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EFFECT OF STAD MODEL OF COOPERATIVE LEARNING ON STUDENTS' PERFORMANCES ON NOMENCLATURE OF HYDROCARBONS IN HO MAWULI SENIOR HIGH SCHOOL

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EFFECT OF STAD MODEL OF COOPERATIVE LEARNING ON STUDENTS' PERFORMANCES ON NOMENCLATURE OF HYDROCARBONS IN HO MAWULI SENIOR HIGH SCHOOL

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DECLARATION

Student's Declaration

I, EMMANUEL NANOR, declare that this Thesis, with the exception of quotations and references contained in published works which have all been identified and acknowledged, is entirely my own original work and it has not been submitted, either in part or whole, to any institution anywhere for any academic purposes.

NAME OF STUDENT: EMMANUEL NANOR

DATE :……

SIGNATURE :……

Supervisors' Declaration

I hereby declare that the preparation and presentation of this thesis was supervised in accordance with the guidelines set for thesis laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: Dr. MAHAMA ALHASSAN

DATE :……

SIGNATURE :……

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DEDICATION

This work is dedicated to my lovely mother Edegbe Doris and my brothers and sisters and all who helped in diverse ways to make this work a successful one.

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Thanks to Doctor Alhassan Mahamma for his selfless guidance and corrections.

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ABSTRACT

Students Team Achievement Division model of cooperative learning was employed to examine students' performance in nomenclature of hydrocarbons. A sample of 41 students were conveniently sampled for the study. The study employed an action research design. Pre and post-intervention tests were conducted before and after the intervention respectively to determine the effect of the intervention on students' performance. Retention test was also administered two weeks after the post-test to determine the effect of the intervention on students' retention. Five points Likert scale questionnaire was used to determine students' perceptions of STAD in learning nomenclature of hydrocarbons. The findings from the study showed that STAD model of cooperative learning significantly improved performances of the students in nomenclature of hydrocarbons. Implementation of STAD has also enhanced students' retention of the concept of nomenclature of hydrocarbons. No significant difference was observed between male and female students after implementation of STAD. The study concluded that STAD model of cooperative Learning is an effective learning model for improving academic performance and retention. The intervention fostered positive classroom interactions, promoted positive attitudes towards learning and provided opportunities for developing critical thinking and analytical skills. The study therefore recommended the use of STAD model of cooperative Learning by students owing to its effectiveness in improving learning outcome.

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CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter provides a general introduction by articulating the background to the study and goes on to identify the problem of the study. This chapter also looked at the reasons for conducting the study and discussed what the research intends to achieve. This chapter again talked about the conditions that posed threat to the study and how these conditions were controlled. This chapter ends with an outline of the structure of the thesis.

1.1 Background to the Study

Despite educational measures and polices, adequate instructional approaches, besides development and implementation of good curriculum content, acquisition of expensive resources and employment of highly trained personnel to improve students learning, students still perform poorly in certain scientific disciplines. According to Mohan (2019), Science is acquisition of body of knowledge through an enquiry and critical thinking, with the aim of arriving at the understanding of the natural world. Abdi (2014) affirmed that science plays a paramount role in our societies and its effects are obvious in every aspects of our lives. Prevention of disease and maintenance of health is made possible through the knowledge of science. Again as a result of scientific knowledge, farmers are able to control pest and diseases of crops and animals bringing about increase in productivity (Deboer, 2019). This means that the knowledge of science is very crucial for survival in this natural world. Chemistry, a branch of science (Salame, Patel, & Suleman, 2019) that deals with the systematic study of composition, properties and activities of organic and inorganic compounds

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(Ajayi, Achor, & Otor, 2020) plays a very vital role in the development of a nation (Yaayin, Oppong, & Hanson, 2021). Chemistry, a major science subject which has very significant usefulness in the field of pharmacy, medicine, biochemistry, petroleum, textile, agriculture, engineering and microbiology (Udu, 2018) is seen as a difficult scientific discipline by learners (Iyamuremye, Mukiza, Nsabayezu, Ukobizaba, & Ndihokubwayo, 2022). In affirmation of difficulty faced by students in chemistry, Oppong, Quansah and Boachie (2022), Devendiran and Vakkil (2017) and Sarkodie and Adu-Gyamfi (2015) stated that students have difficulty grasping the concept of nomenclature of hydrocarbons which is a major component of organic chemistry. As a result, students perform very poorly in the concept of nomenclature of hydrocarbons in the West African Senior School Certificate Examination. The abysmal performance of students in the concept of nomenclature of hydrocarbons is affirmed by WEAC (2019) and WAEC (2020) Chief Examiners' report. Inability of students to comprehend the concept of nomenclature of hydrocarbons is due to poor learning approach on the part of the students. The knowledge of organic chemistry for that matter hydrocarbons, play a remarkable role in medicine, pharmacy, agriculture and engineering (Udu, 2018). Poor performance in nomenclature of hydrocarbons hinders students' understanding of certain concepts in pharmacy and medicine. There is therefore the need for solution to this crucial problem. In attempting to remedy the learning difficulty of students, many studies looked at the use of technology in instruction (Afurobi, Izuagba, Obiefuna, & Ifegbo, 2015; Devendiran & Vakkil, 2017; Muthukumari & Ramakrishnan, 2017). Some researchers also investigated effect of teaching method on students' learning outcome (Afurobi *et al.*, 2015; Sugano & Nabua, 2020), others researched into motivation of students (Almalki, 2019). However, it is the learning process that plays a very vital role in enhancing the

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excellent performance of students (Marpaung, Pongkendek, Azzajjad, & Sukirno, 2021). It is therefore very beneficial for learners to be assisted in employing an effective learning strategy to enable them comprehend the concept of nomenclature of hydrocarbons. There is therefore the need for research into how learning style on the part of learners can bring about improved learning outcome of students since only very few studies have been conducted on how learning styles of students can bring about improve performance of the students.

Silva, Lopes, Dominguez and Morais (2022) stated that cooperative learning is an active learning technique that is learner centered, and involves learners working in heterogeneous group of relatively small members with the aim of sharing ideas, helping one another towards attainment of common goal of the group. Cooperative learning is very effective in improving students' understanding and achievement. As a result, it is one of the best learning strategies (Mahamod & Somasundram, 2017). Students learn far more effectively when they actively participate in and reflect on their own learning process. Facilitators must therefore ensure that active learning atmosphere is created for leaners to be active participants in the process of learning rather than just mere note takers (Bradforth, Miller, Dichtel, Leibovich, Feig, 2015). Foldnes (2016) opines that cooperative learning approach enables learners to achieve better understanding of concepts.

Student Team Achievement Division (STAD) is an active learning model of cooperative learning (Zubaidah & Corebima, 2021) that involves placing students or learners in a heterogeneous group (group of learners with different levels of ability, ethnicity and gender) of three to five members (Kim, 2018) with the aim of helping one another in mastering a given learning material (Jahanbakhsh, AliAsgariZamani, &

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Garman, 2019). Yildiz and Arici (2021) affirmed that STAD model of cooperative learning is effective in improving students' performance. In assertion. Kristin (2016) stated that STAD model of cooperative learning is effective in enhancing student learning outcome (as cited in Suastika, Suartama, Sanjaya, & Arta, 2021). The aim of this study therefore was to improve students' performance in the concept of nomenclature of hydrocarbons through STAD model of cooperative learning

1.2 Statement of the Problem

Academic performance is a key issue to all stake holders of education. It is expected that students who are taught in school will perform excellently in every concept in their final West African Senior School Certificate Examination. This is however not the case in Ghana. Oppong *et al.* (2022) specifically stated that IUPAC nomenclature of hydrocarbon is an area of organic chemistry where students have difficulty. Fendos (2021) also affirmed that students have difficulty giving IUPAC nomenclature of organic compounds of which hydrocarbon forms a major constituent. WEAC Chief Examiner's report on chemistry bitterly lamented about the abysmal performance of students in the concept of nomenclature of hydrocarbons (WEAC), 2010). Inability of students to grasp the concept of nomenclature of organic compound is seen among leaners in every continent of the world (Obumnenye & Ahiakwo, 2013).

Poor performance in chemistry of which the concept of chemical nomenclature is part, prevents students from entering into scientific disciplines like pharmacology, biochemistry and biotechnology (Fendos, 2021). However, if students are able to overcome this difficulty, they will be able to gain admission into higher educational institutions to pursue courses in the above-mentioned disciplines thereby realizing their dreams of becoming medical doctors, pharmacists, biochemists and other

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professionals. Efforts made in addressing the problem with previous research include: use of models, curriculum and course content development, employment of electronic online homework system, implementation of peer led team learning (Austin, Ben-Daat, Zhu, Atkinson, Barrows, 2015). Others also researched on teaching methodology (Afurobi *et al.*, 2015). In the literature however, there was no study on the use of active learning technique like STAD model of cooperative learning in helping students to overcome their difficulty in the concept of nomenclature of hydrocarbons. Meanwhile, Kustyarini (2020) and Hendrickson (2021) affirmed that active learning techniques yield successful learning outcome and enhances students understanding and transfer of knowledge acquired. There has been a general agreement that learners need to be active participants in learning, This call for employment of learning approach that will ensure active participation of students (Loh & Ang, 2020). Past researches have proved STAD model of cooperative learning as a major learning technique that enhances active participation of learners in the process of learning (Chen, 2018). Cariaga, Tomada, Velonta, Villagonzalo, Gaco (2022) stated that STAD model of cooperative learning is effective in improving students' learning outcome. In affirmation, Abd Mokmin, Bungsu and Shahrill (2022), stated that Students Team Achievement Division (STAD) model of cooperative learning is one of the students' centred leaning approach that is associated with high student retention resulting to high achievement regardless of the ability levels of the learner. It is for this reason that the researcher wanted to find out the effect of STAD model of cooperative learning on students' performance on chemical nomenclature of hydrocarbons in Ho Mawuli Senior High School

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1.3 Purpose of the Study

The purpose of the study was to find out the effect of STAD model of cooperative learning on students' performance in the concept of nomenclature of hydrocarbons in Ho Mawuli Senior High School

1.4 Objectives of the Study

The objective of the study was to:

1. Find out the effect of STAD model of cooperative learning on students' performance on the concept of nomenclature of hydrocarbons in Ho Mawuli Senior High School
2. Find out whether male or female will influence students' performance in the concept of nomenclature of hydrocarbons using STAD model of cooperative learning in Ho Mawuli Senior High School
3. Find out the effect of STAD model of cooperative learning on students' retention of the concept of nomenclature of hydrocarbons in Ho Mawuli Senior High School
4. To determine students' perception of STAD model of cooperative learning in Ho Mawuli Senior High School

1.5 Research Questions

The study considered the following research questions

1. Does STAD model of cooperative learning have any effect on students' performances in the concept of nomenclature of hydrocarbons?
2. Do males and females perform similarly after being exposed to STAD model of cooperative learning?

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3. Does the STAD model of cooperative learning improve upon students' retention of the concept of nomenclature of hydrocarbons?
4. What is the perception of students toward STAD model of cooperative learning?

1.6 Significance of the Study

The outcome of this study would be used to educate teachers who have conservative attitude towards instructional strategies. The outcome could serve as guide for effective teaching and learning strategy for both teachers and students. The findings could serve as guide to ministry of education in the development and implementation of curriculum for schools. Finally, the outcome of this study could serve as utilitarian guidelines to researchers of education and students.

1.7 Delimitation

Delimitation of a study refers to limits deliberately set out by researchers which determine the boundary of their study and ensuring the possibility of realization of objectives and aims of the study at hand. Delimitation of a study is actually under the control of the researcher. It includes study background, study sample, objectives, study variable aim and sampling strategy (Dimitrios & Antigoni, 2019). The study was delimited to nomenclature of hydrocarbons and to only S.H.S 3 students of Ho Mawuli Senior High School in the Ho municipality.

1.8 Limitation

Limitation of a research refers to weaknesses of the study that are beyond the control of the researcher. They are usually associated with financial constrain, research

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design, statistical model and other factors. The limitation of a study has the potential of influencing the conclusion, result and study design (Dimitrios & Antigoni, 2019). The researcher encountered the following limitations:

1. Test anxiety on the part of the students could possibly affect their scores
2. Different learning ability of the students could also affect the findings.
3. Inadequate time did not allow for larger students' population.

1.9 Organization of Study

The study was organized under five chapters. Chapter one dealt with, the background, the statement of the problem, purpose, research questions, significance, delimitation, limitation and organization of the study. Chapter two reviews related literature for the study. Chapter three covered the methodology. Chapter four took care of results, findings and discussions. Finally, chapter five was on the summary, conclusions and recommendation

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CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter reviewed literature related to the study. The review commenced with the theoretical framework of the study. Literature was also reviewed on theories of learning. Under the theories of learning, literature was extensively reviewed on social constructivism. Review of literature on nomenclature of hydrocarbons was conducted in this same chapter. There was also a review of literature on stages, implementation, and advantages of STAD model of cooperative learning. In this chapter, literature was also reviewed on factors affecting academic performance. The chapter ended by reviewing literature on factors affecting learners' retention of knowledge.

2.1 Theoretical Framework

The study was guided by social constructivist theory of learning. Vygotsky in 1978 developed this theory of learning (Boutin Jr, 2021; Li & Lam, 2013; Mwanda & Midigo, 2019). Social constructivism theory has been applied in the field of Science and Technology Studies (STS), mathematics, social sciences, humanities as well as many other areas of sociology, anthropology, and communication studies (Lynch, 2016) .This theory proposes that, students learn best through active construction of their own knowledge (Finnegan & Ginty, 2019). Succinctly, social constructivism presupposes that, the way and manner knowledge is constructed is unique to each individual. Social group of people have much knowledge in common. Knowledge therefore is constructed by means of social interactions within the framework of specific social and societal context (Knapp, 2019). As applied to my study. this theory holds that social interaction among learners will result in meaningful construction of

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knowledge This theory is applicable to this study for the reason being that, it substantiates the fundamental importance of acknowledging various opinions in the classroom without restricting social interaction among students, teachers and facilitators creating a conducive atmosphere for active participation of learners in construction of their own knowledge leading to successful learning outcome (Adebola, Tsotetsi, & Omodan, 2020).

