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Unlocking the Mysteries of Alkenes How the REACT Teaching Strategy Fuels Students' Performance in Alkenes

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ABSTRACT

The research looked at how well Senior High School (SHS) students in Lambussie District, Upper West Region, Ghana performed when it came to understanding the concepts of alkenes in chemistry when taught using REACT versus traditional methods. This study's quasi-experimental pretest and posttest non-equivalent control group design was implemented by using a quantitative approach.

For the study, a sample group of eighty-seven (87) SHS 3 students was selected from two complete classes. Data for the study were gathered using instruments called the Alkenes Concepts Test (ACT). To address the study topics, the means, standard deviations, frequencies, percentages, mean differences, and independent sample t-test were employed. According to the findings, students had trouble understanding alkenes. Students who were taught alkenes utilizing the REACT teaching strategy performed significantly better than those who were taught using the traditional method. It was recommended, amongst other things, that Lambussie SHS teachers be urged to employ REACT instructional techniques when introducing alkenes to their students.

Keywords: Alkenes, REACT teaching strategy, Conventional approach, Alkenes concept test, IUPAC.

INTRODUCTION

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 .75.1 percent of students could not correctly write the structural formula for 4-ethyl-2,3-dimethylhex-2-ene, according to Adu-Gyamfi *et al.* (2012). 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. According to Adu-Gyamfi *et al*. (2017), the majority of chemistry students struggled to name any compounds that contained branched or substituted chains, such as dienes (an alkene compound with two double bonds).The challenges faced by these students were evident in their final external exams. According to the leaders of the West African Examination Council (WAEC) examination committee, most applicants were unable to draw the correct diagram that illustrates how an alkene generates 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).

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In an attempt to solve this major problem, researchers sought to ascertain the possible causes of students' conceptual challenges encountered when instructing students in organic chemistry. Students find organic chemistry topics too abstract, for example, finding it difficult to apply the concepts to their everyday lives, according to Anim-Eduful and Adu-Gyamfi (2022). 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). According to Lak *et al*. (2017), the term "student-centered" refers to an approach in which the student is positioned at the center of the educational process, with the instructor in the classroom only taking on this role after the process has started.

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 and 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 and 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 and Nygatayeva, 2017). Because of this, students soon forget concepts being taught since they learned it abstractly (Felder and 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.

In a learner-centered classroom, on the other hand, students actively participate in the teaching and learning process and have greater control over what they learn, how they learn it, and when they learn it (Lak *et al*., 2017). That is, the teacher designs the lessons to suit the needs of the learners. This shows that learners are accountable for their education and actively engage in the process of learning. According to Lak *et al*. (2017), a learner-centered teaching approach prioritizes students' learning processes over teachers' methods of instruction. In a learner-centered learning environment the instructor 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, the dynamics of power in the classroom are changing, 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 and Nygatayeva, 2017). Critical thinking abilities improve when students take an active role in their learning processes – 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.

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

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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).

Statement of the Problem

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 of chemical reactions, preparation (synthesis), isomerism (Nartey and Hanson, 2021), as well as general misconceptions in alkene concepts (Şendur, 2012). These students' difficulties have been reflected in their final external examinations as stated by the West African Examination Council (WAEC) examiners), 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 and 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.

Purpose of the Study

This study examines the relative effects of traditional teaching methods and REACT teaching tactics on the academic performance of senior high school chemistry students in the topic of alkenes.

Research Questions

1. What difficulties exist among SHS Chemistry students studying alkenes?
2. When it comes to learning alkenes, how do SHS Chemistry students taught utilizing the REACT teaching style perform academically compared to those taught using the traditional method?

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).

In a constructivist classroom, students actively engage in the learning process and the teacher primarily serves as a facilitator. According to this concept, a teacher who serves as a "facilitator" who mentors, directs, and

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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 and Ilmadi, 2022), as it occurs within the "cooperating" phase of the REACT instructional techniques. This means that the learners 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).

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 (Dita Oktavia, Alwasilah and Rest, 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.

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. Karsli and Yigit (2017) assessed how well the REACT teaching strategies affected students' understanding of the Alkenes concept. In order to compare the outcomes of the pretest, posttest, and delayed posttest that were given in this study, the researchers employed a one-way Analysis of Variance. The one-way ANOVA findings showed a significant difference in the pretest, posttest, and delayed posttest scores ($F(2,57) = 9.61$, $p=0.00$). In particular, there were statistically significant differences between the pretest and posttest (mean=4.10) and posttest (mean=9.00) in favor of the posttest, and between the pre-test and delayed test (mean=7.85) in favor of the delayed posttest ($p=0.00$).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,12^{th} 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), The authors used a pretest/posttest control group design for their study. In terms of learners' academic achievements as judged by post-test scores, the results of an independent sample t-test showed a significant difference in the performance of the experimental group (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), investigated the effects of REACT methods on the motivation and academic achievement of tenth grade chemistry students. Pretest/posttest comparable control group design used in a quasi-experimental setting, sixty (60) high school learns—27 girls and 33 boys—were employed in the study.While there was no statistically discernible variation in the pretest results between the experimental and control groups' students ($t(58)=0.410$, $p=0.683$), There was a notable distinction ($t(58)=6.465$, $p<0.05$) between scores on the posttest for the experimental group (Mean=63.60,

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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* (2019). This suggests that using REACT teaching techniques to improve students' academic performance in Chemistry is beneficial.

