" that Bloom et al. (1973) proposed.

According to Hoque (2016), the development of intellectual abilities and knowledge are defined by the cognitive domain. This involves the ability to recollect or recognize particular facts, patterns of behavior, and ideas that support the growth of cognitive capacities. The application of motor skills, coordination, and physical movement are all included in the psychomotor domain. These abilities must be developed by practice and are assessed based on methods, techniques, speed, accuracy, and distance covered. The way we respond to emotions, values, appreciation, fervor, motivations, and attitudes are all included in this domain (Sönmez, 2017). Therefore, in order to have a thorough grasp of the instructional process and assess whether or not the students completed the learning objectives, teachers must consider all three domains while evaluating the academic achievement of their students. In Ghana, students' academic performance is measured using class exercises, class tests, homework, project work and end of term/semester examinations (Ministry of Education, 2010).

2.5 The Concept of Gender

The economic, social, political, and cultural characteristics and opportunities that come with being a woman or a man are referred to as gender. Cultural and historical variations can be found in the social notions of what it means to be a woman or a male. Gender, then, is a sociocultural manifestation of specific traits and behaviors that are connected to specific social groupings concerning their sexual orientation and gender identity. It is a method of examining how opportunities and lives of various groups of men and women are impacted by social norms and power systems. Gender roles are firmly ingrained, yet because social values and standards vary through time, they are also subject to change. For instance, a gender standard in many cultural situations is that men are expected to be the family's primary financial contributors while women are expected to be the home keepers. However, studies show that both men and women can perform tasks that are traditionally performed by men, such as housework and leadership and management roles. The aforementioned suggests that the idea of gender does not support any kind of domination of one group, say males, over another, say females. Therefore, it indicates that men and women should have equal access to education and achieve at comparable levels in the field of education. For example, in a Chemistry classroom, it should be seen that male and female Chemistry students are reaching similar performance levels which can lead to equal opportunities for all students, regardless of gender after schooling. Therefore, Oladejo et al. (2021) claimed that a better examination of what transpires in senior secondary school chemistry classes is necessary to bridge the performance gap between male and female students in STEM. At this point, most students start to decide what job path they want to take in the near future, according to Oladejo et al (2021).

2.5.1 Gender and Chemistry Students' Academic Achievement

Numerous research endeavors have been carried out to examine the impact of gender on students' performance in Chemistry. The results showed conflicting reports in the literature. For instance, Busolo (2010) discovered a substantial correlation between gender and achievement in Chemistry ($r = 0.9880$, $\alpha > 0.001$). Boys' schools outperformed girls' schools as a result. Udousoro (2011) discovered, however, that there was no discernible difference between male and female students' performance in chemistry. The computed t-value, according to Udousoro's (2011) findings, was 1.48, and the matching table value (t-tab), at the 0.05 alpha level, was 1.96. Given that the computed value was below the threshold value, Udousoro came to the conclusion that gender had no discernible impact on chemistry students' academic achievement.

In a similar vein, Tambaya et al. (2016) found that, in Chemistry, male students scored 51.34 on average with a standard deviation of 11.13, whereas female students scored 51.63 on average with a standard deviation of 9.14. At the 81-degree of freedom, a t-value of 1.14 was found and a p-value of 0.91 was noted. Since, there is no discernible difference in the performance of male and female pre-degree students in Chemistry, the crucial P-value of 0.91 was higher than the alpha value of 0.05.

On the other hand, a study by Akunne (2020) discovered that there was a considerable difference in academic achievement levels across genders, with the male and female t-calculated values of 37.49 and 40.43 exceeding the critical t-value of 1.96. As a result, girls outperformed males in terms of academic achievement among undergraduate chemistry education degree students, according to Akunne (2020).

In Ghana, 252 students (54% men, 46% women) were used in the study by Wrigley-Asante et al. (2023) on "*Gender Differences in Academic Performance of Students Studying Science Technology Engineering and Mathematics (STEM) Subjects at the University of Ghana*". The performance of the 252 science students at the SHS level was assessed using their WASSCE grades using a significant chi-square test ($p=0.003$, $\chi2=17.506$). The results showed that, in Chemistry, 89.3 percent of male respondents and 71.7 percent of female respondents received grades between A1 and B3. A Chi-square test revealed a substantial disparity in chemistry grades between the two sexes.

2.6 The Concept of Alkenes

Alkenes are acyclic (branched or unbranched) hydrocarbons with the general chemical formula CnH_2n with a single carbon-to-carbon double bond (C=C). Alkenes are referred to as unsaturated because they have fewer hydrogen atoms per carbon atom than is feasible. Olefins is an ancient term that is still used in the petroleum industry to refer to alkenes. Similar to alkanes, alkenes are created by adding methylene ($-CH_2–$) units to molecules of increasing molecular weight, forming a homologous series. The most basic molecule in the alkene series is ethene, or ethylene (C_2H_4). Propene, or propylene (C_3H_6), butene, or butylene (C_4H_8), pentene (C_5H_{10}), and so forth are the molecules that follow. A double bond that is found at the end of a molecule is called a terminal alkene.

Internal alkenes, on the other hand, are alkenes without a double bond at the end of the molecule. Names for alkenes, their characteristics, their synthesis, and their reactions are a few of the topics covered in the Alkenes course on the SHS curriculum Ministry of Education, (2010).

2.7 Students' Difficulties in Alkenes

The current state of the teaching and understanding of Alkenes to Chemistry students has been well-documented to provide significant challenges. Students studying chemistry typically run into a variety of problems when studying alkenes, according to studies. For example, according to Adu-Gyamfi et al. (2012), the majority of Chemistry students were unable to create the correct structural formulas for the provided IUPAC names. The structural formula for 4-ethyl-2,3-dimethylhex-2-ene was found to be incorrectly written by 75.1% of students, according to the authors. A number of concepts, such as geometric and structural isomerism, the application of the Markovnikov and anti-Markovnikov Rules, the nomenclature of cycloalkenes, polymerization reactions, and the synthesis of alkenes from alcohols and alkyl halides, were among the misconceptions observed by Sendur (2012) in relation to aspiring science teachers.

Once more, it was discovered in the study by Nartey and Hanson (2021) that students thought it was difficult to understand how alkenes are prepared and react chemically.Nartey and Hanson reported that 37% of students said they "comprehended it only after substantial effort" and 24% said they found the preparation and chemical interactions of alkenes "challenging" (p. 334). But Nartey and Hanson asserted that it is possible to say that an idea is fairly difficult if it must be "understood after a considerable effort” in order to be understood. This led to the conclusion that SHS students found the preparation and chemical interactions of alkenes to be challenging. Adu-Gyamfi et al. (2017) revealed that most Chemistry students had difficulty naming any alkene or diene with branched and substituted chains (an alkene compound with two double bonds). For instance, Adu-Gyamfi et al. discovered that most students had trouble naming $CH_3CH{\doteq}CHCH_2C(Cl)(CH_3)_2$. The item's difficulty index for that particular item was estimated to be roughly 0.4 in the findings of Adu-Gyamfi et al. This is due to the fact that only 34.7% of students correctly identified 5-chloro-5-methyl-2-hexene as the IUPAC term. As a result, 65.3 percent of students overall said that they had trouble giving the right IUPAC name.Other inaccurate names provided by students include 5-chloro-5-dimethylprpo-2-ene, 5-methyl-5 chlorohexene, 2-chloro-2-methyl-4-hexene, and 2-chloro-2-methylhexene. Additionally, the authors noted that SHS Chemistry students in the same study found it difficult to give the proper nomenclature for $BrCH{\doteq}CHBr$ (cis-1,2- dibromoethene). Students have given incorrect names such as Cis-1,2-bromoethene, Cis-2,2-dibromethene, and 1-2-dibromoethene. Merely 20.0% of the pupils accurately recognized trans-3,4-dichloro-3-hexene as the IUPAC designation of the trans isomer of the chemical $CH_3CH_2(Cl)CC(Cl)CH_2CH_3$ (trans-3,4-dichlorohex-3-ene). Given that the difficulty index for this topic was 0.2, 80.0 percent of students found it difficult to identify the trans isomer's correct IUPAC designation.