2.2 Theories of Learning

According to Olson (2012) in the field of science, a theory refers to interconnected set of ideas and concepts that explicate a given data and makes prediction about experiments yet to be conducted. Aliakbari, Parvin, Heidari and Haghani (2015) asserted that, theories are set of associated propositions, which are capable of describing, clarifying, forecasting or predicting, a phenomenon. Theories of learning seek to deliver enlightenments about learning. Al-Shammari, Faulkner and Forlin (2019) affirmed that, theories of learning offer designers of curriculum effective teaching methodologies for effective learning. Akpan and Kennedy (2020) hold that, theories of learning serve as vital instruments for apprehending how teaching might lead to an effective learning. Many theories have been postulated by researchers and educational psychologists to elucidate how learners learn (Aliakbari *et al.*, 2015). Zhang and Bayley (2019) affirmed that, cognitivism, social constructivism, connectivism and behaviourism are theories that support learning.

2.2.1 Behaviourism

According to Dietrich and List (2016), behaviourism is a theory that is pioneered by B. F. Skinner (1904–1990). Ivan Pavlov (1849– 1936), and Leonard Bloomfield (1887–1949). Behavourism is a learning theory that explain animals and human

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behaviour in terms of conditioning without resorting to feelings and thought. Behaviourists hold the view that psychological disorders are capable of being treated by changing patterns of behaviour. Behaviourists view behaviors as rejoinders to stimuli. To behaviourist, the environment of an organism is the determinant of its behaviour. This implies that, environment is considered to be the source of stimuli to which the organism responds. Supporters of behaviourism don't describe behaviour by referring to mental process (Akpan & Kennedy, 2020). Beahaviourist see instruction as knowledge transmission from teacher to learner and for that matter do not consider the role of the mind during the process of instruction (Stoilescu, 2016). Outcome-based education, programmed learning, over emphasis on skill drill and practice, mastery learning and too much attention given to skill based testing rather than testing understanding and application of knowledge are some of the negative effects of behaviourism (Stoilescu, 2016).

2.2.2 Cognitivism

Dietrich and List (2016), argue that, learning cannot occur only by a respond to a stimulus without involvement of innate potentials. The involvement of innate capabilities in the learning process is what brings about cognitivist theory of learning. Cognitivist theory of learning emphases the ability of the learner to think, and do self-reflection. Cognitivism involves motivation of the learner as well as his or her memory (Al-Shammari *et al.*, 2019). According to Schunk (2012) social cognitive learning theory stresses that attitudes, belief, skills, strategies and values are acquired from social environment by seeing others. Kay and Kibble (2016), asserted that, cognitivism emphasis acquisition, representation and construction of knowledge in the mind.as well as how it is recalled. Cognitivists lay emphasis on active participation of

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learners in the process of learning. Cognitivist theory of learning holds the view that learners come to the classroom with previous skills or knowledge that has impart on learning outcome. One of the key issues of cognitivism is how information is processed and stored mentally.

2.2.3 Connectivism

According to Dennis (2020) connectivism theory of learning was introduced by Siemens (2005) and Downes (2012). Connectivism is social learning that is interconnected (Duke, Harper, & Johnston, 2013). Connectivism a pedagogical and learning theory refers to knowledge as that which is derived from interaction in a community. Connectivism view knowledge as that which cannot be controlled unbalanced, unpredictable and in a progressive manner. To connectionists, knowledge is out of control of one person and is in his or her external network (Downes, 2019). Goldie (2016) asserts that, Connectivism is a theory of network learning developed for e-learning. This theory of learning views learning as network phenomenon in which interaction and technology have a major role or effect. Learning occurs in connectivism when knowledge is activated by learners who connect and take part in a learning community. The eight principles of connectivism theory of learning according to Utecht and Keller (2019) are:

1. Learning and knowledge rest in diversity of opinions.
2. Learning is a process of connecting specialized nodes or information sources.
3. Learning may reside in non-human appliances.
4. Capacity to know more is more critical than what is currently known.
5. Nurturing and maintaining connections are needed to facilitate continual learning.
6. Ability to see connections between fields, ideas, and concepts is a core skill.

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7. Currency (accurate, up-to-date knowledge) is the intent of all connectivism learning activities
8. Decision making is itself a learning process. Choosing what to learn and the meaning of incoming information is seen through the lens of a shifting reality. While there is a right answer now, it may be wrong tomorrow due to alterations in the information climate affecting the decision.

2.2.4 Social Constructivism

Bozkurt (2017) and Schunk (2012) asserted that, social constructivism involves interactions among leaners in the form of discussion is a major instrument for enhancing learning. Social constructivism argues that comprehension and learning are functions of social interaction and for that matter, knowledge is not rooted in the individual, it is through cultural activities and the use of what Vygotsky describes as "tools of intellectual adaptation" (memories, mnemonics and mind-maps) that the individual acquires knowledge. These tools, which vary between cultures, include symbols (such as a child using a banana as a phone while playing), artefacts and language and through their use. Thought, learning and knowledge are not just influenced by social factors but are social phenomena and cognition is a collaborative process (Abderrahim & Gutiérrez-Colón Plana, 2021). According to Mwanda and Midigo (2019) social constructivism holds the view that learning is communally mediated activity by which individual constructs his knowledge as a result of interacting with cultural or social environment.

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2.2.4.1 Propositions of Social Constructivism

Social constructivism's propositions are centered on the elements: Learning, knowledge and reality. These three elements form the foundation of assumptions of models that are rooted in social constructivism. Learning to social constructivist is seen as a social activity. To social constructivists, learning does not only take place within the individual, it comes about as a result of social interaction. Reality in social constructivism refers to knowledge that can only be constructed and for that matter cannot be found. This implies that knowledge does not exist without social interaction. Reality is only created by members of society through social interactions or activities. Social constructivist see knowledge as that which is constructed from cultural or social activity. To them, knowledge is a product of social interactions with the surrounding of the individual or with others (Amineh & Asl, 2015; Kim, 2001). Social constructivism proposition according to Adams (2006) is that, social interaction with people and the environment, interpretation as well as comprehension lead to construction of knowledge by learners. Knowledge construction takes place first of all between people before its internalization (Gillies & Ashman, 2003). Knowledge construction therefore cannot occur outside the sphere of social interaction,

2.2.4.2 Social Constructivist view of Learning and Learners

Learning in the field of social constructivism is the systematic process by which knowledge is constructed by learners themselves rooted in their active involvement in a planned and organized activity. Social constructivist learning is a type of learning that places emphasis on construction of knowledge and not transmission, not retention of knowledge but comprehension and application of knowledge. Critical thinking and

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careful analysis are also key elements that characterized social constructivist learning. Learning in the setting of social constructivism is a dynamic process (Tran, 2013). Social constructivists hold the view that, learning (recognition, meaning, understanding and knowledge) are constructed and internalized first of all by the individual within the framework of social setting. To them knowledge construction by learners originates from collaborative elaboration. Social constructivists see learning as that which comes about as a result of active participation in discovering principles, rules and understanding of concept. Owing to this, social constructivists create room and conducive atmosphere for critical thinking and interaction among learners and between learners and facilitator. Social constructivist stress that learning occurs when learners engage in meaningful interaction with the learning environment and other learners. To social constructivists, learning is mental activity and social interaction (Amineh & Asl, 2015).

Knowledge construction to social constructivists is done differently by individuals. Social constructivists hold the view that learners construct knowledge in different ways. In order for learning to take place by the learner, the teacher need to be aware of the fact that, each learner has a unique way of constructing knowledge. The way and manner in which this is done depend on how the individual gets information, organize and interpret the information received from his or her environment. Social constructivists see learning as an active process of knowledge construction within social context. To social constructivists, social interaction is the pivot of learning. Understanding, interpretation and social interaction are the basic ingredients of the product learning. This implies that the learning environment to social constructivists ought to be one that encourages learners to interact among themselves. (Adams, 2006). Social constructivism stresses two important factors of learning. The first one

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being the social environment of the learner and the second the context of learning. The social environment of the learner encompasses the culture of the learner. Learning can be viewed in four perspectives when view through the lens of social constructivism. The situated cognitive perspectives, Idea-based social constructivism perspective, Pragmatic approach, and cognitive tool perspective. Cognitive tool perspective stresses the learning of cognitive techniques. Idea-based social constructivism places emphasis on every vital concept in different subject areas. Situated cognitive perspectives stresses how the learner interacts with his environment of which he or she is part. People who hold Pragmatic approach are of the view that learning can be addressed from the perspective of the individual and from the perspective of the whole class. Social constructivists see learning as a mental activity that result from interacting with the environment and with other people. Change in the environment and relationship will bring about change in learning. Learning therefore cannot take place outside the environment (Kim, 2001). Social constructivist learners are active participators of the process of learning. As a result, they are actively involved in the construction of meaning, reflection of experience as well as construction of the experience to becoming more knowledgeable individual (Garbett, 2011). Within the ambient of social constructivism, each learner is seen as unique individual with different cultural background, prior knowledge, experience and of course different learning style (Mellis, Carvalho, & Thompson, 2013). Constructivist learners are active participant in the process of meaning making (Tran, 2013). Social constructivists see learners as unique individual whose construction of knowledge and meaning making can be achieve effectively by means of social interaction (Amineh & Asl, 2015).

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2.2.4.3 Social Constructivism view of Teachers and Teaching

Social constructivism acknowledges instructor, facilitator or coach but not a teacher. To social constructivist the facilitator does not give lectures covering the subject matter or the content. What he does is guiding or coaching learners to construct their own understanding. This he does by creating opportunities for learners to be active participant in the process of learning. One of the major role play by a teacher in social constructivism is creating room for active interaction among learners and between himself and the learners (Amineh & Asl, 2015; Brownstein, 2001). The major role of a teacher in social constructivism is creation of an atmosphere that enhances engagement of learners (Bozkurt, 2017). A constructivist teacher motivates his learners to construct their own knowledge (Chang, 2016). In social constructivism, teaching is carried out in ways that make information meaningful and relevant to learners, by creating the opportunities for learners to discover or apply ideas themselves, Teaching in social constructivism is done as provision of guidance (Slavin, 2019). Teaching in social constructivism place learners at the central position during instruction. Social constructivist teaching makes use of collaborative learning strategies for knowledge construction and comprehension making by learners themselves. Cooperative activities among learners and between learners and facilitator are utilized to assist learners in construction of their own knowledge. Teaching in social constructivism also ensure adequate supply of resources to learners to help learners get a deeper understanding of concepts for their own creation of knowledge (Liu & Zhang, 2014).

2.2.4.4 Social Constructivists' Learning Environment

Akpan and Beard (2016) stated that typical social constructive classroom environment is tasks oriented and organize to enhance hands-on and minds-on learning for learners

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similar to those encountered in the real world. This type of learning environment focuses on authentic tasks similar to what we see in our daily lives. Social constructivist learning environment furnish leaners with the opportunity to have a feel of real-world experiences and meaningful practices. Within social constructivist classroom, an atmosphere that allows interaction among learners and between learners and facilitators is created in such a way that learners feel free to express themselves and bring to light their idea relative to the subject under discussion. Social constructivist learning environment create room for inspiration, ideas, knowledge meaning making to glow within each learner without hindrance (Kalina & Powell, 2009). Social constructivist learning environments often offers leaners the opportunity to explore, conduct experiment, construct, discuss and reflect on what they are doing so as to enhance learning from their experiences (Wang, 2009). Constructivist learning environment enables learners to interact with knowledge and with each other using various tools. Social constructivist classroom emphasizes learning environment where learning occurs rather than instruction itself. In a constructivist learning environment the teacher acts as a facilitator and guide learners to achieve learning goals (Cetin-Dindar, 2015). Adams (2006) identified the following principles of constructivism learning environment.

1. Focus on learning not performance.
2. View learners as active co-constructors of meaning and knowledge.
3. Establish a teacher–pupil relationship built upon the idea of guidance not instruction.
4. Seek to engage learners in tasks seen as ends in themselves and consequently as having implicit worth.

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5. Promote assessment as an active process of uncovering and acknowledging shared understanding

2.3 Cooperative Learning

Different people have different definitions to cooperative learning (Tran, 2013). This means that cooperative learning can be defined in so many ways. Cooperative learning a classroom technique (Agarwal, 2010). Is a learner centered instructional approach that is usually guided by a facilitator. This type of learning is organized in such a way that members of a group have the opportunity of interacting with one another with the aim of mastering a particular concept or subject matter (Slavin, 2011a). Gillies (2016) affirmed that, cooperative learning is a pedagogical instructional approach that enhances social interaction and learning among learners across different subject areas. It creates that conducive atmosphere for learner to work together in group to achieve desirable tasks According to Slavin (2011b), cooperative learning is a teaching technique characterized by organization of learners by instructors into relatively smaller groups of four or five members with the aim of group members assisting one another in learning.

Johnson and Johnson (2018) argued that, various forms of active learning ensure that learners work collaboratively in small groups. Cooperative learning for that matter is the foundational block on which active learning approaches are built. According to Óhidy (2011) cooperative learning is an attitude of life which prioritizes group work based on mutual respect and accountability of each group member. A basis of cooperation learning is mutual agreement which result from the cooperation among the community members. Based on previous experience it can be said that those

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pupils who are able to use cooperative learning are also able to adapt this cooperative approach to other areas of life (as cited in Kövecses-Gősi, 2018).

You (2014) argued that: real cooperative learning is a type of teaching methodology which is directed by instructional objective, organized on the basis of the heterogeneous groups, driven by the power resources from the interactive cooperation of the dynamic factors in the teaching and rewarded for the team achievements

2.3.1 Elements of Cooperative Learning

There are certain elements or principles that set out conducive atmosphere for productive cooperative learning (Wichadee, 2005). According to Agarwal (2010), Song (2012) Johnson and Johnson (2018), Opdecam and Everaert (2018), Hussien (2020), Yusuf, Jusoh and Yusuf (2019) and De la Barra and Carbone (2020), these principles of cooperative learning, are individual and group accountability, positive interdependence, group processing, face-to-face promotive interaction, and interpersonal and small group skills.