Günter (2018), used a pre-test-post-test control method that was quasi-experimental in a study named "*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 found that although the post-test results of the experimental group and the control group differed significantly ($U = 374.5$, $p < 0.05$), The pre-test results of the two student groups did not differ statistically significantly. The experimental and control groups' pre- and post-test scores differed statistically significantly ($z = -5.997$, $p < 0.001$ and $z = -6.095$, $p < 0.001$), according to the results of the Wilcoxon test. Based on these statistics, it was determined that posttest results for both groups.

A study titled "Effect of the REACT strategy on senior high school students' achievement in molecular genetics" was carried out in Ghana in 2021 by Quainoo *et al*. "A qualitative element was incorporated into the main quantitative pre-test/post-test non-equivalent control group design through the use of the embedded mixed methods 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 divided into two groups: the control group, which was instructed using conventional teaching techniques, and the experimental group, which was instructed using REACT teaching methodologies. 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). The pretest mean scores of the students chosen for the two groups did not differ statistically significantly. (t=0.66, p=0.94). This proves the efficacy of the REACT teaching methods.

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 producing alkenes from alkyl halides and alcohols, 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 learns 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 $CH_3CH{=}CHCH_2C(Cl)(CH_3)_2$.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

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in the same study found it difficult to give the proper nomenclature for BrCH≒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 had trouble determining the correct IUPAC label for the trans isomer.

Once more, Adu-Gyamfi *et al*. (2017) discovered that learns had trouble identifying 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, based on statements made recently by the West African Examination Council's (WAEC) chief examiners for Chemistry (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.

METHODOLOGY

The quantitative method was applied in a quasi-experiment pretest-posttest non-equivalent group design. This is to make sure that, rather than allocating students to groups at random, intact classes were used, potentially avoiding any potential variations in the groups used for the research.

Population

The target audience was all Form 3 Senior High School (SHS) students in Ghana who studied elective chemistry in high school. All third-year Form 3 students who enrolled in Elective Chemistry at two of the district's three public senior high schools were part of the accessible population. Because they had already studied about alkanes, which is a prerequisite for comprehending the concepts of alkenes, the Form 3 students were selected for this study project. Once more, at the time the research was conducted, the students had not yet been taught the concepts of Alkenes.

Sampling Procedure

To select a sample from the population, the multi-stage sampling approach was applied. 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), alkenes are studied 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 interaction effect. Random assignments were made to the experimental and control groups within the selected intact classes. The experimental group was taught using REACT strategies, whilst the control group was instructed using the conventional method. As a result, 87 people in total were sampled to participate in the study.

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Tools for gathering data

Two distinct devices were used to collect the research's data. This comprised a survey on students' challenges with alkenes and an accomplishment test in the subject. The exam consisted of eight (8) essay-style questions to determine achievement.

RESULTS AND DISCUSSIONS

The purpose of the study was to compare how senior high school chemistry students performed academically in alkenes when taught using REACT against traditional teaching methods.

This chapter presents and discusses the findings from the data that was collected for the study. Research question 1: "*What challenges exist among SHS Chemistry students in alkenes*?" is the research question posed. In order to answer this question, percentages of scores for each pretest item were calculated, and the outcomes are displayed in Table 1.

Table 1: 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%

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 principles of organic chemistry. Students' demonstrating such difficulties could be partly due to their insufficient understanding of Alkene concepts (Anim-Eduful and 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.

Research Question 2

In terms of alkenes, what is the difference in the academic performance of SHS Chemistry students taught using the traditional technique and the REACT teaching strategy?

In order to do this, the pretest for the students in the REACT and traditional approaches in alkenes was subjected to an independent sample t-test. 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 outcome of the independent sample t-test on the students' pretest in the traditional and REACT methods for alkenes is shown in Table 2.

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Table 2: 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			

p>0.05

According to Table 2, 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.

After the intervention was implemented, a post-test independent sample t-test was used to assess how well the students performed (both traditional and REACT). Table 3 displays the outcome of the independent sample t-test on the post-test of the traditional method and REACT in alkenes. The initial assumption tests for homogeneity of variance, linearity, and normalcy were all passed.

Table 3: 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			

According to Table 3, 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. Students using the REACT strategy scored significantly better than those using the traditional approach, according to a comparison of mean scores. The magnitude of the mean difference was determined using eta squared statistic, which produced an eta squared value of 0.131, indicating a small effect size (Cohen and Cohen ,1983). The findings of this study corroborate Karsli and Yigit (2017) results showed that Turkish students' comprehension of alkenes ideas improved more with the REACT approach than with the traditional approach. Karsli and Yigit (2017) investigated the impact of the REACT approach on the retention of alkanes knowledge among Turkish 12th grade students and discovered that it outperformed the traditional method in terms of learning retention. 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). The pretest means scores of the students chosen for the two groups did not differ statistically significantly (t=0.66, p=0.94).

In studies conducted by Karsli and Yigit (2017) and Quainoo *et al* (2021), it was discovered that the REACT strategy outperformed the traditional method in raising students' academic achievement. Karsli and Yigit (2017) discovered that learns' conceptual understanding of impulse and momentum increased when the REACT approach was applied. Karsli and Yigit (2017) discovered that using the REACT approach improved Chemistry students' academic performance..

CONCLUSIONS

The study's conclusions confirm that students exhibited challenges while learning about alkenes. Also, when teaching alkenes utilizing the REACT teaching approach, students' academic performance improved in comparison to the traditional way.

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