Once more, Adu-Gyamfi et al. (2017) found that students had trouble naming the diene class of alkene compounds, with $CH_2{=}CH{-}CH{=}CHCH_3$. Only 10.6% of students correctly identified 1,3-pentanediene as the IUPAC nomenclature for $CH_2{=}CH{-}CH{=}CHCH_3$, according to the authors' findings (or pentan-1,3-diene). As a result, 89.4% of students overall said that it was difficult to give the right International Union of Pure and Applied Chemistry (UPAC). nomenclature for $CH_2=CH-CH=CHCH_3$. This is a result of the difficulty index of the item being determined to be 0.1. Students have given incorrect names for pentene, 1,3-pentene, 1,4-pentene, 1,2-pentanediene, and pentene.

The majority of applicants were unable to draw the appropriate diagram to show the formation of the C=C double bond in an alkene, according to the chief examiners for Chemistry at the West African Examination Council (WAEC) in recent years (WAEC, 2017). This observation suggests that the students encountered difficulties in their final external exams.Furthermore, one of the main challenges Chemistry applicants had in the domain of alkenes was their inability to choose an organic compound from a list of compounds that might be cracked and undergo substitution reactions (WAEC, 2021). Based on the aforementioned, there is enough evidence to conclude that students struggle to understand alkene concepts. Using effective teaching and learning strategies to teach alkenes to students is one way to help them learn and comprehend these concepts better. Nartey and Hanson (2021) claimed that using ineffective teaching strategies caused students to exhibit conceptual difficulties when learning and teaching alkenes.

2.8 Empirical Research on the Impact of REACT Instructional Methods on Students' Academic Outcomes

Research has examined the potential effects of using REACT teaching tactics on students' academic achievement. This section reviews a few of them. For instance, Karsli and Yigit (2017) used the single group pretest/posttest design with twenty (20)

12th grade students in Turkey (10 girls and 10 boys, ages 17 to 18) enrolled in a Chemistry course at a public high school. The impact of the REACT teaching tactics on students' comprehension of the Alkenes concept was evaluated by Karsli and Yigit. The researchers used a one-way Analysis of Variance to compare the results of the pretest, posttest, and delayed posttest that were administered in this study. The pretest, posttest, and delayed posttest scores differed significantly, according to the one-way ANOVA results ($F(2.57) = 9.61$, $p=0.00$). Particularly, there were statistically significant differences between the pre-test and delayed test (mean=7.85) in favor of the delayed posttest ($p=0.00$), and between the pretest and posttest (mean=4.10) and posttest (mean=9.00) in favor of the posttest.The post-test and delayed test did not, however, vary significantly ($p=0.425$).This means that, after using the REACT teaching strategies to teach Alkenes concepts,12th Grade Chemistry students understood and retained concepts better than prior to using it. Therefore, in accordance with Karsli and Yigit, the REACT teaching methodologies are successful in correcting alternative beliefs and enhancing students' conceptual comprehension.

"*The impact of a developed REACT strategy on students' conceptual understanding of the particle nature of matter*" was also studied by Bilgin et al. (2017) with 6th graders from a primary school that was chosen at random in Trabzon, Turkey. With fifty-five (55) experimental group students (taught using REACT teaching techniques) and forty-seven (47) control group students (taught using 5E instructional strategies), A pretest/posttest control group design was employed by the authors. In terms of learners' academic achievements as judged by post-test scores, an independent sample t-test revealed a significant difference between the experimental group's performance (mean =55.27) and the control group's (45.53) ($t=2.29$, $p=0.024$). Consequently, their results showed that using REACT teaching strategies enhanced students' conceptual knowledge.

A study conducted in Turkey in 2019 by Demÿrcyoylu et al(2019). examined the impact of REACT techniques on the academic performance and motivation of tenth grade students in chemistry. In a quasi-experimental pretest/posttest equivalent control group design, sixty (60) high school students—27 girls and 33 boys—were employed in the study.While there was no statistically significant difference between the students in the experimental and control groups' pretest scores ($t(58)=0.410$, $p=0.683$), there was a significant difference ($t(58)=6.465$, $p<0.05$) between the experimental group's posttest scores (Mean=63.60, SD=12.93) and the control group's (Mean=42.13, SD=12.78), favoring the experimental group. These findings are reported by Demÿrcÿoÿlu et al. This suggests that using REACT teaching techniques to improve students' academic performance in Chemistry is beneficial.

Günter (2018), employed a quasi-experimental pre-test-post-test control design in a study titled "*The effect of the REACT strategy on students' achievements with regard to solubility equilibrium: using chemistry in contexts*". Günter employed 96 second-year students who were enrolled in the Pharmacy Services ($n = 49$) and Medical Laboratory Techniques (MLT) programs at the Ahmet Erdogan Vocational School of Health Services ($n = 47$). Using a Mann-Whitney U test, Günter discovered that while there was a significant difference between the experimental group's and the control group's post-test scores ($U = 374.5$, $p < 0.05$), there was no statistically significant difference between the pre-test scores of the two groups of students. The Wilcoxon test results demonstrated a statistically significant difference in pre-test and post-test scores between the experimental and control groups ($z = -5.997$, $p < 0.001$; $z = -6.095$, $p < 0.001$), respectively. Based on these statistics, it was determined that posttest results for both groups.

In Ghana, Quainoo et al. conducted a study in 2021 with the title "Effect of the REACT strategy on senior high school students' achievement in molecular genetics. "Using the embedded mixed methods design, a qualitative component was added to the primary quantitative pre-test/post-test non-equivalent control group design. Fifty-seven (57) SHS 2 elective biology students were randomly selected from two intact SHS 2 biology classes in the Ajumako-Enyan-Essiam district in Ghana's Central region. They were then split into two groups: the experimental group, which received instruction using REACT teaching strategies, and the control group, which received instruction using traditional teaching methods. Students taught utilizing REACT teaching methodologies outperformed the conventional group (mean=11.50) in an independent sample t-test, with an effect size of 1.52, suggesting a large effect size (mean=16.48, t=5.647, p=0.001). There was no statistically significant difference in the pretest mean scores of the students selected for the two groups (t=0.66, p=0.94). This proves the efficacy of the REACT teaching methods.

2.9 Empirical Review of REACT teaching Strategies on Gender

With the gender perspective, it appears only a single study exists which employed the REACT teaching strategies to help bridge the gender gap in Chemistry. Thus, in the same study by Demÿrcÿoÿlu et al. (2019), the authors sought to determine how male and female students differ in performance after employing the REACT teaching strategies. Demÿrcÿoğlu et al. discovered, after a two-way Analysis of Variance, that there was no statistically significant interaction between gender (male/female) and group (experimental and control) on the accomplishment test scores ($F (1.55) = 3.325$; $p=0.074$). Demÿrcÿoğlu et al. also found no significant difference in the mean scores of male and female students when taking into account the primary influence of gender on performance ($F (1,59) = 0.170$; $p=0.682$). This suggests that using the REACT teaching techniques could aid in closing the gender gap in chemistry academic achievement.