1. **Individual and group accountability:** This means that each and every individual in the group need to be responsible and participate towards helping the group to achieve its goal or task. As a result, the whole group is accountable for its own achievement (Jahanbakhsh *et al.*, 2019).

2. **Positive interdependence:** Positive interdependence occurs when the actions of every single individuals enhance the achievement of the goal of the group (Johnson & Johnson, 2009). “Positive interdependence exists when there is a positive correlation among individuals' goal attainments. Individuals perceive that they can attain their goals if and only if the other individuals with whom they are cooperatively linked attain their goals” (Johnson, 2009, as cited in Meng, 2017,p.95).

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Positive interdependence stresses the need for group members to depend on one another towards the achievement of the goal given to them. Contribution of an individual whether good or bad does not affect that individual but the whole group. Jolliffe (2007) argue that positive interdependent demand that every single member of the small group contributes his or her quota towards the achievement of the task assigned to the whole group. This means that each individual in the group requires the contribution of others for their success and the success of the whole group.

3. **Group processing**. This element stresses discussion and decision making, the need for all the members of the group to express themselves freely towards the achievement of the task given to the group. There is therefore the need for good moral relationship, social interaction and respect for every single member of the group regardless of their state or short fall. This element emphasis the actual working together of the members of the group (Webb, 2008).

4. **Face to face promotive interaction.** This is where team members directly communicate and interact with one another within the team and actively participate in activities to contribute themselves towards the success of the group (Lv, 2014). This element is characterized by rendering of support to each and every member of a group. Here learners encourage, support and motivate one another to learn. The success of the group is the success of everyone (Arra, D'Antonio, & D'Antonio Jr, 2011).

5. **Interpersonal and small group skills**. For the success of the whole group, there is the need for every single individual to possess and exhibit certain basic skills such as leadership, communication, decision making and collaborative skills, organizational skill, and respect for each other (Lv, 2014).

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2.3.2 Categories of Cooperative Learning

There are three categories of cooperative learning (Johnson etal 2008 as cited in Chen & Lin, 2020; Gillies, Ashman, & Terwel, 2007). These are formal cooperative learning, informal cooperative learning, and cooperative base groups.

2.3.2.1 Formal Cooperative Learning

This is a category of cooperative learning where learners work together, for a class period for several weeks, in order to achieve set goals and specific tasks. Formal cooperative learning enhances active participation of learners in academic work. The work can be seen in the form of searching for information, organizing, explaining interpreting and summarizing or researching on a given subject matter. Formal cooperative goals can also be seen in the form of report writing and conduction of experiments. Members of formal cooperative learning groups discuss how effectively and collaboratively they can work together towards the achievement of the goals of the group and how they can improve in the future. Selection of objectives, determination of group size, assignment of various roles and responsibilities, room arrangement and materials required for successful lessons are decisions made by facilitators of formal cooperative learning. Other responsibilities of facilitator within the ambient of formal cooperative learning include

1. Explanation of task to be performed, clear specification of assignment as well as concept and strategies
2. The facilitator of formal cooperative learning group spelt out criteria and social skills required for success of the group.
3. He intervenes and aids the groups towards achievement of goals
4. Collection of data, assessing and evaluation of the groups is also done by the teacher during formal cooperative learning.

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2.3.2.2 Informal Cooperative Learning

Informal cooperative learning group is ad-hoc group that last for a whole class period. Informal cooperative learning groups are often organized so that students engage in three-to-five minutes focused discussions before and after a lecture and two-to-three-minute turn to-your-partner discussions throughout a lecture. This group is created for the purpose of carrying out task for short duration. This group can be formed during lectures or demonstration in order to focus learners' attention to what they are currently learning. Informal cooperative learning group help to outline the expectations and scope or coverage of the lesson.it ensures that learners are actively involved in a lesson. Apart from the above informal cooperative group provides a mean for closure to an instructional session (Kopparla & Goldsby, 2019).

2.3.2.3 Cooperative base group

These are long-term, heterogeneous cooperative learning groups with stable membership Base groups give the support, help, encouragement, and assistance each member needs to make academic progress and develop cognitively and socially in healthy ways. Base groups are permanent that is lasting from one to several years and provide the long-term, caring peer relationships necessary to influence members consistently to work hard in school. The use of base groups tends to improve attendance, personalize the work required and the school experience, and improve the quality of learning. Positive development is enhanced when base groups are given the responsibility for conducting a year-long service project to improve the school. The three types of cooperative learning complement and support each other. A typical ninety-minute class session, for example, begins with a base group meeting of five to ten minutes in which members welcome each other and check each member's

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homework to ensure it is completed and understood. Second, the instructor gives a short lecture with informal cooperative learning to introduce the objectives, schedule and topic of the class session. Third, the instructor uses formal cooperative learning to conduct an instructional activity focused on the topic of the session. Fourth, near the end of the class the instructor summarizes (using informal cooperative learning) what has taken place, interesting ideas generated by the formal cooperative groups, and explains how the lesson leads into the assignment for the next class session. Fifth, the class session ends with a base group meeting in which students review what they have learned, what homework has been assigned, and what help each member needs to complete the homework (Agarwal, 2010; Johnson, Johnson, & Smith, 2014; Kopparla & Goldsby, 2019).

2.3.3 Benefits of Cooperative Learning

Cooperative learning has many benefits (Shawver, 2020). According to Du (2016, as cited in Shawver, 2020) cooperative learning enhances interest of learners. Christensen, Harrison, Hollindale and Wood (2019) believes that cooperative learning enhances achievement and satisfaction of learners. Chen (2018), affirmed that cooperative learning creates conducive environment for learners to be actively involved in classroom knowledge construction. Cooperative learning enhances motivation of learners by means of peer support and increases the thinking skills of learners (Graham, 2006). It provides a means for establishing good peer relationship (Azizan, Mellon, Ramli, & Yusup, 2018). Cooperative learning is effective in instilling healthy values necessary for teamwork (Sharan, 1980, as cited in Azizan *et al.*, 2018). Cooperative learning reduces the occurrence of undesired atmosphere in a group work such as having free riders that will claim equal mark with hard working individual in a group (Smith, Sheppard, Johnson, & Johnson, 2005). Cooperative

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learning according to Tran, Nguyen, Van De, Soryaly and Doan (2019) strengthens individual belief and confidence than in individualistic learning. Again, cooperative learning develops in learners good attitude towards learning leading to improvement in comprehension and learning outcome All the merits of cooperative learning can be summarized by two factors, better achievement and improved social relations among learners (Tran, 2019).

2.3.4 Types of Cooperative Learning.

There are several cooperative learning methods (Slavin, 2019). Ranging from very concrete and prescribed to very conceptual and flexible. Notable cooperative learning methods used to ameliorate student learning reported in the literature are: Learning Together, Student Teams Achievement Divisions, Teams-Games-Tournaments,

Complex Instruction, Constructive Controversy, Cooperative Integrated Reading and Composition, Cooperative Structures,, Group Investigation Jigsaw, Think-Pair-Share and Team Assisted Individualization.(Sharma & Saarsar, 2018b; Woods & Chen, 2010) All types of cooperative instructional approaches involve students working together in heterogeneous groups. small groups to assist one another in achieving academic excellence (Bilen & Tavil, 2015)

2.3.4.1 Think-Pair-Share

This model of cooperative learning was developed by Prof. Frank Lyman (Sharma & Saarsar, 2018a). This type of cooperative learning method allows learners to do their independent work and at the same time offering learners the opportunity to collaborate with each other. Think pair share model of cooperative learning involve three steps, thinking, pairing, and sharing. The first step think involves learners doing

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individual thinking. The next step being pair is where learners paired with a seatmate and discuss their answers, the last step share involve learners sharing their answers with another mate or the whole class (Rahayu & Suningsih, 2018) Nasution and Surya (2017) advocated that, in the application of think Pair Share, learners embark on discussing of correct responses to questions posed by the teacher with each other. In this model, the teacher asks the class a question and gives students reasonable time to answer the question individually, after which the teacher tells the students to turn to someone sitting next to them and discuss their answer.

2.3.4.2 Group Investigation.

Group investigation method of cooperative learning was invented by Shlomo and Yael Sharan in university of Tel Aviv (Jianhua & Akahori, 2001; SHARMA & Saarsar, 2018a; Sugiharto, 2020). This type of cooperative learning method or model is based on democracy and decision making processes (Sangadji, 2016).This method does not only involve learners in planning the topic, but also ensures that learners are involved in planning of procedures to be followed in investigating (Parinduri, Sirait, & Sani, 2017). Sugiharto (2020) argued that, GI cooperative learning model provides an opportunity for learners to play an active role in planning what you want to learn and how to learn, including contributing to the searching for the source. Each group discusses what they are interested in and it agreed on. Each member of the group investigation is also instrumental in planning how the problem is resolved, divide the tasks and roles. The final stage of learning at each group summed up the results of work and presentation to the class. According to Asyari, Al Muhdhar and Susilo (2016) GI cooperative learning method inspires learners to collect their own

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information that will help them in solving problems. GI cooperative learning technique activate students' high-order thinking skill.

2.3.4.3 Jigsaw Method

This is a pure cooperatives learning method (Açıkgöz, 2006, as cited in Sahin, 2010). developed by Aronson in 1978 (Maden, 2010; Sahin, 2010). It is cooperative instructional technique that allow students to learn through hearing, reading, seeing and teaching one another (Ab Murat, 2018). This method involves the introduction of the topic and various subtopics by the teacher.to learners. Home groups are then formed by learners where each learner of the home group is assigned different subtopic task to master. (Marinescu & Marzo, 2019). A student from each of the home group then come together to form an expert group. The expert group is form by student who had perform the same task in their home group. this expert group focuses on researching and discussing and studying a specific subtopic as a result, they become expert in the subtopic (Azmin, 2016).finally, each of the members of the expert group return to their various home group where they teach the subtopic that they have mastered.(Oliveira, Vailati, Luiz, Böll, & Mendes, 2019). Tasks performed by every individual are later integrated to form a whole learning process (Marinescu & Marzo, 2019).thus completion of the main topic.

2.3.4.4 Teams-Games-Tournaments (TGT)

Teams-Games-Tournaments is a cooperative learning model (Kholidah & Qohar, 2021) that was first developed by David Devries and Keith Edwards (Jianhua & Akahori, 2001). It involves learners contending as team representatives against members of other team in playing academic game with equal academic accomplishment through academic quizzes, and tournaments (Haryono, Samsudin,

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Aini, & Siahaan, 2021). Usman, Saud and Achmad (2018) stated that In Team Game Tournament of cooperative learning, students after learning in their various groups, each group member will be met with other group members who have the same ability in a match. The game played is scored and the score is added to the earlier score of the team (Barr, 2018). This model has cooperation and competition within and between groups respectively (Simsek & Baydar, 2019).

2.3.4.5 Cooperative Problem-Based Learning (CPBL)

PBL is a collaborative, constructivist, and contextualized learning and teaching technique that utilizes real-life problems to motivate learners in knowledge construction (Ghufron & Ermawati, 2018) it involves incorporation of Cooperative Learning (CL) principles into Problem-Based Learning (Helmi, El Hassani, Yusof, & Phang, 2017). CPBL technique requires learners to be creative and critical thinkers (Tristanti & Nusantara, 2022) Cooperative problem-based learning proceeds in five stages. Stage (1) involves presentation of the problem to learners. Stage (2) has to do with identification of the given problem; by learners. Stage (3) is the stage where learners sought for information from various sources to solve the problem; stage (4) is the stage where learners choose the most appropriate solution to solve the problem; stage (5) being the last stage is the stage where the facilitator evaluates the works of the learners (Saputra, Joyoatmojo, Wardani, & Sangka, 2019). One of the distinctive features of CPBL is that, in CPBL attention is shifted from teaching to learning where learners are motivated to think of various means of arriving at a solution to a problem. It involves the combination of the alternate synchronous traditional face to face instructional approach with asynchronous research (Parson & Bignell, 2017). CPBL enhances utilization of scientific approach and practical curriculum in realization of educational goal of cooperative learning (Han & Son, 2020).

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2.3.4.6 Learning Together Technique

In this learning together technique, certain roles are given to students, and they are appointed into heterogeneous groups. Students strive to achieve the common group objective in different roles in these groups; that is, each student completes the part of the work he/she is assigned to (Erbil, 2020).

2.3.4.7 Team Assisted (Accelerated) Instruction (TAI)

This technique of implementing cooperative learning involves combination of individualized instruction and cooperative learning (Yarmasi, Fonna, & Mursalin, 2020). Implementation of TAI involve placing learners into heterogeneous group of three members. During implementation, learners are made to learn a material alone by themselves using computer. Here learning is done at learners' own pace. Members of a team assist and check each other's work against an answer sheet. The final stage of TAI is where learners are made to take group and individual units test based on units studied. During the individual test, team members are not allowed to help one another. The teacher then score the test and find the score of every team by adding the score of the members of the team Teams are then rewarded based on their performance (Gambari & Yusuf, 2017; Syam, Akib, & Syamsuddin, 2020).

2.3.4.8 Student Teams–Achievement Divisions (STAD)

This is a cooperative learning model developed by Robert Slavin in 1978 (Berzener, 2021; Nair & Sanai, 2018). Slavin (1980, as cited in Kim, 2018) at that time defined the model as an effective instructional approach in a class circumstance in which learners carry out learning activities as a team and receive rewards and credits based on their team scores.

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STAD is a highly structured (Ishtiaq, Ali, & Salem, 2017) cooperative instructional model (Kim, 2018) that involves formation of heterogeneous teams (Awada, Burston, & Ghannage, 2020) of four to five members (Suastika *et al.*, 2021) with the ultimate aim of maximizing academic achievement, (Syafril, Rahayu, Wati, & Yuberti, 2018). Zubaidah and Corebima (2021) argued that, Student Team Achievement Division (STAD) is a practical and straightforward cooperative learning instructional approach that accentuates classroom interactions that furnish students with the opportunity to work together in group, motivate, and help each other in apprehending a given learning materials for the ultimate purpose of achieving academic excellence hence requires the need of the teacher to monitor group proceedings to ensure active participation of everybody (Nair & Sanai, 2018). With reference to the above definitions of student team achievement division (STAD) I conclude that STAD is a cooperative learning model that is capable of creating conducive atmosphere for learners to improve their academic, social, problem solving and critical thinking skills by learning to fathom a given learning material in heterogeneous team without unhealthy contention among learners. STAD model of cooperative learning aim at inspiring learners in a group to encourage each other, work together and help each other to apprehend a specific concept contain in a given learning material. STAD model of cooperative learning presupposes that learners construct knowledge through social interactions with others (Mukuka, Mutarutinya, & Balimuttajjo, 2021) .