2.10 Overview of the Literature Review

The literature review showed that the REACT teaching strategies is rooted in the constructivism theory. These instructors follow the belief that students learn best when they are given opportunities to apply what they have learned in the classroom. Consequently, students are enabled to participate actively in class lessons through the use of REACT teaching methodologies.

Again, the literature revealed that students' academic performances in Chemistry can be influenced by gender. Notwithstanding, the literature showed varied reports on how gender differences affect students' academic performances in Chemistry. Accordingly, there is the need to conduct more research on gender perspectives on students' academic performances in Chemistry. Also, the literature review revealed that Chemistry students in Ghana and abroad exhibit conceptual difficulties in Alkenes. But it appears only a single study in the literature reviewed showed that REACT teaching strategies, which is a student-centered instructional method, can improve students' academic performances, as well as helping bridge the gender gap in performance. This is due to the fact that students are given equal opportunities to access the learning material to aid better under understanding Demÿrcÿoÿlu et al. (2019).

CHAPTER THREE

METHODOLOGY

3.0 Overview

The research methodology is covered in this chapter. It explains the quasi-experimental research design that was used to gather study data. The demographic, sample, and sampling methods used determine the study's sample size are covered in this chapter. Additionally, a thorough explanation of the research tools utilized to gather study data is provided in this chapter. This chapter also covers the validity and dependability of the research instruments. The data gathering process and the analysis of the generated data round up this chapter.

3.1 Study Area

This study was conducted in Lambussie District. The previous Jirapa-Lambussie District Assembly in Ghana's Upper West Region was divided into the Lambussie District as part of the country's decentralization program on February 29, 2008. The district is situated in Ghana's Upper West Region's northwest portion. It is roughly located between Longitudes 20.250 and 20.400 West and Latitudes 10.250 and 11.000 North. It has one of the smallest overall land areas (1,356.6 sq km), making it one of the smallest districts in the Region. The district makes up around 6% of the 18,476 square kilometers that make up the Region. It extends northward to Hamile and south to Karni. The Jirapa District forms its southern boundary, the Burkina Faso border forms its northern boundary, the Nandom District forms its western boundary, and the Sissala West District forms its eastern boundary. The district center of Lambussie is about 92 kilometers away from Wa, the regional capital. Thus, the district serves as a point of entry into Burkina Faso at Hamile, in the northern part of the region. The Lambussie-Karni district contains 101 elementary schools, including 25 Junior High Schools, 2 Senior High Schools, 39 kindergartens, and 35 primary schools (Ghana Statistical Service, 2021).

3.2 Research Framework

The pragmatism paradigm serves as the foundation for the study's philosophical viewpoint. One reason for selecting the pragmatism paradigm is that, according to Ugwu et al (2021) emerged among the philosophers, who contended that, contrary to the positivist paradigm, it was not feasible to ascertain social reality as it was formed by the interpretivist paradigm, nor was it possible to comprehend the "truth" of the real world through a single scientific approach. Thus, these philosophers contended that a monoparadigmatic viewpoint was insufficient and that is what was required instead was a worldview that would provide research methodologies or a mix of approaches that might provide light on participant behavior as it actually occurs. This study, which has its roots in pragmatism, took a pluralistic and methodologically heterogeneous approach to research, utilizing positivist and interpretivist epistemologies according to application and considering reality as socially and objectively produced.

3.3 Research Design

Because this study operates in the pragmatist domain, the mixed method design more especially, the embedded design was utilized. Quantitative and qualitative data are simultaneously collected during a single data collection period used in the embedded architecture. A primary method that directs the project and a secondary database that plays a supporting function in the procedures are both present in the embedded approach, according to Creswell (2014). In a study's discussion part, the data from the two approaches are usually combined in order to integrate the information and compare one data source with the other. Alternatively, the data might not be compared at all, but instead exist side by side as two distinct images that together form a composite overall assessment of the issue. This is what would happen if the researcher applied this methodology to evaluate various study questions. Therefore, by using the embedded type of the mixed-methods design, research questions 1, 2, and 3 were analyzed quantitatively, while research question 4 was analyzed qualitatively. Both quantitative and qualitative data were collected quasi-experimentally, notably, pretest/posttest non-equivalent control group design. Quasi-experimental design was employed because, it was not possible to randomize participants since they were already in their intact classes. A small sample of students from the experimental group were asked about their perceptions of the employment of REACT teaching tactics in the teaching and learning of alkenes in order to gather qualitative data. This enhanced the quantitative results and gave a thorough grasp of how REACT teaching tactics affected the teaching and learning of alkenes.

3.4 Population

All SHS 3 Chemistry students in the Upper West Region of Ghana were the study's target participants, while all SHS 3 students in the Lambussie District who were enrolled in elective Chemistry classes made up the accessible population. In all the population size is 87.

3.5 Sample and Sampling Procedure

The multi-stage sampling method was used to choose a sample from the population. Therefore, to choose SHS 3 Chemistry students to take part in this study, purposive sampling was employed. Students in SHS 3 were chosen because, according to the Ministry of Education (2010), studying alkenes is in SHS 3. Additionally, both of the Lambussie District's two SHSs were included for this study because there were only two of them. Since there were multiple intact classes in each chosen school, a simple random sample method was utilized to choose one Chemistry SHS 3 intact class from each school. The purpose of doing this was to avoid the interaction effect. The chosen intact classes were divided into experimental and control groups at random. While the control group received instruction using the traditional teaching approach, the experimental group was taught utilizing REACT teaching tactics. Consequently, 87 persons in all were sampled to take part in the research. Additionally, from the experimental group, ten students made up of five male and five female were chosen at random and interviewed in person to find out how they felt about the employment of REACT teaching tactics in the Alkenes teaching and learning process.

3.6 Research Instruments

Data collecting instruments are tools used in a study to assist the researcher in gathering unprocessed data that can be coded, altered, or transcribed for additional analysis and conclusions (Creswell, 2009). Data from participants were gathered in this study using an achievement test (Alkene Concept Test – ACT), and a semi-structured interview guide. This study employed Alkene Concept Test (ACT) which was designed by the researcher. Eight essay-style questions covering the topics of alkenes properties, nomenclature, preparation, and reactions were included in the ACT (Appendix I and II).

Additionally, a semi-structured face-to-face interview guide was utilized in this study to gather student comments regarding how they evaluated the teaching and learning after being exposed to the REACT technique. The researcher asked a few general questions during the semi-structured interview and encouraged the students to answer. This aided the researcher in developing a thorough grasp of how the REACT teaching strategies affected the performance of the students. The interview guide consisted of five open-ended items.

3.7 Validity of the Instruments

Chemistry tutors and seasoned researchers were given the achievement test and interview guide to provide their opinions and suggestions, regarding the items' suitability for evaluating the constructs that the instruments were designed to examine. This was carried out in order to assess the instruments' validity. Following that, the required adjustments were done prior to the instruments being piloted.

Five experts were invited to assess the instruments, and during the assessment of the instruments by the experts, they were asked to rate the achievement test and interview guide based on the relevance and appropriateness of items. Therefore, items were rated as essential or non-essential. Afterwards, Lawshe's (1975) content validity ratio (CVR) was used to determine the content validity of the ACT and interview guide. To determine the CVR, Content Validity Index (CVI) was calculated for each item on the instrument. CVI is determined by dividing the total number of experts who evaluated the items by the number of experts who rated the items as essential (Ayre & Scally, 2014). After determining the CVI for each item, the CVI is calculated for the entire instrument. This is the mean of all individual CVIs (Almanasreh et al., 2018). The CVRs of the ACT and interview guide were then determined by dividing the overall CVI by the total number of items. Table 3.4 presents the Content Validity Ratio and Content Index for ACT.

Table 3.0: Content Validity Index and Content Validity Ratio of ACT

Item	**Panel 1**	**Panel 2**	**Panel 3**	**Panel 4**	**Panel 5**	**Agreement**	**CVI**
1	X	X	X	X	X	5	1.00
2	X	X	X	X	X	5	1.00
3	X	X	X	X	X	5	1.00
4	X	X	X	X	X	5	1.00
5	X	X	0	X	X	4	0.80
6	X	X	X	X	X	5	1.00
7	X	X	X	0	X	4	0.80
8	X	X	X	X	X	5	1.00
CVR							**0.95**

O =non-essential

X= essential

CVI = Content Validity Index = $\frac{N_E}{N}$

CVR = Content Validity Ratio = $\frac{CVI}{total\ number\ of\ items}$

N = total number of experts

N_E = Number of experts indicating items as essential.

According to Almanasreh et al. (2018), CVR varies between 1 and −1, where high values of CVR indicate the agreement of experts on the relevance of an item in the instrument. Therefore, as seen from Table 3.0, the CVR value for ACT was 0.95, which indicates a valid instrument. Table 3.1 also shows the CVI and CVR for the interview guide.

Table 3.1: Content Validity Index and Content Validity Ratio of Interview Guide

Item	Panel 1	Panel 2	Panel 3	Panel 4	Panel 5	Agreement	CVI
1	X	X	0	X	X	4	0.80
2	X	X	X	0	X	4	0.80
3	X	X	X	X	X	4	0.80
4	0	X	X	X	X	4	0.80
5	X	X	0	X	X	4	0.80
CVR							**0.80**

As revealed in Table 3.1, the CVR value for PSAQ was 0.80, which also indicates a valid instrument.

3.8 Pilot testing of instruments

To ascertain the ACT's dependability, 51 SHS 3 students from Lawra District Senior High School were given the test. Although they were among the target group, the students that were employed for the instrument's pilot testing were not involved in the primary research.

3.9 Reliability of Instruments

Since the pilot study's answers were essay-style, two raters were tasked with rating the completed items in order to evaluate the reliability of the research tools. Thus, using the inter-rater reliability method and Cohen's kappa, Cohen and Cohen (1983), the scores from the two raters were used to ascertain the internal consistency of the item scores. Table 3.0 displays the findings of the kappa measure of agreement between the two raters.

Table 3.2: Inter-Rater Reliability of Alkene Concept Test

		Value	Approximate Significance
Measure of Agreement	Kappa	.651	.000
N of Valid Cases		51	

Mchugh (2012) states that Kappa values less than zero (≤0) denote no agreement, 0.01–0.20, none to slight, 0.21–0.40, fair, moderate, 0.41–0.60, substantial, and 0.81–1.00, practically perfect agreement. As a result, from Table 3.0, the Kappa measure of agreement of the score of the two raters for the ACT was 0.651, which Mchugh(2012) interpretes it as a substantial agreement. This suggests that the ACT was a trustworthy tool for the primary investigation.

3.10 Data Collection Procedure

As previously mentioned, the data collection process enabled the researcher to gather both quantitative and qualitative data. Three steps made up the data collection process.

3.10.1 Pre-intervention Stage

The headteachers of the schools chosen for the study were formally asked for their consent. These schools' chemistry teachers were duly informed as well. Teachers, administrators, and students from the sampled schools were assured of the confidentiality of the student data and the study's findings, as well as the study's significance and implications. Following the approval of various authorities, one intact SHS 3 class from each school was chosen using simple random sampling, and they were divided into experimental and control groups.

For confidentiality and data entry purposes, the experimental school was identified as SCHOOL A (taught using REACT teaching method), while control school was identified as SCHOOL B (taught using the conventional teaching method). The study was carried out when there were no significant activities taking place in the schools. The sampled schools were then visited to begin the pretest. In order to ensure that students were prepared for the pretest, students were informed one week prior to the conduction of the pretest. The purpose of the pretest was to make sure that all participants performed about equally before the intervention. The researcher gave out the pretest with the help of the sampled schools' chemistry tutors. The pretest was administered, and students in both groups had sixty minutes to complete the questions primarily sought to investigate students' perceptions of REACT teaching strategies.

3.10.2 Intervention Stage

The second stage, which is the intervention stage, started after the pretest was successfully completed. To account for teacher differences, the researcher at this stage taught the subject matter to the two (2) groups. During the four-week intervention stage, both the experimental and control groups were taught the same content; however, the experimental group was taught using REACT techniques, whereas the control group was taught using the traditional manner. Table 3.3 provides a summary of the various contents that were covered during the research, the treatment activities for experimental and control groups are illustrated in Table 3.4 and 3.5 respectively.

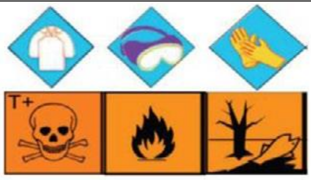
Table 3.1 provides a summary of the various contents that were covered during the research, the treatment activities for experimental and control groups are illustrated in Table 3.2 and 3.3 respectively.

Table 3.3: Content of Alkenes

SPECIFIC OBJECTIVES	CONTENT
The student will be able to:	
1. Explain the origins and properties of alkenes.	Source and characteristics of alkenes.
2. Describe the isomerism and nomenclature of alkenes.	Nomenclature and alkene isomers.
3. Elucidate the synthesis and chemical processes of alkenes.	Alkene preparation and chemical reactions.
4. List the applications of alkenes.	Applying alkenes

Table 3.4: Treatment Activities for Experimental Group

Stage	The instructor's role	Students' role	A portion of the instructional materials
Relating	The teacher gives the students their prepared work sheets. The teacher starts the lesson by using the text "Plastic" from the first section of the work sheet. Asks questions concerning the rubber (plastic) that is referenced in the book, both natural and manmade. Questions like "What are the qualities of plastic?" are used to introduce the concept of plastic to the students. How does the subject of alkenes connect to plastic? What role does plastic play in our daily lives?	The students strive to pinpoint the main ideas and qualities of the issue by concentrating on the material they are reading. They attempt to draw a comparison between alkene and plastic.	 