2.3.4.8.1 Stages of STAD

STAD is carried out in five stages (Arifin, 2022; Zubaidah & Corebima, 2021). Which are: classroom presentation, group work, quiz or test, evaluation, and reward (Arifin, 2022; Berzener, 2021; Irawan, Zubaidah, Sulisetijono, & Astriani, 2021;

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Shobirin & Hildiana, 2021). The first stage classroom presentation is the stage where the teacher presents the material to the whole class. He does this by introducing the lesson to the students the teacher conveys all the lesson objectives to be achieved in the lesson and motivates students to learn. The teacher encourages students to help their teammates to learn the material if they want their team to earn team rewards, during this stage, students are informed by the teacher to encourage their teammates to do their best. The main aim of the presentation is to present material based on the learning plan that has been prepared. The teacher presents information to students by way of demonstrations or through reading material (Berzener, 2021; Nasution & Hafizah, 2020).

The second stage of STAD referred to as group discussion is characterized by team learning activities. This is the stage where Students work in their various heterogeneous teams on the given task towards achievement of the set goal. The aim of this stage of STAD is to make learners study together in groups. During this stage, students are encouraged to help and teach one another to master the material. During team study, group members work cooperatively with provided worksheets and answer sheets The heterogeneous group or teams in which students learn is usually made of four to five members in a group (Nasution & Hafizah, 2020; Shobirin & Hildiana, 2021). The third stage is the stage where quiz is being conducted. It is at this stage that students take individual quizzes or test. During the conduction of the test, students are not allowed to help one another. Independent work by students are valued to see whether students have improved according to their past performance and how much they have improved. Quizzes are purported to determine the level of mastery of knowledge. The efforts and success of each student will make a very valuable contribution to the success of the group (Nair & Sanai, 2018; Zahara &

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Maryam, 2021). The fourth stage of STAD is the stage where Quiz discussion and evaluation are carried out.

Educational evaluation is an assessment of the performance of education that has been running in order to obtain information that will later be used to improve things that really need to be improved in education (Trisnamansyah, 2015). This is the stage where the teacher evaluates the learning outcomes of the material that has been studied by learners. This stage is characterized by the scoring of the test after which a discussion is carried out for further clarification (Berzener, 2021; Suastika *et al.*, 2021; Wichadee, 2005)

The final stage of STAD is Team recognition or Group reward. The first step before giving a group reward is calculating the group mean, which is carried out by adding up the progress score of each group member, then the number is divided by the number of group members who took the quiz**.** Groups may win certificates or other kinds of rewards if their averages of improvement scores exceed a certain level. Using a scoring system that ranges from 0 to 30 points and different degree of individual improvement over previous quiz scores, the teacher scores the papers. Each team receives one of three recognition awards, depending on the average number of points earned by the team. (Berzener, 2021; Suastika *et al.*, 2021; Wichadee, 2005)

2.3.4.8.2 Setbacks of STAD

Desnita, Kartikowati and Makhdalena (2021) affirmed that Students Team Achievement division model of cooperative learning is time consuming. One of the drawbacks of STAD model of cooperative learning is that some members of the team may rely on others thereby not participating actively (Islami, Budiasih,

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Sukarianingsih, & Sulistina, 2021). Novianti and Sinaga (2021) stated that it is difficult to achieve curriculum target using STAD model of cooperative learning

2.3.4.8.3 Pros associated with the use of STAD Model of Cooperative Learning

Anam, A'yun, Asitah, Purnomo and Laili (2021) argued that, student team achievement division model of cooperative learning enhances interpersonal and communication skills of students. Anam *et al.* (2021) claimed that STAD is an excellent instructional strategy that aid in enhancing learners' attitude and understanding of subject matter. According to Takdir (2021), STAD offers learners the privilege of learning more effectively from their peers. Islami *et al.* (2021) affirmed that STAD is effective in improving learners' achievement. The heterogeneous group to which learners belong in STAD make it possible for learners to motivate one another. STAD also encourages students to think positively (Adawiyah, Zubaidah, Listyorini, & Astriani, 2021). Irawan *et al.* (2021) asserts that student team achievement division empowers learners. Student team achievement division aids students in overcoming, mistakes, learning difficulties and misconceptions. STAD helps create interactive learning, fun, and motivates students to participate actively in learning (Bahari, Luthan, Azmi, & Anshar, 2021) . According to Mulbar and Minggi (2021). Students Team Achievement Division pushes students to encourage and help one another towards mastering of skills taught by the instructor. Kim (2018) stated that, STAD enhances learning skills require for cooperation and self-control

2.3.4.8.4 Related Studies that Employed STAD

A study conducted by Rorimpandey, Maaluas, Mangangantung and Suryanto (2022) examined the effect of Student Team Achievement Divisions learning model on the

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motivation and science learning outcomes of elementary school students. The study adopted an experimental non-equivalent group pre-test post-test design without a random control. The participants of the research were 30 students of fourth grade elementary school students. The experimental and the control group of the study each composed of 15 students. Questionnaires and tests were used for data collection. The researcher concluded that Student Team Achievement Divisions learning model significantly increased learners' motivation and science learning outcomes of the experimental group compared to the conventional lecture learning model.

Manalu (2022) conducted classroom action research on improving students' descriptive paragraph writing through STAD (Student Team Achievement Division) technique. Instruments such as writing test was used in collecting quantitative data. Qualitative data was also obtained using interview, diary notes and observation sheet. It was concluded that application of STAD technique improved students' achievement in writing descriptive text

A study entitled Cooperative learning on the academic achievement of middle-school students based on learning style was conducted by Arifin (2022) with the aim of verifying whether students who are taught with cooperative learning model Teams Assisted Individualization (TAI) will learn mathematics better than students who are taught using the Student Team Achievement Division (STAD) model of cooperative learning. The findings from the study revealed that: students who received the TAI model of instruction had better learning outcomes than those who were taught using the STAD model

Padalia, Jamilah, Yatim, Alimuddin, Handayaningrum (2022) investigated the effect of STAD model of cooperative learning on activeness and Learning Outcome.

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Classroom action research design was employed during the intervention. Students Team Achievement Division (STAD) model of cooperative learning was implemented. The classroom action research was carried out in two cycles, with each cycle consisting of planning, acting, observing, and reflecting. Total Samples for the study was 38 students of which 18 were male and 20 female students. The results of the study show high increase in students' activeness in learning as well as the overall learning outcome compared to using conventional method. The researcher concluded that STAD model of cooperative learning is an effective learning technique that can increase students' understanding and improving quality of teaching and learning.

Ha**ritsah (2022)** also investigated the effect of STAD on science learning outcome of class IX D SMP Negeri 7 Alla students. Classroom action research design was employed. STAD model of learning was implemented as an intervention in the investigation. The technique used for data collection was direct observation the results of the study showed an increase in the average value of science learning outcome

A quantitative research approach employed by Kamid, Winarni, Rohati, Pratama and Triani (2022) investigated the impact of Student Team Achievement Division Learning Model and Student Process Skills The study aimed at comparing and correlating student response variables in the student team achievement division learning model of block and cube material and student process skills. This quantitative experimental research compared four classes using process skill variables and student responses to student team learning outcomes. The study employed purposive sampling technique 144 students were sampled from a population of two public elementary schools and two Islamic elementary schools. The instrument used to collect data was questionnaire. SPSS version 25 was used for data analysis Based on the t-test, it is known that there are significant differences in students' process

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skills in each school and student responses to the student team achievement division learning model on the volume of blocks and cubes in each school. Based on the correlation test, the researcher reported that there was a relationship between students' process skills and student responses to the STAD learning model on the material of volume of blocks and cubes between schools. It was concluded that learning with STAD model can improve process skills of students

In the same vein, Prihatnawati, Amin and Muhdhar (2017) adopted quasi-experimental research with Pre-test Post-test Non-equivalent Control Group Design in investigating the effect of module implementation with STAD cooperative learning toward process skills in science and cognitive achievement of 8th grade students with the ultimate purpose of explaining the influence of implementation of teaching materials module with STAD cooperative learning on science process skill, and student cognitive learning result on material plant life system in VIII grade laboratory Junior High School The results showed that the implementation of teaching materials module with STAD cooperative learning has a significant effect on the science process skill and cognitive learning outcomes of students of VIII Laboratory Junior High School. The researcher concluded that, the implementation of module learning with STAD cooperative learning can improve the science process skills, and cognitive learning achievement.

Prananda and Hadiyanto (2019) carried out an experimental research that implemented cooperative learning model STAD in teaching fifth grade students of SDN 43 river meadow weaning science. In the study, purposive sampling technique was employed. Students who received STAD model of cooperative instruction recorded an average value of 80 while that of the control group recorded 69.82 based on the findings of the study, the researcher concluded that STAD (Students Team

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Achievement Division) model of cooperative instruction improved the learning outcome of the students

Takko, Jamaluddin, Kadir, Ismail, Abdullah (2020) investigated the effectiveness of the cooperative learning module Student Teams-Achievement Divisions (STAD) techniques in enhancing students' higher order thinking skills (HOTS) achievement in the topic digestive system and food absorption. Quasi-experimental design was employed in the study to determine the effectiveness of the module. Purposive sampling technique was used to sample the respondents. The study involved 182 participants The Students belonging to the experimental group were given an intervention Home Science STAD Module for five weeks. Descriptive statistics and paired sample t-test were utilised in determining the effectiveness of the Home Science STAD module on students' higher order thinking skills achievement. The findings from the study proved STAD model of cooperative learning as an effective technique for improving learning outcome of students.

Driven by the aim of determining the effect of Student Teams-Achievement Divisions cooperative learning with models on academic achievements of undergraduate university students in electrochemical cells Karaçöp (2016) made use of pre-test post-test non-equivalent comparison-group design.. During the study, 70 students from first class of science teacher education program were sampled. The study was carried out in three distinct groups. Cooperative learning with models' group (CLMG), cooperative learning group (CLG), and the control group (CG). Data was obtained by Electrochemistry Achievement Test (EcAT). The data obtained by the instrument was evaluated through descriptive statistics, one–way ANOVA, and ANCOVA. The results indicated that teaching electrochemical cells via STAD with Model method

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was more effective than the traditional teaching method and only STAD increased academic achievement.

Faramarz and Mowlaie (2017) carried out a study on the effect of using STAD technique on improving Iranian Elementary EFL learner's reading comprehension. The mean score of the experimental group in the pre-test was 32.04 while 35.79 for their post-test which showed an improvement. The mean score for the control group also showed improvement from 32.39 to 33.00, however, the value was not as high as the value gained from the experimental group. The researchers also stated that STAD would be more beneficial in crowded classes because it can prevent the inherent limitation of time and resources imposed on teacher-cantered classes. Thus, STAD can be regarded as a good practice for both second and foreign language reading comprehension classes.

Jamaludin and Mokhtar (2018) implemented an achievement test study to compare experimental group and control group through quasi pre-test and post-test. Driven by the aim to evaluate students' attitude towards tourism geography subject, the researcher carried out the STAD using Kemnis and McTaggart's Participatory Action Theory. An attitude inventory scale and teamwork satisfaction were measured for understanding students' perceptions on the STAD teaching technique. The researchers reported that STAD technique improved students' achievement tests, as well as their attitude and teamwork. Students found to be more focused and motivated as their roles in groups were recognized by peers.

The effect of cooperative and individual learning method on the conceptual understanding at sub-micro level of pre-service science teachers (PST) in equilibrium chemistry was investigated by Okumus, Özdilek and Arslan (2020). The study

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adopted a pre-test post-test non-equivalent quasi experimental design 52 pre-service science teachers (PSTs). Were conveniently sampled for the study. Three study groups were selected. Cooperative student Team Achievement Division (STAD), Reading Writing Application (RWA) and Individual Learning were randomly assigned to the groups. Test was used as instrument for data collection. Data collected was evaluated using content analysis. The researcher reported that there was no significance difference among groups related to conceptual understandings of the concept of equilibrium in chemistry. However, some misconceptions related to topic were decreased.

Wang (2012) investigated effectiveness of competitive Student Team Achievement Division (STAD), non-competitive STAD, and traditional learning on chemistry learning this study examined 144 nursing students at a five-year junior college in northern Taiwan during the first semester. The study lasted for 18 weeks. The researcher found that competitive STAD group and traditional group of students performed better than the non-competitive STAD group.