<table>
<tr>
<td>Experiment</td>
<td>The purpose of the experiment, which the teacher leads the students through, is to identify the properties of the alkenes (CnH2n) that make synthetic plastic. He gave the kids instructions to make their own data tables and show them to the class as a whole. The following questions are posed to the class by the teacher, who bases their answers on the experiment: describe how alkenes affect potassium permanganate ($KMnO_4$); Indicate whether an alkene dissolves in water or carbon tetrachloride (CCL_4). Write how alkenes affect bromine's hue (Br_2)</td>
<td>In a group of 3 or 4, the students carry out an experiment in order to discover the characteristics of hexene, under the guidance of their teacher. They answer the questions related to the experiment based on their observations obtained during the experiment and write down notes on the work sheet.</td>
<td>


</td>
</tr>
<tr>
<td>Applying</td>
<td>Students are given a work sheet with questions about alkene names according to IUPAC nomenclature, their existence in nature, how to obtain alkenes, their physical characteristics, the mechanisms of chemical reactions, polymerization, features of products obtained as a result of polymerization, and areas these products are used. The teacher assigns the students to search, discuss,</td>
<td>In an attempt to find the answers, the students share their findings with the other members of their group while conducting research for the questions.</td>
<td><table>
<tr><td>Akene (C_nH_{2n}) names</td><td>Open formulae of the alkene</td><td>The top-bar model of the alkene</td></tr>
<tr><td>Ethene</td><td></td><td></td></tr>
<tr><td>Propene</td><td></td><td></td></tr>
<tr><td>Butene</td><td></td><td></td></tr>
<tr><td>Pentene</td><td></td><td></td></tr>
<tr><td>Hexene</td><td></td><td></td></tr>
</table></td>
</tr>
</table>

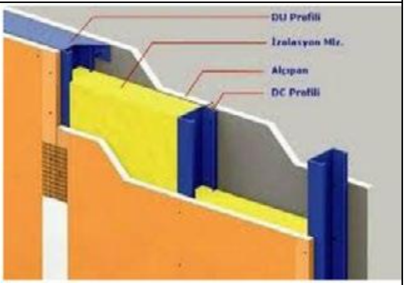
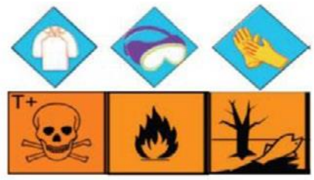
	and then respond to the questions.		
Cooperating	The instructor gives the class instructions to conduct group study and then present the findings to their peers. She does this by posing questions like these to the class: (1) Examine the other places in daily life where alkenes, which make up the structure of polymer compounds like plastic, are used. (2) What is utilized in building sound insulation? Examine the arrangement.	The students carry out group work to find out the answers to the questions and present them to their classmates.	
Transferring	Using the knowledge, they have recently acquired, the teacher assigns the pupils to solve situations from real life that they have never encountered before.	Following their individual statements, the students engage in classroom conversations to exchange information.	

Table 3.5: Treatment Activities for Control Group

STAGE	ACTIVITIES	TEACHING AND LEARNING MATERIALS(TLM)
Introduction	1. The teacher displays images of the TLM. 2. The instructor requests that the pupils connect the image to any pertinent Chemistry topics. 3. Teacher states the objectives of the lesson. **4.** Teacher defined the term alkenes and uses of alkenes**.**	  
Main learning	Teacher explains: 1. The origins and features of alkenes. 2. Describe the isomerism and nomenclature of alkenes. 3. The preparation and chemical reactions of alkenes.	
Assessment	4. Teacher asks students questions about what he has taught them.	

3.10.3 Post-Intervention Stage

After the intervention stage, students were given one week to revise their notes, after which the posttest was conducted. With assistance from Chemistry teachers at the different schools, the researcher conducted the posttest as well. Following a 60-minute period for students in both the experimental and control groups to complete the posttest, ten students were chosen at random from the experimental group to take part in the focus group interview. This was done in order to find out how the students felt about the way REACT teaching tactics were applied in the teaching of alkene in the classroom.

3.11 Data Analyses Procedure

Both quantitative and qualitative analyses were performed on the data obtained from the study instruments. Using SPSS for Windows version IBM, 2022, the ACT scores were quantitatively examined, and the student perspectives and opinions were examined thematically. Using the established level of significance ($p<0.05$), the following statistical tools and statistics were used as shown in Table 3.6.

Table 3.6: Statistical tools for Data Analyses

Research Question	Type of Data	Descriptive Statistics	Inferential Statistics
Research Question 1	Test (ACT)	Frequencies and Percentages	-
Research Question 2	Test (ACT)		Independent sample t-test
Research Question 3	Test (ACT)		Independent sample t-test
Research Question 4	Interview	Thematic Analysis	-

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Overview

This chapter looks at the results and discussion of the study.

4.1 Demographic Characteristics of Students

This section discussed the demographic characteristics of the respondents .This includes gender of the students.

4.1.1 Gender Distribution of the Participants

There were total of eighty-seven (87) participants in this study. Table 4.0 shows that there were more men than women among the participants. Of the eighty-seven (87) participants in total, 46 (52.88 percent) were males and 41 (representing females) (47.13 percent).

Table 4.0: Gender Distribution of Participants

Group	Frequency	Percentage
Experimental		
Male	23	26.44%
Female	19	21.84%
Total	**42**	**47.13%**
Control		
Male	23	26.44%
Female	22	25.29%
Total	**45**	**52.88%**

Additionally, the experimental and control groups were randomly assigned to the individuals. There were forty-two (42) (47.13%) individuals in the experimental group (exposed to REACT teaching methodologies). Among them were nineteen (19) (21.84%) females, or 21.84 percent, and twenty-three (23) (26.44%) males. Moreover, the control group (exposed to conventional teaching method) were forty-five (45) in number, which consisted of twenty-three (23) males, representing 26.44% and twenty-two (22) females, representing 25.29%.

4.2 Normality Test for Pretest and Post-test Scores

The normality test was used to assess whether non-parametric or parametric analysis should be performed on the pretest and posttest data that were gathered from the experimental and control groups. The outcomes are displayed in Table 4.1.

Table 4.1: Results for Normality Test for Pretest and Post-test Scores

		Kolmogorov-Smirnov[a]		
	GROUP	**Statistic**	**Df**	**Sig.**
PRETEST	Experimental	.093	42	.200*
	Control	.077	45	.200*
POSTTEST	Experimental	.114	42	.198
	Control	.106	45	.200*

*. This represents the genuine significance's lower bound.
a. Correction to Lilliefors Significance

Mishra et al. (2019) state that the Kolmogorov-Smirnov test is suitable for samples with 50 or more participants ($n \geq 50$). The null hypothesis asserts that the data are drawn from a normally distributed population, according to Mishra et al. (2019). When the data is normally distributed and the accepted probability value shown in Table 4.1has sig $p > 0.05$, the null hypothesis is accepted. As a result, Table 4.1 indicates that the experimental and control groups' pretest and post-test scores had p-values 0.200 and 0.200 respectively. The null hypothesis is so accepted. Therefore, the experimental and control groups' pretest and post-test results follow a normal distribution.

4.3 Results of the Study

The research questions guided the analysis of the data that was gathered. But before the research issues were addressed, the pretest results for the experimental and control groups were examined to ascertain the student admission characteristics. The results are shown in the following section.

4.3.2 Results for Research Question 1

"*What challenges exist among SHS Chemistry students in alkenes*?" is the research question posed. In order to aanswer this question, percentages of scores for each pretest item were calculated, and the outcomes are shown in Table 4.2.

Table 4.2: Students' Difficulties in Alkenes

Difficulty	Number of Students	Percentage of students
Inability to draw the correct IUPAC structures of alkene compounds	65	74.71%
Inability to explain the meaning of alkenes	71	81.61%
Inability to formulate suitable chemical equations for alkene compound reactions	85	97.7%
Unable to accurately depict and identify potential isomers of alkenes	41	47.13%

The pretest revealed that students struggled with drawing the correct IUPAC structures of alkene compounds, explaining the meaning of alkenes, writing appropriate chemical equations for reactions involving alkene compounds, and accurately drawing and labelling potential isomers of alkenes, as indicated in. Among the challenges, drawing the accurate IUPAC structures of alkene compounds was difficult for 74.71 percent of the sampled students. For example, it was revealed that some students misplaced the positions of double bonds, when drawing structures for some alkene compounds. Again, it was noticed that, in drawing structures for alkene compounds, some students either used the alkyl group substituent incorrectly, or misplaced the positions of the alkyl group substituent.

Also, from Table 4.2, it was observed that 81.6% of the sampled students were unable to explain alkene concepts. Specifically, this study revealed that students either failed to attempt questions, which demanded explanation of alkene concepts or wrongly explained the concept. For example, when students were asked "Why are alkenes called unsaturated hydrocarbons"?; some students answered "*because they have less hydrogen*". Some also explained that "*because they can undergo substitution reaction*". Also, students failed to give appropriate explanations to some reactions of alkenes and properties of alkenes. For example, when students were asked "Would you expect but-1-ene to be soluble in water at room temperature? Briefly explain your answer", The 85 of the students did not provide adequate justification for their answers; instead, they merely wrote "yes" or "no" in response to the first half of the question. Furthermore, when asked to explain what occurs to the C=C bond when alkenes react with hydrogen, water, or halogens, students were unable to give proper explanation. The majority of the students gave incorrect answers, that "*the alkenes will undergo a substitution reaction*" as their justification.

Furthermore, as observed in Table 4.2, almost all the students (97.7%) demonstrated inability to write appropriate chemical equations for reactions of alkene compounds. This was observed in relation to a question when students were asked to explain, with chemical equation, how they would bring about the conversion of ethanol to ethene, and also propose mechanisms for some alkene reactions.

Lastly, 47.13 percent of the students in the sample population were unable to accurately name and sketch potential isomers of alkenes. Students were instructed to sketch and identify each of the alkene molecule C_4H_8's four potential isomers for this project. Students' answers revealed several common specific issues, such as their exclusive consideration of the compound's chain isomers and neglect of its positional isomers. This rendered majority of the students not getting the required and expected possible isomers of the compound. Consequently, naming of such isomers of the compound became difficult for some students.

4.3.3 Results for Research Question 2

This research question sought to find out the difference in academic performance between SHS Chemistry students taught alkenes using the REACT teaching technique and students taught using the usual teaching method.

To achieve this, an independent sample t-test was conducted on the pretest for the students in the REACT and conventional approach in alkenes. This aimed to determine whether students in the REACT and conventional approaches performed similarly or if there was a substantial difference in performance between them prior to the intervention. The result of the independent sample t-test on the pretest of students in the REACT and conventional approaches in alkenes is presented in Table 4.3.

Table 4.3: Results of an Independent Sample T-test on Pretest Scores for REACT and conventional approaches

Teaching Approach	N	Mean	SD	T	Df	P
REACT	42	12.07	4.21	.153	85	.879
Conventional	45	11.93	4.21			

N= sample size
SD= standard deviation
T= t-tailed
Df= degree of freedom
p>0.05

According to Table 4.3, students who were taught using the REACT strategy (M = 12.07, SD = 4.21) and those who were taught the conventional method (M = 11.93, SD = 4.21; t (85) = 0.153, p =.879) did not significantly differ on the pretest. This indicates that prior to the intervention, the performance standards of the students in the experimental and control groups were equal. This means that the students from the two groups (REACT and conventional) were performing at the same level before the intervention was implemented. This situation provides a good justification for comparing students' post-test results. In order to investigate the post-test scores in the academic achievement of students in the REACT and conventional approaches, an independent sample t-test was used. There were no breaches in the preliminary assumption tests for normality, linearity, homogeneity of variance.

4.3.4 Results for Research Question 2

What is the difference in academic performance between SHS Chemistry students taught in alkenes using the REACT teaching technique and students taught using the conventional teaching method?

An independent sample t-test was further conducted on the performance of students (REACT and conventional) after the implementation of the intervention (post-test). The result of the independent sample t-test on the post-test of REACT and conventional approach in alkenes is presented in Table 4.4.

Table 4.4: Post-test Results of an Independent Sample t-test of students in the REACT and conventional group Experimental and Control group

Teaching Approach	N	Mean	SD	T	df	p
REACT	42	23.17	3.69	3.604	85	.001
Conventional	45	20.29	3.74			

N= sample size
SD= standard deviation
T= t-tailed
Df= degree of freedom

According to Table 4.4, students who were taught the REACT strategy (M = 23.17, SD = 3.69) and those who were taught the conventional way (M = 20.29, SD = 3.74; t (85) = 3.604, p <.001) had significantly different post-test scores. A comparison of mean scores suggests that students in the REACT strategy outperformed those in the conventional approach, and the difference in performance was significant. The magnitude of the mean difference was determined using eta squared statistic (Appendix III), which produced an eta squared value of 0.131, indicating a small effect size.

4.3.5 Research Question 3

Research question 3 sought to find out, *"what is the difference between male and female SHS Chemistry students' academic performances in alkenes taught using REACT teaching strategy*"?

To achieve this, an independent sample t-test was conducted on the pretest for the REACT strategy on gender in alkenes. This aimed to determine whether males and females performed similarly or if there was a substantial difference in performance between them in the REACT strategy prior to the intervention. The result of the independent sample t-test on the pretest of the REACT strategy on gender in alkenes is presented in Table 4.5

Table 4.5:Results of an Independent sample t-test of pretest scorces for male and female students taught using REACT strategy

Gender	N	Mean	SD	T	df	p
Male	19	11.79	4.07	-.390	40	.698
Female	23	12.30	4.39			

N= sample size
SD= standard deviation
T= t-tailed
Df= degree of freedom
$p>0.05$

As seen in Table 4.5, there was no statistically significant variation in the pretest scores between male students who were taught using the REACT approach (M = 11.79, SD = 4.07) and female students who were taught using the REACT technique (M = 12.30, SD = 4.39; $t(40) = -0.390$, $p = .698$).

This means that the students from the two groups (males and females) in the REACT were performing at the same level before the intervention was implemented. This situation provides a good justification for comparing students' post-test results in the REACT strategy. In order to investigate the post-test scores of sex differences in the

REACT, independent sample t-test was used. There were no breaches in the preliminary assumption tests for normality, linearity, homogeneity of variance.

An independent sample t-test was further conducted on the performance of students in the REACT strategy after the implementation of the intervention (post-test) in terms of gender. Table 4.8 displays the results.

Table 4.6: Independent Sample T-test of the Effect of Gender on Post-test Scores of Students in the REACT approach.

Gender	N	Mean	SD	t	Df	p
Male	19	22.58	3.99	.212	40	.883
Female	23	22.83	3.55			

N= sample size
SD= standard deviation
T= t-tailed
Df= degree of freedom

The post-test scores between males (M=22.58, SD=3.99) and females (M=22.83, SD=3.55; t (40) =-0.212, p=.833) in the REACT strategy using independent-sample t-test showed no statistically significant difference. This means that the students from the two groups (males and females) in the REACT strategy were performing at the same level after the intervention was implemented. That is the REACT strategy implemented could not discriminate among gender.

4.3.8 Results for Research Question 4

In order to corroborate the findings about the efficacy of the REACT teaching strategies, this question aimed to ascertain the opinions of SHS Chemistry students who were exposed to REACT taeching strategy during the teaching and learning of alkenes. Accordingly, the research question says that, "*What are the perceptions of SHS*

Chemistry students on the use of REACT teaching strategy in the teaching and learning of alkenes"?

Consequently, ten (10) members of the experimental group participated in-person, semi-structured focused group interviews to gather qualitative data. As a result, three topics were identified from which the opinions of the students were examined. These themes include making connections between concepts and prior knowledge, engaging students actively in the classroom, and improving concept memory. In certain typical assertions, all names are pseudonyms.