2.3.4.8.5 Gender differences in science achievement and perception towards science

Gender can be referred to as values, attitudes and beliefs that a particular socio-cultural group ascribe to males and females. (Otoijamun, 2021) Gender is a cultural construct of a particular society that differentiates between the roles, emotional attitudes behaviour and values of females and males. It specifies conduct and attributes expected of an individual on the basis of being born as male or female (Udousoro, 2011). Knowledge of gender difference in interest, participation, and performance in science is well known all over the world. (Nosek, Smyth, Sriram, Lindner, Devos, 2009) and across different cross-cultural studies in both cognitive and non-cognitive domains.,(Navarro-González, Padilla, Benítez, Navarro-González,

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Padilla, 2022) Difference in achievement in science owing to gender have been well documented in secondary school (Curran & Kellogg, 2016) Previous studies on perception towards science among males and females have reported contradictory findings; (Musalamani, Yasin, & Osman, 2021) The difference in achievement of male and female in science is usually visible from the early stages of schooling with the male significantly outperforming the female. Gender differences in science achievement become more prominent as leaners progress in their education. As students climb up the academic ladder, males continue to significantly demonstrate greater gains than females in science achievement. Males continue to take more science courses and more advanced science courses at the higher level of education than do females. (Muller, Stage, & Kinzie, 2001). Better performance of boys over girls in science appears during primary school, and cross-sectional data seem to indicate that the gap exits even in secondary school (Bacharach, Baumeister, & Furr, 2003). It was also noted that girls perform better than boys on language courses, while boys outperform girls in math (Zhou, Wang, Zhou, Zhan, Sun, 2022). Women continue to be underrepresented in science, technology, engineering, and mathematics education and careers. Female adolescents report lower self-concept in science compared to male adolescents (Else-Quest, Mineo, & Higgins, 2013) Literature revealed that, there is gender difference in achievement in chemistry with different opinions and findings. (Onyi, Njoku, & Nwafor, 2022). Abimbade, Akinyemi, Bello and Mohammed (2017) employed Pre-test-protest control group quasi-experimental design in examining the comparative effects of an individualized Computer Based Instruction (CBI) and a modified conventional strategy on students' academic achievement in organic Chemistry. During the study, moderating effect of gender was investigated. The finding from the study indicated no significant difference between

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the academic performance of male and female students who used the individualized Computer Based Instruction. Chukwunazo and Chikendu (2022) investigated the interaction effects on teaching with improvised instructional materials and standard instructional materials on secondary school chemistry. The findings from the investigation revealed that, there was no interaction effect of gender and type of instructional materials on students' achievement and retention in chemistry.

Scientific attitudes refers to scientific way of thinking, including the desire to know and comprehend an enquiring approach to all statements, a search for data and their interpretation and demand for verification, and respect for logic (Wan & Lee, 2017). Contradictory findings have been reported from previous studies on perception towards science among male and females .some noted that males have better perception towards science relative to females and that male are more willing to continue studying science while females are less enthusiastic in engaging in scientific inquiries and have less desire to continue with science and technology-related careers (Musalamani *et al.*, 2021) Gender difference in performance in science education has been a long issue of great concern. A good number of previous studies have unveiled the difference between male and female students in their academic achievement and in attitudes towards science (Wan & Lee, 2017) Toma, Greca and Orozco Gómez (2019) examined the perception of male and female students toward science and their views of nature of science among Spanish students of gypsy ethnicity and second-generation Spanish students with east-European heritage, Data for this study was gathered from seven elementary schools in Spain, forming a convenience sample of 149 students. The result from the study revealed that boys had better perception toward Science than girls but more naïve views of the empirical nature of science. A number of previous studies reported that males had a more favourable perception

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towards physical sciences while females showed a more favourable perception towards biological sciences (Zhou, Zeng, Xu, Chen, & Xiao, 2019)

Musalamani *et al.* (2021) in his quantitative study examined the effect of the SB-CPBL on Jordanian 8th-grade students' attitude towards science. Quasi-experimental design with a non-equivalent control group was employed in the study. 120 8th-graders, were sampled for the study. The result from the study reveal that gender has insignificant effects on students' attitudes towards science.

Difference in gender achievement in science can be explained by cultural factors such as societal norms and stereotypes, which influences encouragement that girls receive (Quinn & Cooc, 2015) Difference in science achievement by gender is an indicator of educational inequity (Quinn & Cooc, 2015). The difference between male and female science students is at best relative depending on the context of the investigation and the content being examined. While males may outperform females in conventional science context dominated by mathematics and experimentation, females achieve higher than males in certain skills that are very necessary to the learning of science.

2.3.4.8.6 Hydrocarbons

Hydrocarbons are organic compounds that contain hydrogen and carbon only. Hydrocarbons can be seen in straight chain, branched chain and as a cyclic molecule (Situmorang, Simaremare, Elnovreny, Naiborhu, & Sumbayak, 2012). Hydrocarbons are put into two main groups based on structural classification. These groups are aliphatic hydrocarbons and aromatic hydrocarbons. Aliphatic hydrocarbons are those organic compounds that do not contained benzene ring. They include alkanes, alkenes and alkynes. Aromatic hydrocarbons are those that contain at least one benzene ring. The alkanes are referred to as saturated hydrocarbons for the reason being that each

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carbon atom is bonded to the maximum number of hydrogen atom. The general formula of the alkanes is C_nH_{2n+2}. The natural product methane with the formula CH_4 is the simplest of the alkanes (Chang & Overby, 2022). Alkenes and alkynes are unsaturated hydrocarbons. Ethylene being one of the most popular alkenes is produced naturally in ripped fruits. Ethylene is a pleasant-smelling gas that serves as phytotoxic to plants and asphyxiant, anesthetic to animals (Headley, 2020). Alkynes are aliphatic hydrocarbons that contain C≡C triple bond (Klein, 2020). The general formula of the alkynes is

C_nH_{2n-2}. They are unsaturated and slightly polar in nature. The boiling point of the alkynes increases with increase in molecular structure. The first three members of alkynes are gases while the fourth to the eighth are liquids, the remaining members are all solids (Kudaibergenova 2020). Acetylene being the first member of the alkynes contains a carbon- carbon triple bond, two hydrogen and two carbons. It is produced by adding water to calcium carbide produced by heating coke and lime. Acetylene is used in combination with pure oxygen to produce a very high temperature when it burns. Owing to this, it is used as the primary fuel for oxyacetylene welding torches in industry for cutting and welding of steel. When burned in the presence of oxygen, a very hot blue flame is produced (Headley, 2020). Alkene are also unsaturated hydrocarbons with a general molecular formula C_nH_{2n}. They contain carbon to carbon double bond. The smallest alkene, ethene is a plant hormone that affects flowering, maturation, ripening and germination of seeds. Most fragrances produce by fruits belong to the alkene family (Bruice, 2017).

2.3.4.8.7 Nomenclature of Hydrocarbons

During the early stages of the nineteenth century, organic compounds were name at the whim of those who discovered them (Klein, 2021). Most of the names given to

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those organic compounds at that time were based on the place of discovery, physical properties of the compound and their appearance (Chang & Overby, 2022). The way and manner compounds were named was not scientifically inclined. For in stands the name barbituric acid, which is found in barbiturate drugs was coined from a woman's name Barbara. A German chemist Adolph Von Baeyer during Saint Barbara's birthday, synthesized a new compound from urea and malonic acid. Unfortunately, he did not have any name for this new compound, since the day of discovery of the compound coincided with the birthday of Saint Barbara, he decided to name it after St. Barbara's day because he was celebrating both the discovery of this new compound and Saint Barbara's birthday that day**.** During the middle of the nineteenth century, a lot of trivial names were used for compound that were either synthesized or discovered at that time. As a result, other chemists other than the discoverers were not able to readily determine the exact structures of the compounds (Headley, 2020). As large number of compounds were discovered, scientists saw the need for a systematic method for naming compounds. In 1892, 34 European chemists met in Switzerland and developed a system "organic nomenclature" for naming organic compounds. This system they referred to as the Geneva rules. The original Geneva rules have been revised and updated and are now referred to as IUPAC nomenclature. Names obtained by following the IUPAC guidelines are called systematic names (Klein, 2021). The organization IUPAC is an International Union of Pure and Applied Chemistry. It is an international federation of national organizations that represent chemists in individual countries. This organisation is universally recognized authority of chemical nomenclature and terminology (Smith, 2020). The ultimate aim of IUPAC system of naming is to establish an international standard of naming organic compounds in other to facilitate communication. The goal of the system is to give each structure a specific

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unambiguous name, and to correlate each name with a unique and unambiguous structure. IUPAC system of nomenclature is frequently revised. The 1993 guidelines place the position number close to the functional group designation (Wade & Simek, 2017). The IUPAC nomenclature system is a set of systematic and logical rules devised and used by organic chemists to solve the problems posed by arbitrary nomenclature. The Knowledge and application of IUPAC rules enable one to be able to write a unique name for every compound when given the structural formula. On the other hand, when furnished with an IUPAC name, one can be able to write the structural formula. In general, an IUPAC name will have three essential features: The first one a root or base showing a major chain found in the molecular structure. Second a suffix or other element(s) designating functional groups and a substituent groups (Kudaibergenova 2020). The steps involve in naming alkanes, alkenes, and alkynes are: Identification and naming of the parent, Identification and naming of the substituents, assigning a locant to each substituent and assembling the substituents alphabetically (Klein, 2021).

2.3.4.8.8 Academic Performance

Terminologies such as achievement, learning outcome and success are usually used interchangeably by educational researchers in explaining academic performance. Academic performance however, can be defined as attainment of excellent educational goals (Rodriguez-Hernandez, Cascallar, & Kyndt, 2020). Academic performance can also be referred to as the excellency of knowledge, good attitude, skills, techniques behaviour and good moral values that students attain in an educational institution (Mwingi, 2014) which can be measured with metrics such as course grades or cumulative grade point average (Menekse, Zheng, & Anwar, 2020). According to Zhou *et al.* (2022), academic performance refers to one's performance

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in school which can be measured by grade point average. Apart from GPA, national standardized tests and total grade points of general examinations are also effective tools for measuring academic performance. Performance in academia refers to course final grade, mark, score or cumulative grade point average of a student (Zahedi, Batten, Ross, Potvin, Damas, 2021). Academic performance is mostly used to envisage or determine the success of an educational system, to evaluate the work output of schools, to assess class management ability of teachers, and to measure students' level of achievement at different stages (Lei, Cui, & Zhou, 2018). It is worth noting that, health, socioeconomic status, occupation and wellbeing of an individual are determined by the academic performance of the individual (Browning & Rigolon, 2019). Kevin (2008) states that good academic performance is based on the social, behavioural, motivational, affective, cognitive and meta-cognitive behaviours of learners (as cited in Kibira, 2017). In almost every country, academic performance plays a crucial role in the life of every individual. One of the ways in which academic achievement influences the individual is that it is used to determine whether a learner has an opportunity to continue his or her education in a university. In other words, academic performance defines whether one can go for higher education, based on the educational points one attains, and influences one's vocational career after education. Besides, academic achievement brings about the wealth of a nation and its prosperity (Kibira, 2017).

2.3.4.8.9 Factors Affecting Academic Performance

A number of studies have been carried out to identify the numerous factors that affect academic performance in various educational institutions. One of the factors that has tremendous impact on academic performance is sleep and mood (Mehta, 2022). Sekhon and Gupta (2020) defined mood as an internal pervasive and sustained feeling

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that influences all aspects of behaviour of a person. Mood disorders are characterized by marked disruptions in emotions and depression. According to Kline (2013), sleep duration is the total amount of sleep obtained during the night or across the 24-hours of the day. Kline (2013) again refers to sleep quality as total satisfaction and refreshment of the individual upon awakening from sleep (as cited in Mehta, 2022). According to Mehta these two inevitable phenomena sleep and mood have significant impact on academic performance.

Knowledge sharing via online is another major factor that influences academic performance of students (Salimi, Heidari, Mehrvarz, & Safavi, 2022)

Another factor that has significant impact on academic performance is the school environment of learners. Facilities like desks, chalkboard, and conducive environment for effective teaching and learning are undoubtedly prerequisite for excellent academic performance. For an expected performance in academia, there is the need for the school environment to be enriched with highly trained and motivated teaching staff, adequately supplied of necessary facilities and equipment. In other words, a good environment for effective academic works must have adequate resources like financial resources, human resources and physical resources, it is worth noting that conducive school environment does not only include infrastructure but also encompasses how supportive communities around are, towards the welfare of the institution (Kibira, 2017).

Home-based involvement refers to what parents and guardians do at home to improve their children's learning. Involvement of parent in the home of the learner is characterized by parents or guardians engaging in communication with their children on school issues, monitoring school activities and assisting their children by providing

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extra teaching or learning opportunities is seen as a major factor that influences academic performance of learners (Boonk, Gijselaers, Ritzen, & Brand-Gruwel, 2018)

Financial and social resources outside the family of the learner can also be related to students' academic performance. For in stands with neighbourhood characteristics and resources like the degree of urbanization and the number of parks and libraries in the area where students stay also influences their performance (Rodriguez-Hernandez *et al.*, 2020)

Active learning is seen as one of the major factors that positively influences learners' academic performance and reduced the learners' probability of failing as compared to the traditional lecturing (Hardebolle, Verma, Tormey, & Deparis, 2022).

Other factors important for academic performance consists of cognitive abilities, including simultaneous information storage and manipulation, the capacity to solve novel and complex problems, and executive function, cognitive and social-emotional processes that underlie goal-directed behaviour such as flexible thinking, self-control, and self-regulation (Peng & Kievit, 2020).

The use of technological equipment like computers also has positive influence on academic performance (Tawafak, Romli, Malik, & Shakir, 2020).

Interaction between students and instructors is another factor that has significant impact on academic performance of students (Qureshi, Khaskheli, Qureshi, Raza, & Yousufi, 2021).

Self-control which refers to self-initiated regulation of feelings, actions and thought when enduringly valued goals conflict with momentarily more gratifying goals is a prerequisite for academic achievement (Duckworth, Taxer, Eskreis-Winkler, Galla, & Gross, 2019).

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Emotions are feelings of arousal, pleasure, or displeasure arising from a complex interaction among subjective and objective factors, mediated by neural and hormonal systems influence students' academic performance. Learners are able to grasp information if emotions are deliberately directed to a specific emotional episode, such as learning of academic materials. In the classroom setting, students experience various emotions during the teaching and learning process which influences their subsequent learning, participation and academic performance. Positive emotions have the ability of promoting effort and perseverance, whereas negative emotions such as sadness, anxiety, frustration, and boredom diminishes involvement. Moreover, emotions shape the relationship between science teachers and their students. In learning of science, emotions enforce and stimulates autonomous learning of difficult subjects. When instructors engage students through enjoyable learning, they encourage students' building of longer-term interest, which will in turn, develop future engagement and solid comprehension of concepts (Chen, Jamiatul Husnaini, & Chen, 2020).