The interviewed students remarked that lessons taught using the REACT teaching strategies enabled the ten (10) members of the experimental group participated in-person, semi-structured focused group interviews to gather qualitative data. As a result, three topics were identified from which the opinions of the students were examined. The themes include: making connections between concepts and prior knowledge, engaging students actively in the classroom, and improving concept memory. According to them, all names are pseudonymed, to understand Alkene concepts better than what they had experienced in the past. The understanding of concepts in Alkenes is a reflection of their performances after the introduction of the intervention. This is because students highlighted that lessons were designed to relate with their previous life experiences and basic knowledge. For instance, Andrews said, "*the approaches used in teaching this topic were full of experiences that helped me to understand the concepts you taught better*". Andrews added "*the examples you gave as well as the activities conducted in the classroom could help me quickly connect those situations to what you wanted us to know in this new lesson*". Abrafi also stressed that, "*I have really enjoyed how you made things so simple by bringing in examples, and other topics which* *we already had some idea about and connecting them to the Alkenes. I wish all teachers adopt these strategies to teach*".

Another noteworthy perception of SHS Chemistry students on the use of REACT teaching strategies in teaching Alkenes is active involvement in the teaching and learning process. When students are active in the class they demonstrate ownership over the learning material (Munna & Kalam, 2021). For instance in this study, Karrim said "*the experimental activities gave me the opportunity to engage what you actually wanted us to learn, and by so doing I was able to get the better understanding in the areas where I struggled to understand*". Similarly, Salamatu stated that "*when we went to the laboratory to practice what we learned in the classsroom, I felt so much involved and that made me perceived that, wow! I am actually learning something*". By agreeing with Salamatu, Barakah added "*this is my first time I could ask questions concerning some difficult concept I struggle to understand. This is because, the practical activities gave me much insight into what we were learning. Therefore, any area where the understanding was not clearer, I could seek for help from you and or my friends*". In addition, Kudus said "*in fact the groups which we formed acyually helped me. Sir, we rarely learn in groups as we did during the learning of Alkenes. I was fully engaged and my group members were also willing to help one another. During the assignments, we always tried to involve each and everyone of us*". Leticia also added "*in my group, when a member could not understand anything concerning the assignments, he or she felt free to ask other members for clarification. That even helped me in the second test, because there was a question which I answered correctly because we learned in groups*".

Moreover, students perceived that the use of the REACT teaching strategies helped them retain concepts better, hence their improved performances in the posttest, as Ibrahim said "*I could remember almost everything that we learned in Alkenes. I think because of how you taught the topic, and how you used different strategies to teach us the topic helped suited my style of learning, thereby making me remember every concept taught*". Additionally, Linda added ,"*I always forget what we learn in Chemistry. Sometimes I will have to use chew and pour to remember a few things. But the different strategies you used to teach us during these four weeks enabled me to learn in my preferered way, where I could understand the concepts better and remember them during the second test*".

4.4 Discussion of Results

The results of this study are discussed in this section. The discussion of the results is based on the research questions.

4.4.1 Discussion of the Findings for the First Research Question

What difficulties exist among SHS Chemistry students in alkenes?

This research question sought to identify some difficulties SHS Chemistry students encounter in Alkenes. It was found that the difficulties include inability to draw the correct IUPAC structures of alkene compounds, inability to explain the meaning of alkene, unable to accurately name and sketch potential isomers of alkenes, as well as to construct the proper chemical equations for reactions involving alkene compounds.These findings agreed with Adu-Gyamfi et al. (2017) who identified that SHS Chemistry students find it difficult to name some alkene compounds, and also draw the correct structural formlae for some alkene compounds. Furthermore, the results of this investigation corroborate those of Nartey and Hanson (2021), who revealed how students ,understood " the Preparation and chemical reactions of alkenes" as one of the difficult concepts in Organic Chemistry. Students' demonstrating such difficulties could be partly due to their insufficient understanding of Alkene concepts (Anim-Eduful & Adu-Gyamfi, 2022) ,which greatly hinges on the teaching method which the teacher employs to represent the concepts (Appiah-Twumasi, 2020). This means that, by employing the appropriate teaching methods, where lessons are delivered in simple, clearer, and concise manner, students will be able to conceptualise what is being conveyed by the teacher. According to Appiah-Twumasi (2020), the inappropriate selection of the correct teaching strategies in teaching chemistry concepts only leads to cramming of information without any meaningful understanding.

4.4.2 Discussion of Research Question 2

What is the difference between the academic performance of SHS Chemistry students taught using the conventional technique and the REACT teaching strategy when it comes to alkenes?

The purpose of this study was to compare the academic performance of SHS Chemistry students in alkenes between the use of REACT teaching tactics and traditional teaching methods. It was discovered through a comparison of the two teaching approaches that using the REACT teaching strategies was more successful than using the traditional approach. The findings of this study corroborate Karsli and Yigit (2017) findings that the REACT method was superior to the conventional method at improving Turkish students' understanding of alkenes concepts. Karsli and Yigit (2017) examined how the REACT method affected Turkish students in the 12th grade's retention of learning about the concept of alkanes and found that it enhanced their retention of learning in alkenes learning over the conventional method. This study is also in line with, Quainoo et al (2021). Students taught utilizing REACT teaching methodologies outperformed the conventional group (mean=11.50) in an independent sample t-test, with an effect size of 1.52, suggesting a large effect size (mean=16.48, t=5.647, p=0.001). There was no statistically significant difference in the pretest mean scores of the students selected for the two groups (t=0.66, p=0.94).

It is in agreement with the findings of Bilgin et al. (2017) that teaching using REACT technique is best to improve students' academic performance. In Bilgin et al. (2017) findings the experimental (REACT strategy) group outperformed the control, Engage, Explore, Explain, Elaborate, and Evaluate (5Es strategy), a pretest/posttest control group design was employed by the authors. In terms of learners' academic achievements as judged by post-test scores, an independent sample t-test revealed a significant difference between the experimental group's performance (mean =55.27) and the control group's (45.53) (t=2.29, p=0.024).

In studies conducted by Karsli and Yigit (2017) and Quainoo et al (2021), it was found that the REACT strategy was better than the c onventional approach in improving the academic achievement of students. Karsli and Yigit (2017) found that when the REACT method was used, students' mental grasp of impulse and momentum improved. Karsli & Yigit (2017) found that the REACT method helped Chemistry students perform better academically.

4.4.4 Discussion of the Findings for Research Question 3

When teaching alkenes using the REACT teaching approach, how do male and female SHS Chemistry students perform once compared?

In an effort to close the gender gap that has been shown in the literature ;according to Akunne (2020) there was a considerable difference in academic achievement levels across genders, with the male and female t-calculated values of 37.49 and 40.43 respectively exceeding the critical t-value of 1.96, and also Wrigley-Asante et al. (2023) a chi-square test revealed a substantial disparity in chemistry grades between the two sexes. This study topic also looked at the impact of REACT teaching strategies on gender. Consequently, it was discovered that there was no discernible difference in alkenes knowledge between male and female SHS Chemistry students following the implementation of the intervention.

Demÿrcÿoğlu et al (2019) also found no significant difference in the mean scores of male and female students, when taking into account the primary influence of gender on performance ($F(1,59) = 0.170$; $p=0.682$), regarding the effect of REACT teaching strategies on gender. Male and female students performed equivalently after using REACT teaching strategies, the disparity in academic performace between the males and females students could be on the part of instuctors inappropriate usage of teaching method . By using REACT teaching technique, Students, both male and female, received equal opportunities to be fully engaged in the lesson through various activities such as hands-on activities and cooperative learning.