2.3.4.8.10 Factors affecting learners' retention of knowledge

Memory retention plays a crucial role in the academic life of students. Students who have a problem in retention may have difficulty in remembering what they have learnt. (Pillado, Maria Chona, & Sheena Mae, 2020). Gambari, Falode and Adegbenro (2014) defined retention as the act of reproducing concept that has been learnt when the need arises. Knowledge retention refers to maintenance and retrieval of knowledge acquired through instruction over relatively long period of time. The amount of knowledge or concept retained by a learner, signifies the level of thinking by the learner (Ahlam & Gaber, 2014). Retention is the ability to retrieve, recall or

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recollect what has already been learnt or experienced after it had been stored in memory. This presupposes that absence of proper storage structures in learners will negatively affect recalling of concept learnt and consequently resulting to poor achievement. Poor achievement and retention can be attributed to poor instructional methodologies such as lecture expository approach, discussion and demonstration. These poor instructional strategies stresses information transfer through memorization (Adonu, Nwagbo, Ugwuanyi, & Okeke, 2021). Poor instructional methodology is one of the major factors affecting retention of concept by learners. Students' retention could be aroused and maintained through the use of appropriate instructional media such as e-learning (Gambari *et al.*, 2014). literature indicates Students Team Achievement Division (STAD) model of cooperative learning as one of the students centred leaning approach that is associated with high student retention resulting to high achievement regardless of the ability levels of the learner (Abd Mokmin *et al.*, 2022). Pillado *et al.* (2020) asserted that motivational practices and experiences, accomplishments, personalized learning, teaching strategies and learning activities, goal setting and educational resources and learning devices are factors influencing learners' retention of what they have learnt. Augmented Reality technology is the technology that allows combination of real world and virtual images as well as their simultaneous interaction. Adedokun-Shittu, Ajani, Nuhu and Shittu (2020) affirmed that augmented reality techniques, enhance memory retention, better task performance and motivation of learners. Individuals who encounter negative experiences while learning a particular concept or subject as well as those who perceived that what they learnt in a particular subject has less use in their daily living, have low chances of retaining or remembering what they have learned in that subject. This type of

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forgetting is known as motivated forgetting. Motivated forgetting consequently affects retention of concept or knowledge by learners. (Valderama & Oligo, 2021)

2.4 Summary

This chapter reviewed literature on the theoretical framework of the study. Under the theoretical framework, literature was reviewed extensively on social constructivism. Literature reviewed under social constructivism includes explanation of social constructivism, propositions of social constructivism, social constructivism view of learning, social constructivist view of learner and learning, social constructivist view of teacher and teaching, and social constructivist learning environment. This chapter also reviewed literature on cooperative learning where the explanation of cooperative leaning based on previous research was given. Again, literature was reviewed on types, elements, benefits and strategies of implementing cooperative learning. Under the literature review on strategies of implementing cooperative learning, Students Team Achievement (STAD) model was extensively discussed since the STAD strategy of cooperative learning is the one adopted by the researcher. Literature was also reviewed extensively on related studies that employed STAD model of cooperative learning, gender differences in science achievement and perception towards science, nomenclature of hydrocarbons, academic performance, factors affecting academic performance and factors affecting learners' retention of knowledge

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CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Overview

This chapter looks at the research design, study design, area of study and population of the study, sample, sampling techniques and instruments for data collection were also brought to light in this chapter. This chapter also encapsulates validity and reliability of the instruments, intervention, data collection procedures and mode of analyzing the data.

3.1 Description of study area

The study was conducted in Ho Mawuli Senior High School. The school is located in Ho Township in the Volta Region of Ghana, the school has a population of 4200 comprising of 3005 girls and 1195 boys. Ho Mawuli Senior High School is rated as category “A” school according to Ghana Education service classification. The school offers programs such as General Science, Home Economics, Business, Agricultural Science, Visual Art and General Art.

3.2 Research Design

According to (Kazdin, 2021) research design is the experimental plan or arrangement that is used in examining research questions and testing of predetermined hypothesis. Research design clearly spelt out description of the various components of the study under investigation. It brings to light the general approach to the research that will be employed as well as the strategy and details about data collection and analysis that will be utilized. The design explains how the various methods of data collection and analysis connects with the research questions being investigated and indicates how

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they will produce desirable data for the kind of research questions being investigated (Denscombe, 2010). The study design is action research. Action research is a cyclical, unending dynamic process that aim at improving practices within a particular setting (Rojas-Bustos & Panniello, 2022). Action research is an educational research approach used by educational professionals and practitioners in enhancing their practices and pedagogies. It involves planning, acting, observing and reflection. Action research was chosen for the reason being that, it is effective in improving personal and professional development of teachers. It is also believed to be effective in improving students' academic performance.

3.3 The population of the study

The target population was all third-year science students in Ho Mawuli Senior High School in the Volta Region of Ghana. The accessible population was General Art Form three students. The sample however consisted of 41 form three students (an intact class of General Art students). Out of the 41 students, 27 were boys and 14 were girls

3.4 Sample and Sampling Techniques

The very fact that, the researcher couldn't use the entire population makes the operation involving sampling statistically vital. Sampling is the process of selecting a portion of the population to represent the entire population. Purposive sampling technique was employed to select the sample (both the school and the classes) for the study. This was because of the distance of the schools to the researcher, the willingness of the school head and teachers to cooperate. The samples were drawn from Ho Mawuli Senior High School in the Volta Region of Ghana. In the school, SHS three (3) students were selected. This was because nomenclature of

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hydrocarbons is to be taught in the third year according to the Ghanaian Integrated Science Syllabus for Senior High Schools (S.H.S 1-3). The school was selected based on accessibility to the researcher and also the school selected was a government assisted school. The sample of this study consisted of a total of forty-one senior high school students.

3.5 Instruments for Data Collection

This study employed data triangulation or the use of multiple data collection process which involves comparing and integrating quantitative and qualitative methods (Patton, 2002). Bogdan and Biklen (2003) advocate for triangulation of data because, sources lead to a fuller understanding of the phenomena under study. Triangulation of data attempts to gain a deep understanding of the topic at hand (Denzin & Lincoln, 2000). In this study, pretest, posttest, retention achievement test (RAT) and five-point Likert type questionnaire were used. Each of the pretest, posttest and retention achievement test consisted of 37 test items. The tests items were put into section A, B, C and D. The pretest, posttest, retention achievement test (RAT) were scored over forty. The Likert type item consisted of ten statements to which respondents were asked to indicate their level of agreements.

3.5.1 The Validity of the Instruments

Validity refers to the degree to which an instrument accurately measures what it has been constructed to measure (Sarkodie., 2013). In order to ensure the content validity of the instruments, the test items in the instruments were compared with the integrated science syllabus in ensuring that the test items represent the contents of the topic in the syllabus. Again, the instruments were validated by giving them to two experienced

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Senior High school Integrated Science teachers for critique and suggestions after which final modification was made for final version of the instruments.

3.5.2 Reliability of the Instrument

Reliability is the degree to which an instrument or test is consistent with its result under the same condition or with the same subject. An instrument is said to be reliable if a respondent's score on the test taken twice under the same condition is the same (Dubey & Kothari, 2022).This means that for a research instrument or test to be reliable, it must demonstrates that, if it were to be carried out on the same group of subjects or respondents under the same condition, then similar results would be obtained. That is if the same test is repeated under the same conditions, the responses should be the same for each individual. Reliability is a measure of the degree to which a research instrument produces consistent results or data after repeated trials (Mugenda & Mugenda, 2003). The reliability of the items was ensured by stating the items in a clear and simple language without any ambiguity. The test items were also piloted on S.H.S three General Science students of Awudome Senior High School. In ensuring the reliability of the instruments, the researcher again employed the test-retest technique. The researcher did this by administering the test items to a group of students outside the research area. The same items were re-administered to the same group of students after a period of two weeks under the same condition. The results were then compared and the relationship between the scores were noted. The Cronbach's alpha reliability coefficient of the tests were 0.8 and 0.9 for pretest and posttest respectively. These values indicated that the test items were reliable for Ajaja (2013), affirmed that reliability value of 0.70 or higher shows reliable instrument. This implies that the test items were appropriate for accurately measuring the characteristic they were designed to measure.

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3.5.3 Pilot Testing of Instruments

Pilot testing simply refers to trying or testing of a test with the aim of finding out whether the test will produce or obtain the intended or purported result (Singh, 2022).The study was pilot tested with 20 students from Awudome Senior High School. These students did not participate in the actual study. In this study, pilot test was conducted by the researcher to improve the validity and reliability of instruments. Items that were either too difficult or found ambiguous were rephrased. The pilot test was also done to identify and clarify any unexpected problems, and difficulties which might arise during the actual study. This helped to refine the research procedures like test administration, scoring procedures and data analysis. On the bases of the result from the pilot study, items which respondents did not understand or answer were reconstructed.

3.6 Pre-intervention

The researcher tested student's knowledge in the concept of nomenclature of hydrocarbons on his first visit to the class. The researcher did this by administering the pre-test (Nomenclature of Hydrocarbons Achievement Test (NOHAT) to determine the strength and weakness of the students in the concept. The pre-test questions were given to students during a normal class teaching periods to solve individually. The duration of the pre-test was 45 minutes. Answers provided by the students were marked using a marking scheme. The test items were scored. Almost all the students performed very poorly on the test. Discussion was held with the students with respect to their poor performance on the test. It came to light that they have very little knowledge on the concept as such, it was difficult for them to pick up high score.

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Marks were recorded for data analysis. Based on that, the researcher decided to come out with the intervention to help solve the problem.

3.6.1 Intervention phase (Implementation of STAD model of cooperative learning)

The intervention employed by the researcher was Students Team Achievement (STAD) model of cooperative Learning. Implementation of STAD model of the cooperative learning proceeded in five stages Classroom presentation, teamwork, quiz, quiz discussion and evaluation and team recognition.

First Stage Classroom Presentation

This is the stage where the researcher presented the material to the whole class. He does this by introducing the lesson to the students after the researcher conveyed all the lesson objectives to be achieved in the lesson and motivates students to learn. The researcher encouraged students to help their teammates to learn the material if they want their team to earn team rewards. During this stage, students were informed by the teacher to encourage their teammates to do their best. The main aim of the presentation is to present material based on the lesson plan that has been prepared. The researcher presented the lesson to students by the convectional method, demonstrations and discussion.

Second Stage (team work)

During the second stage the researcher helped Students to form heterogeneous teams of five members. The researcher ensured that each team represented all parts of the class in terms of academic performance, gender, race and ethnicity. The researcher encouraged learners to work in their various heterogeneous teams on the given task towards achievement of the set goal. The aim of this stage of STAD was to make learners study together in groups. During this stage, the researcher encouraged

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students to help and teach one another to master the material. During team study, group members were made to work cooperatively with provided worksheets.

Third Stage (quiz conduction)

This is the stage where students took individual quizzes. During the conduction of the quiz, the researcher did not allowed students to help one another. Independent work by students were valued to see whether students have improved upon their past performance and how much they have improved.

The Fourth Stage

This stage of the intervention is where the researcher evaluated the learning outcomes of the material that has been studied by learners. This is the stage where the quizzes were scored by the researcher after which a discussion was carried out for further clarification.

The Fifth Stage

This stage is the final stage of the implementation of STAD model of cooperative learning. This is the stage where the researcher rewarded the teams based on their performance. Before giving a group reward the researcher calculated the group mean, this he did by adding up the progress score of each group member after which the result was divided by the number of group members who took the quiz. Each team received one of three recognition awards, depending on the average number of points earned by the team.

3.6.2 Post Intervention

After the intervention, a post-test (Nomenclature of Hydrocarbons Achievement Test (NOHAT) was conducted to find out how the intervention activities helped the students to improve their performance in the concept of nomenclature of

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hydrocarbons. The post-test was equivalent to the pre-test. The aim of the post-test was to determine the effectiveness of the intervention on learning outcome of the participants in the concept of nomenclature of hydrocarbons. The post- test consists of (37) items and the duration of the test was 45 minutes. Answers provided by the students in the post-test were marked using a marking scheme. Two weeks after the conduction of the post test, another test known as Nomenclature of Hydrocarbons Retention Achievement Test (NOHRAT) simply referred to as Retention Achievement Test (RAT) was given. The essence of RAT was to determine the effect of STAD model of cooperative learning on students' retention of the concept of nomenclature of hydrocarbons. RAT was administered two weeks after the post test. RAT was administered two weeks after the post-test because Haynie (1997) asserted that two weeks after an intervention is appropriate for administering of retention test. (as cited in Abd Mokmin *et al.*, 2022)

3.7 Method of data collection

Pre-test was administered to the students on the concept of nomenclature of hydrocarbons. The concept of nomenclature of hydrocarbons was then taught using STAD cooperative learning model within four weeks. Post-Test was then administered in the fifth week. After two weeks, Retention Achievement Test (RAT) was given. The essence of RAT was to determine the effect of STAD model of cooperative learning on students' retention of the concept of nomenclature of hydrocarbons.

In other to determine the perception of the students towards the intervention, Likert type item consisting of ten statements was given to each of the students. The students

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were then asked to indicate their level of agreement to each of the statements. The items were then collected for analysis.

3.7.1 Method of data analysis

Data analysis is the systematic process of ordering and breaking down of data into constituent parts follow by performing statistical calculations with the raw data with the purpose of providing solutions to questions initiating a particular study (Sarkodie., 2013). The collected data was analysed by applying descriptive and inferential statistical measure. Coding schemes were developed for the Likert type item to organize the data into a form that can be manipulated by the statistical software. The categorised data were later converted into frequency counts. Simple percentages were used to answer the research questions generated in the study; this descriptive statistical approach was used in the analysis of the qualitative part of the data. Inferential statistics which involved the computation of pre-test, posttest and the delayed posttest mean scores, standard deviation and variance for each variable were done. Data collected were processed using the Statistical Package for Social Science (SPSS) version 25. The pre-test and post-test scores of students were analysed statistically using dependent sample t-test. The posttest and retention achievement test scores were also analysed using the same pair sample t-test.

3.8 Ethical consideration

Since students' academic performance is a key crucial issue to school stakeholders, the

researcher sought formal permission from the headmasters and headmistresses in the participating schools prior to the administration of the questionnaire. An introduction letter was obtained from the Faculty of Science Education from the University to

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headmaster and assistant headmaster of academic and the head of the General Arts department. The purpose of the study was made known to the heads of the school and the respondents in the school. The authorities of the school and the respondents were also given the opportunity to ask questions for clarification. Consent of the respondents was also sought. Respondents were also made aware of their confidentiality.