4.4.5 Discussion of the Findings for Research Question 4

What opinions do SHS Chemistry students have about the use of the REACT teaching approach to the study and instruction of alkenes?

Following the instruction of 12th graders in alkane concepts through the use of a worksheet developed based on the REACT approach, Karsli and Yigit (2017) performed a semi structured interview to find out how the students felt about the REACT technique.

Students felt that the alkane worksheet, which used the REACT approach to tie classroom learning to real-world problems, has made chemistry classes entertaining, attractive, and motivating, according to Karsli and Yigit (2018). When Karsli and Yigit (2018) looked at the impact of the REACT approach on students' understanding of solubility equiribrium and then performed a structured and semi-structured interview on the students' perception of the REACT technique, they found a similar outcome. Students' perceptions towards the use of REACT strategies in the teaching and learning of Alkenes also agreed with the findings of previous studies, where students perceived the use of REACT teaching strategies to aid their understanding of concepts better than the conventional teaching method (Quainoo et al., 2021).It helped them remain active in the teaching and learning prrocess (Frimpong et al., 2023), and related concepts to previous knowledge (Günter, 2018).

The majority of the students believed that the REACT strategy made the concept they were taught memorable, understandable, interesting, and applicable to everyday life. They also believed that groupwork assisted them in sharing information through discussion.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, RECOMMENDATIONS AND SUGGESTIONS FOR MORE RESEARCH

5.1 Overview

The study's conclusions have been summarized in this section. On the basis of the results, conclusions, advice, and ideas for additional research were made.

5.2 Summary of Findings

The purpose of the study was to determine how SHS Chemistry students' academic performance in alkenes is affected by the use of the REACT teaching technique in comparison to the traditional teaching approach. The study used a mixed-method approach by adopting a quasi-experimental design, where research questions were answered using quantitative and qualitative data. A sample of 87 SHS 3 Chemistry students from two comparable whole classes that were chosen at random from two separate schools was used in the study. The experimental group in the sampling classrooms was randomly assigned to receive instruction in REACT teaching strategies, whereas the control group received instruction in conventional teaching methods. The Alkenes Concept Test (ACT), an accomplishment test, and semi-structured interviews guide were the instruments utilized to collect the data.

After collecting and analyzing data, it was found that SHS Chemistry students demonstrated difficulties in studying alkenes concepts which hampers their performances in alkenes. Some of the difficulties include inability to draw the correct IUPAC structures of alkene compounds, inability to explain the meaning of alkene ,and unable to accurately name and sketch structure of potential isomers of alkenes, as well as to construct the proper chemical equations for reactions involving alkene compounds. As a result, participants in the intervention were divided into experimental and control groups and an intervention utilizing REACT teaching methodologies was created. Following the intervention, it was discovered that SHS 3 Chemistry students taught using REACT teaching methodologies performed significantly better than those taught with the traditional way (MD=2.878, t=3.604, p=0.001), with the experimental group benefiting from the difference. Because of this, the REACT teaching strategies were more successful than the traditional teaching approach.

The study also showed that there was no significant difference (mean difference=0.247, t=-0.212, p=0.833) between male and female SHS Chemistry students who were taught utilizing the REACT teaching methodologies after implementing them. SHS Chemistry students taught using REACT teaching strategies articulated their perceptions in a semi-structured interview that the use of REACT teaching strategies helped them to understand concepts better in their studies of Alkenes. More specifically, it helped them in relating concepts to previous knowledge, promoted their active involvement during lessons, and gave them better retention of concepts.

5.2 Conclusions

The study's conclusions confirm that students exhibited challenges while learning about alkenes. Also, compared to the traditional method of teaching, the students' academic performance improved, when they are taught alkenes using the REACT teaching method. Moreover, the REACT teaching method helped to bridge the gap between the male and female students’ academic performance. Furthermore, the nature and methodology of the REACT teaching approaches appear to be well-liked by the students.

5.3 Recommendations

A few recommendations have been made based on the study's findings that should be taken into account, when making important decisions about education:

1. It is advised that Chemistry instructors in Lambussie District use REACT teaching techniques when instructing students on Alkenes. This will help them get beyond any obstacles they may have, and also boost their performance.
2. Additionally, teachers in the Lambussie District should be made aware of the importance of implementing REACT teaching strategies through in-service training, workshops, conferences, and seminars. This will provide all SHS Chemistry students with equal opportunities and access to the learning materials in an effort to support male and female students' performance at equal levels.
3. Teachers in Lambussie district are also recommended to use REACT teaching strategies, since students in Lambussie district perceived that REACT teaching strategies helped them to relate concepts to previous knowledge, promote their active involvement during lessons, and also give them better retention of the concepts they are taught.

5.4 Suggestions for Further Research

A few recommendations have been made for additional research based on the study's findings:

1. The effectiveness of REACT teaching methods in various geographic locations, at various educational levels, and with alternative Chemistry concepts should all be the focus of future research.
2. It is also suggested that REACT teaching strategies should be compared with different learner-centered teaching strategies to inform teachers about the most appropriate learner centered teaching methods appropriate for teaching SHS students.
3. For a more thorough understanding of REACT teaching techniques, further research should be conducted into how they affect students' attitudes, motives, and other affective components of learning.

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APPENDICES

APPENDIX I

ALKENES CONCEPT TEST

GENDER: **Male** ☐ **Female** ☐

Duration: 60 minutes **Date: …………………….**

Answer all questions

1. Why are alkenes called unsaturated hydrocarbons? **(2 marks)**
2. Draw structures corresponding to the following IUPAC names:
   a. 2-methyl-1, 5-hexadiene
   b. 3-ethyl-2, 2-dimethy, l-3-heptene
   c. 2,3,3-trimethyl-1,4,6-octatriene (**3 marks)**
3. Describe what happens to the double carbon to carbon bond when alkenes react with hydrogen, water or the halogens **(8 marks)**
4. Explain, with chemical equation, how you would bring about the conversion of ethanol to ethene? **(3 marks)**
5. Predict the major products of the following reactions, and propose mechanisms to support your predictions.
   a. pent-1-ene + HCl
   b. 2-methylpropene + HCl (**4 marks)**
6. When 1 mol of buta-1,3-diene reacts with 1 mol of HBr, both 3-bromobut-1-ene and1-bromobut-2-ene are formed. Propose a mechanism to account for this mixture of products. **(4 marks)**

7. There are four isomers of C_4H_8 containing a carbon-carbon double bond. Draw their structural formulae, and state their correct IUPAC names. **(8 marks)**
8. Would you expect but-1-ene to be soluble in water at room temperature? Briefly explain your answer. **(3 marks)**

APPENDIX II

Semi-Structured Interview Guide to Determine the Perceptions of SHS Chemistry Students on the Use of REACT Teaching Strategies

1. How does these teaching strategies used to teach Alkenes differ from other teaching methods you have experienced in the past?
2. What aspects of these teaching strategies do you find most helpful in understanding difficult concepts?
3. How does these new teaching strategies address your learning style in the classroom?
4. Which stage in these teaching strategies used in the teaching and learning of Alkenes did you think benefited you in the understanding of concepts, and why?
5. Will you suggest that Chemistry teachers should continually use these teaching strategies in Chemistry concepts, and why?

APPENDIX III

Eta Squared Formular and Interpretation

Eta Squared= $\frac{t^2}{t^2+(N-1)}$

where t= calculated t-value

N= Number of Students

Eta Squared Interpretation

Effect size	Interpretation
≤ 0.1	Small effect
≤ 0.6	Medium effect
≥ 1.38	Large effect