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CHAPTER FOUR

RESULT AND DISCUSSION

4.0 Overview

This chapter presents the statistical analysis of the research data, findings and discussions. Data gathered from students' pre-test and post-test scores, and perception of students towards STAD model of cooperative learning were also analysed and discuss in this chapter. The analysis was conducted based on the research questions posed.

4.1 Research question 1:

Does STAD model of cooperative learning have any effect on students' performances in the concept of nomenclature of hydrocarbons?

Table 1: Paired sample t-test comparing the mean of students' pre and post-test scores

Test	N	Mean	SD	df	t-value	Sig(2-tailed)
Pretest	41	9.02	2.72	40	19.30	0.00
Post test	41	27.83	5.27			

Statistically significant at Alpha (α) = 0.05 level. P<0.05

The mean score of the pre intervention test was 9.02 while the standard deviation was 2.72. (Table 1). The mean score of the pre-test result shows the performance of the students before implementation of STAD model of cooperative learning. Also, the mean score of the post-tests was 27.83 while the standard deviation was 5.27 (Table 1). The mean score of the post test result shows the performance of the students after the implementation of STAD model of cooperative learning. Greater means score of the post-test shows that there was much improvement in student's performance in the post-intervention test. The mean difference was 18.81 (Table 1) indicating that

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students performed better in the post-intervention test than the pre- intervention test. The difference between the mean scores was significant at p-value of 0.00. In this study, the significant difference was set at alpha value of (α=0.05). This means that there was statistically significant difference between the performance of students before and after the implementation of STAD model of cooperative learning. This proved that the implementation of STAD model of cooperative learning in studying the concept of nomenclature of hydrocarbons significantly improved the performance of the students. This implies that STAD model of cooperative learning as an intervention had a positive effect on the performance of students in the concept of nomenclature of hydrocarbons.

This finding is consistent with the finding of Haritsah (2022) who employed an action research in investigating the effect of STAD on science learning outcome and concluded that, STAD model of cooperative learning resulted in better performances. Again, better performance of students after the implementation of the intervention as observed in this study is also supported by Prananda and Hadiyanto (2019) who carried out an experimental research that implemented. STAD model of cooperative learning in teaching fifth grade students of SDN 43 river meadow weaning science and found out that students who employed STAD model of cooperative learning performed better than those who did not. Again this finding is consistent with that of Tabatabaei and Heidari Shahreza (2022) who investigated the impact of Student Team Achievement Divisions (STAD) on Iranian secondary school EFL learners' overall achievements and creativity and concluded that STAD model of cooperative learning brought about statistically significant difference in performance of students who utilised STAD and those who did not.

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Better performance of the students after the implementation of STAD is attributed to active participation of students, and the fact that they compete with their classmates to win the prize or award (Khidr & Sabri, 2022). Jainal and Shahrill (2021) ascribed the high performance of students as a result of STAD to active involvement, cooperation and peer teaching, and learning, and sharing of ideas among students (as cited in Abd Mokmin *et al.*, 2022).

4.2 Research question 2

Do males and females perform similarly after being exposed to STAD model of cooperative learning?

This research question aimed at finding out whether STAD model of cooperative learning will bring about difference in performance of male and female students. In other to answer this research question, the test score of male and female students after the implementation of STAD was subjected to statistical analysis. The table below shows the data obtained from the analysis.

Table 2: Comparison of mean of post-test score of male and female

Gender	N	Mean	SD	df	t-value	Sig(2-tailed)
male	27	28.00	5.35	39	0.285	0.95
female	14	27.50	5.29			

Statistically significant at Alpha (α) = 0.05 level. P<0.05

The mean of post-test score of the male was 28.00 while that of the female was 27.50 (Table 2). The means of the post-test shows that the male performed better than the female. In other to determine whether there is statistically significant difference between the performance of the male and the female, the data was further subjected to analysis. The difference between the mean of the post-test scores was not significant at p-value of 0.95. In this study, the significant difference was set at alpha value of

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(α=0.05). This proved that STAD model of cooperative learning has not brought about any significant difference between the performance of male and female. This means that males and females perform similarly after being exposed to STAD model of cooperative learning. This finding is supported by the finding of Bonyadi and Ebrahimi (2014) who investigated the effect of student team-achievement division (STAD) on language achievement of Iranian EFL students across gender and concluded that there was no gender differences in students' language achievement after being taught through STAD. Again no statistically significant difference in performance of male and female as seen from the data is also consistent with the finding of Inuwa (2017) who examined the effect of gender and group learning on financial accounting performance among secondary school students in Gombe state, Nigeria and found no significant difference in the performance of male and female students who employed STAD model of cooperative learning and their counterpart who did not.

4.3 Research Question 3

Does the STAD model of cooperative learning improve upon students' retention of the concept of nomenclature of hydrocarbons?

In other to determine the effect of STAD model of cooperative learning on students' retention, retention test was administered three weeks after the post test. Haynie (1997) opined that a retention test should be administered two or three weeks after the implementation of the intervention (as cited in, Abd Mokmin *et al.*, 2022). It was therefore considered appropriate to administer the retention test two weeks after the intervention. Students' post-test and retention test was subjected to paired sample t-test. The table below shows the result obtained from the analysis.

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Table 3: Comparing the mean of students' post-test and retention test scores

Test	N	Mean	SD	df	t-value	Sig(2-tailed)
Posttest	41	27.83	5.27	40	2.81	0.008
Retention test	41	27.19	5.19			

Statistically significant at Alpha (ά) = 0.05 level. P<0.05

Students' performance in the post-test (mean =27.83, SD=5.27) does not significantly differ from their retention test (mean=27.19, SD=5.19) with a mean difference of 0.64. This provides evidence to prove that the students were able to retain what they have learnt owing to STAD model of cooperative learning. It therefore means that STAD model of cooperative learning improved upon students' retention of the concept of nomenclature of hydrocarbons. STAD model of cooperative learning has positive effect on retention. Students retention of what they have learnt as a result of STAD model of cooperative learning as seen from the data presented is supported by the findings of Abd Mokmin *et al.* (2022) and Khun-Inkeeree, Omar-Fauzee and Othman (2018). Students' ability to retain what they have learnt as a result of STAD model of cooperative learning can be attributed to the conducive platform for discussion, equal opportunity for success and constructing of one's own knowledge created by STAD (Rabgay, 2018).

Analysis of data with respect to research question four:

4.4 Research question 4

What is the perception of students on STAD model of cooperative learning?

In order to determine students' perception of STAD in learning nomenclature of hydrocarbons, respondents' responses to the Likert type questionnaire were collected and subjected to statistical analysis. The data collected is displaced in Table 4.

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*Table 4:**Students' perception of STAD model of cooperative learning***

Statement about STAD model of cooperative learning	Number and percentage strongly disagreeing to statement	Number and percentage disagreeing to statement	Number and percentage neutral to statement	Number and percentage agreeing to statement	Number and percentage strongly agreeing to statement
STAD model of cooperative learning didn't improve my perception towards learning	29 (70.7%)	7 (17.1%)	2(4.9%)	1 (2.4%)	2 (4.9%)
STAD model of cooperative learning didn't motivate me to learn	24 (58.5%)	15 (36.6%)	1 (2.4%)	1 (2.4%)	0
STAD model of cooperative learning improved my performance	0	1(2.4%)	2(4.9%)	13(31.7%)	25(61.0%)
STAD model of cooperative learning didn't make me participate actively in learning	29(70.7%)	7(17.1%)	2(4.9%)	1(2.4%)	2(4.9%)
STAD model of cooperative learning motivated me to learn	0	2(4.9%)	3(7.3%)	13(31.7%)	23(56.1%)
STAD model of cooperative learning didn't help me to overcome my mistakes and learning difficulties	27 (65.9%)	1 4(21.5%)	3(7.3%)	0	0
STAD model of cooperative learning didn't improve my performance	21(51.2%)	20 (48.8%)	0	0	0
STAD model of cooperative learning improved my perception towards learning	0	2(4.9%)	3(7.3%)	13(31.7%)	23 (56.1%)
STAD model of cooperative learning helped me to overcome my mistakes and learning difficulties	0	2(4.9%)	3(7.3%)	13(31.7%)	23(56.1%)
STAD model of cooperative learning made me participate actively in learning	0	2(4.9%)	3(7.3%)	13(31.7%)	23(56.1%)

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From (Table 4), 29 of the participants corresponding to 70.7% strongly disagreed that STAD model of cooperative learning didn't improve their perception towards learning. Seven correspondents corresponding to 17.1% also disagreed that STAD model of cooperative learning didn't improve their perception (Table 4). Out of the 41 respondents, two remained undecided. One of the students agreed that STAD did not improve his perception towards learning (Table 4). Two of the students representing 4.9% strongly agreed that STAD model of cooperative learning did not improve their perception towards learning. In all, out of the 41 participants, 36 of them corresponding to 87.7% disagreed that STAD model of cooperative learning did not improve their perception towards learning (Table 4).

Again, from (Table 4), 24 out of the 41 participants of the study strongly disagreed that STAD model of cooperative learning didn't motivate them to learn. 15 of them also disagreed. One of them remained undecided. One of them also agreed to the statement. None of them strongly agreed that STAD model of cooperative learning didn't motivate him or her to learn (Table 4). In all, 39 out of the 41 participants disagreed that STAD model of cooperative learning did not motivate them to learn (Table 4).

Only one of the respondents in the study disagreed to the fact that STAD model of cooperative learning improved his performance. Two of the respondents did not express any view on whether their improved performance is as a result of STAD model of cooperative learning (Table 4). Thirteen (13) of the participants agreed that STAD model of cooperative learning improved their performance. Twenty-five (25) out of forty-one (41) of the participants strongly agreed that STAD improved their performance. In all, out of the 41 participants 38 of them representing 92.7% agreed that STAD model of cooperative learning improved their performance (Table 4).

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Data from the table also depict that, students' level of agreement with regards to whether STAD model of cooperative learning enabled their active participation in learning reveal that, 70.7% representing 29 students strongly disagreed that STAD model of cooperative learning didn't make them participate actively in learning the concept of nomenclature of hydrocarbons. 17. 1 % of the students disagreed that STAD model of cooperative learning didn't make them participate actively in learning. 4.9% of the students couldn't expressed any view. 2.4% agreed and 4.9% of the participants strongly agreed. In all, 87.8% of the students disagreed that STAD model of cooperative learning didn't make them participate actively in learning the concept of nomenclature of hydrocarbon (Table 4).

Again, from the table above, none of the respondents of the study strongly disagreed that STAD model of cooperative learning motivated him or her to learn (Table 4). Only two of the respondents disagreed with the fact that STAD model of cooperative learning motivated them to learn (Table 4). Three of the respondents did not say anything about whether STAD motivated them to learn or not. 13 of the students who took part in the study agreed that STAD model of cooperative learning motivated them to learn

(Table 4). Also, 23 of the students strongly agreed that STAD model of cooperative learning motivated them to learn (Table 4). The data from the table reveal that 87.8% of the respondents agreed that STAD model of cooperative learning motivated them to learn (Table 4).

Furthermore, data obtained as shown in the table above revealed that 27 of the students strongly disagreed that STAD model of cooperative learning didn't help them to overcome their mistakes and learning difficulties. 14 of them also disagreed.

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This means that all the students disagreed that STAD model of cooperative learning didn't help them to overcome their mistakes and learning difficulties Data gathered also presented that all the students disagreed that STAD model of cooperative learning didn't improve their performance

Data shown in the table above further revealed that 4.9% of the participants affirmed that STAD model of cooperative learning did not improved their perception towards learning. 7.3% remained neutral to whether STAD model of cooperative learning improved their perception towards learning. 87.8% of the respondents agreed that STAD model of cooperative learning improved their perception towards learning (Table 4).

Also, none of the student strongly disagreed that STAD model of cooperative learning helped him or her to overcome his or her mistakes and learning difficulties. Two of them disagreed, three remained undecided (Table 4). In all, 36 out of 41 of the participants agreed that STAD model of cooperative learning helped them to overcome their mistakes and learning difficulties.

Lastly, none of the students who participated in the study strongly attested to the fact that STAD model of cooperative learning did not enhance their active participation in learning. Only 2 of the students disagreed that STAD model of cooperative learning enhanced their active participation in learning. Three of the participants representing 7.3% remained neutral to whether STAD model of cooperative learning enhanced their active participation or not. Out of the 41 participants, 13 of them agreed to the fact that STAD model of cooperative learning enhanced their active participation in learning. 23 of the participants accounting for 56.1% strongly agreed that STAD model of cooperative learning enhanced their active participation in learning. In all,

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87.8% of the participants agreed that STAD model of cooperative learning enhanced their active participation in learning. The result from the data revealed positive perception of students towards STAD model of cooperative learning

The perception of students towards STAD model of cooperative learning from this study is supported by the finding of Shafiee Rad, Namaziandost and Razmi (2022) who examined the impact of the Student Team Achievement Division (STAD), a structured cooperative learning method and flipped learning on improving students' expository writing skills and their perceptions about learning. Where they found that students had positive perceptions and experiences related to the STAD model of cooperative learning. Again the positive perception of the participants towards STAD as seen in this study is also consistent with the finding of (Wu, 2021).

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CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.0 Overview

This chapter provides summary of the findings, conclusion and the recommendations with respect to effect of STAD model of cooperative learning on students' performance in nomenclature of hydrocarbons

5.1 Summary of findings

Based on the results and the discussions presented in relation to the research questions, the study revealed that the third-year students of Mawuli Senior High School performed poorly in the pre- intervention test in the concept of nomenclature of hydrocarbons. The 2-tailed t-test analysis of the students' pre- and post-test scores showed that students' knowledge in the concept of nomenclature of hydrocarbons has improved significantly as a result of the implementation of STAD model of cooperative learning. Again, no significant difference was recorded between male and female students after the implementation of STAD model of cooperative learning. Data obtained from the study also revealed that, students were able to retain what they have learnt owing to STAD model of cooperative learning. It has also been found that students have positive perception towards STAD model of cooperative learning owing to its effectiveness in enhancing students' attitude towards learning, active participation in teaching and learning as well as motivating students to learn. STAD model of cooperative learning therefore is an effective learning strategy that can enhance students' academic achievement. The findings of this study had further established the fact that acceptable methods of learning can improve students' performance or learning outcome science.

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5.2 Conclusion

The problem that necessitated the study was consistent report of abysmal performance of students by the chief Examiner (WAEC) in the nomenclature of organic compound. The study employed action research design in examining effect of STAD model of cooperative learning on students' performance in nomenclature of hydrocarbons**.** Findings from the study showed that STAD model of cooperative learning significantly improved learning outcome of students. It was also found that implementation of STAD model of cooperative learning helped students in retaining what they have learnt. It was also found that students have positive perception towards STAD model of cooperative learning owing to its effectiveness in enhancing students' attitude towards learning, active participation in learning as well as motivating students to learn. STAD model of cooperative learning is an effective learning model for improving academic performance of students.

5.3 Recommendations

Based on the findings of the study, the following recommendations could be made;

1. Science teachers should embrace STAD model of cooperative learning in the schools, since it helps in improving students' academic achievement. This will also help to solve the problem of students withdrawing from the study of science and performing poorly in internal and external examinations.
2. STAD model of cooperative learning can improve students' positive perception towards learning as well as enhancing their active participation in learning and collaborative working skills. Therefore, it should be adopted as one of the basic methods of learning in the school
3. It is necessary that workshops and seminars are organized for practicing science teachers in the school to brief them on the importance of STAD model of

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cooperative learning since STAD model of cooperative learning enhance students' academic achievement

4. At the in-service level, seminars and workshops should be organized by Stakeholders of Education, such as Ghana Education Service, GAST, GNAT, NAGRAT etc. to educate practicing teachers on how to implement STAD model of cooperative learning in the school. This is because most teachers would not like to try any new method they are not accustomed with.

5.4 Suggestions for Future Research

The following suggestions are made for further research:

1. Further research studies can be carried out to investigate the effectiveness of STAD model of cooperative learning in understanding science concepts in different schools, so that, generalization for Ghana can be provided.
2. The sample size was quite small due to the focus of this study. It is therefore recommended that the study be replicated using larger samples to provide a basis for more generalization of the findings of the study about the effectiveness STAD model of cooperative learning in the teaching and learning.
3. The study was limited to only nomenclature of hydrocarbons. Thus, it is suggested that the study be replicated on other Science topics such as Electricity, Light, Classification, electrochemistry and Photosynthesis. Based on these there could be greater generalization of the findings of the study.
4. Further studies may be conducted in other science subject areas such as Biology, Physics and Integrated science to investigate the effectiveness of STAD model of cooperative learning in enhancing achievement of students

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APPENDICES

APPENDIX A

LIKERT SCALE QUESTIONNAIRE

STUDENTS' PERCEPTION TOWARDS STUDENT TEAM ACHIEVEMENT DIVISION (STAD) MODEL OF COOPERATIVE LEARNING

UNIVERSITY OF EDUCATION, WINNEBA

DEPARTMENT OF SCIENCE EDUCATION

This questionnaire aims to find out your perceptions of STUDENT TEAM ACHIEVEMENT DIVISION (STAD) MODEL OF COOPERATIVE LEARNING

Please respond to each item to the best of your knowledge. Your thoughtful and truthful responses will be greatly appreciated. Your responses will be kept confidential and will not affect your examination result anywhere; it will be used only for research purposes.

Thank you for taking time to complete this questionnaire.

Name of student …….

Sex …….

Instruction: Each statement in this section is followed by four options. Choose the most appropriate option for your answer by ticking (√) the box that corresponds to your chosen option with a pencil. If you decide to change your answer, erase the first one completely and re-tick your new choice

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SD: Strongly disagree **D**: disagree **N**: Neutral **A**: agree **SA**: strongly agree

S/N	STATEMENT	SD	D	N	A	SA
1	STAD model of cooperative learning didn't improve my attitude towards learning	☐	☐	☐	☐	☐
2	STAD model of cooperative learning didn't motivate me to learn	☐	☐	☐	☐	☐
3	STAD model of cooperative learning improved my performance	☐	☐	☐	☐	☐
4	STAD model of cooperative learning didn't make me participate actively in learning	☐	☐	☐	☐	☐
5	STAD model of cooperative learning motivated me to learn	☐	☐	☐	☐	☐
6	STAD model of cooperative learning made me participate actively in learning	☐	☐	☐	☐	☐
7	STAD model of cooperative learning didn't improve my performance	☐	☐	☐	☐	☐
8	STAD model of cooperative learning improved my attitude towards learning	☐	☐	☐	☐	☐
9	STAD model of cooperative learning helped me to overcome my mistakes and learning difficulties	☐	☐	☐	☐	☐
10	STAD model of cooperative learning didn't help me to overcome my mistakes and learning difficulties	☐	☐	☐	☐	☐

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APPENDIX B

PRE-TEST QUESTIONS

NAME: …….
SEX. …….

Instruction: In this section, each of the questions is followed by four options. Choose the option that answers the question correctly.

1. A molecule with the formula C_3H_8 is a(n):

   A. Hexane

   B. Propane

   C. Decane

   D. Butane

2. Select the correct IUPAC name for:

   $CH_3\,CH_2\,CH_2\,CH_2\,C\,(CH_3)\,(CH_2CH_2CH_3)\,CH_2\,CH_3$

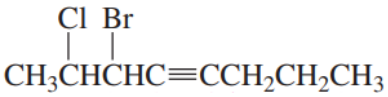
   A. 5-methyl-5-ethyloctane

   B. 5-methyl-5-propylheptane

   C. 4-ethyl-4-methyloctane

   D. 3-methyl-3-propyloctane

3. The correct name for the compound given below is:



   A. 3-bromo-2-chloro-4-octyne

   B. 2-ethyl-1-propyne

   C. 2-ethyl-1-pentyne

   D. 3-methyl-2-butyne

4. Which of the following formulas represents an alkene?

   A. $CH_3CH_2CH_3$

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B. CH_3CH_3

C. $CH_3CH_2CHCH_2$

D. CH_3CH_2Cl

5. Which of the following represents the general formula of alkenes?

A. C_nH_{2n}

B. C_nH_{3n}

C. C_nH_{4n}

D. C_nH_{5n}

6. Which of the following is a saturated hydrocarbon?

A. Methane

B. Ethene

C. Buthyne

D. Propyne

7. All the following are hydrocarbons except

A. CH_4

B. CH_2CH_2

C. CH_3OH

D. C_3H_4

8. Aliphatic hydrocarbons include the following groups except

a. Alkanes

b. Ketones

c. Alkenes

d. Alkynes

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9. A ……. Is an atom or group attached to the longest continuous carbon chain
    a. Functional
    b. Substituent
    c. Homologue
    d. halogen
10. The name of two carbon substituent is
    a. Methyl
    b. Ethyl
    c. Propyl
    d. butyl
11. Which of the following is used to separate numbers when writing the IUPAC nomenclature of hydrocarbons?
    a. Comma
    b. Hyphen
    c. Colon
    d. Semi colon

12. The general formula for alkanes is
    a. C_nH_{2n+2}
    a. C_nH_{3n+2}
    b. C_nH_{2n-3}
    c. C_nH_{3n+2}
    d. C_nH_{2n+1}

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13. The IUPAC nomenclature of the compound below is

    $CH_3CH\ (CH_3)\ CH\ (CH_3)\ CH_3$

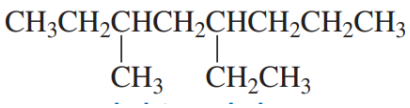
a. 2,3-dimethylbutane

b. 2,3-hexane

c. 2,3-dimethylhexane

d. 2,3-ethylhexane

14. What is the IUPAC name of the compound below?



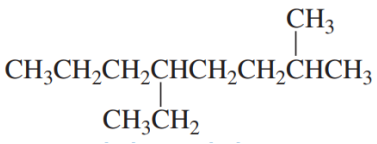
a. 4-ethyl-6-methyloctane

b. 5-ethyl-3-methyloctane

c. 2,4-dimethylhexane

d. 5-ethyl-2,5-dimethylheptane

15. What is the IUPAC nomenclature of the compound below?



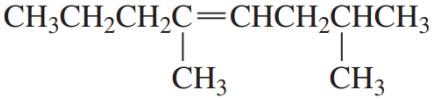
a. 5-ethyl-2-methyloctane

b. 6-ethyl-3,4-dimethyloctane

c. 2,2,4-trimethylpentane

d. 3-ethyl-5-methylheptane

16. What is the systematic name of the compound with structural formula below



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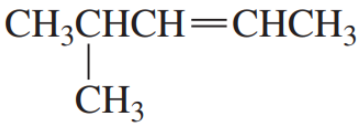
a. 2,5-dimethyl-4-octene

b. 3,4-methyl-5-octene

c. 2-dimethyl-3-octene

d. 2,3-trimethyl-2-octene

17. What is the IUPAC nomenclature of the compound below?



a. 4-methyl-2-pentene

b. 2-methyl-3-pentene

c. 2-methyl-3-pentene

d. 4-methyl-4-pentene

SECTION B

Instructions: Read each of the following statement carefully and indicate whether it is true or false

18. Alkanes are also known as olefins. **True/ False**

19. CH_3 CH_2 $CH_2CH_2CH_2CH_3$ is known as heptane. **True/ false**

20. Acetylene is the simplest of the alkynes, which are compounds that have the general formula C_nH_{2n-2} and contain carbon-carbon triple bonds. **True/ False**

21. Alkanes are composed of only carbon atoms and hydrogen atoms and contain only single bonds. Compounds. **True/False**

22. Removing a hydrogen from an alkane results in an alkyl group **True/False**

23. The systematic name of an alkyne is obtained by replacing the “ane” ending of the alkane name with “yne.” **True/False**

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SECTION C

Write down the condensed structural formula of the compounds below

24. 2-methyloctane
25. 3-ethyl-2-methylheptane
26. 2-Methyl-2-pentene
27. 2,5-Dimethyl-3-hexene
28. 2,3-Dimethyl-2-butene
29. 5,5-Dichloro-2-heptyne
30. 6-bromo-2-methyl-3-heptyne

SECTION D

Explain the following terms

31. Homologous series
32. Hydrocarbons
33. What are alkenes?
34. State two uses of alkanes
35. State two properties of alkenes
36. Write down two examples of alkynes
37. Explain the term functional group

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APPENDIX C

POST TEST QUESTIONS

NAME: …….
SEX. …….

Instruction: In this section, each of the questions is followed by four options. Choose the option that answers the question correctly.

1. The general formula for alkanes is

   A. C_nH_{2n+2}

   B. C_nH_{2n+3}

   C. C_nH_{2n+4}

   D. C_nH_{2n+5}

2. Select the correct IUPAC name for

   $CH_3\,CH_2\,CH\,(CH_3)\,CH_2\,CH\,(CH_3)_2$

   A. 1,1,3-trimethylpentane

   B. 1-ethyl-1,3-dimethylbutane

   C. 2,4-dimethylhexane

   D. 3,5-dimethylhexane

3. The correct name of the compound $CH_3CHCHCH_2CH_3$ is

   a. 2-Pentene

   b. 3-Pentene

   c. 4-Pentene

   d. 5-Pentene

4. All the following are alkanes except

   A. $CH_3CH_2CH_3$

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B. CH_3CH_3

C. $CH_3CH_2CHCH_2$

D. CH_3CH_2Cl

5. The general formula of alkynes is

A. C_nH_{2n-2}

B. $C_{2n}H_{2n-3}$

C. $C_{3n}H_{3n-4}$

D. $C_{4n}H_{4n-5}$

6. Which of the following is an example of unsaturated hydrocarbons?

A. Butane

B. Propane

C. Pentane

D. Ethene

7. …… are compounds composed of hydrogen and carbon only

A. Functional groups

B. Hydrocarbons

C. Inorganic compounds

D. fertilizers

8. Which of the following is not part of aliphatic hydrocarbons?

a. Alcohol

b. Alkynes

c. Alkenes

d. alkanes

9. A group of atoms that is attached to the main longest continuous chain is known as

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a. Substituent

b. Homologue

c. Alkanols

d. Functional group

10. What is the name of three carbon atom substituent?

a. Methyl

b. Butyl

c. Propyl

d. ethyl

11. Which of the items below is used to separate numbers and letters when writing the IUPAC name of organic compounds?

a. Colon

b. Semi colon

c. Hyphen

d. comma

12. C_XH_{2x-2} is the general formula of

a. Alkanes

b. Alkenes

c. Alkynes

d. alcohols

13. what is the name of the compound $CH_3CH_2CH_2CH_2CH_2CH_3$

a. butane

b. pentane

c. hexane

d. octane

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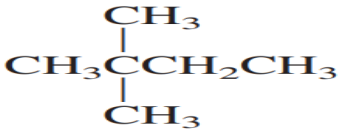
14. Give the IUPAC name of the compound below



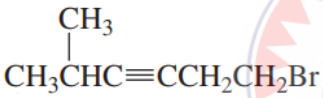
a. 2,2-dimethylbutane

b. 3,3-dimethylbutane

c. 2,2-methylbutane

d. 2-methyl-2-ethylbutane

15. The IUPAC nomenclature of the compound below is



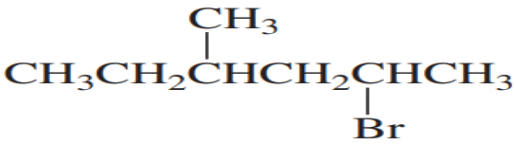
a. 1-bromo-5-methyl-3-hexyne

b. 6-ethyl-3,4-dimethyloctane

c. 2,2,4-trimethylpentane

d. 5-ethyl-2-methyloctane

16. Which compound is represented by the structural formula below?



a. 2-bromo-6-methylhexane

b. 4-methy-5-bromohexane

c. 3-methul-2-bromohexane

d. 2-bromo-4-methylhexane

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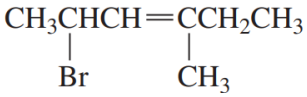
17. What is the systematic name of the compound with the structure shown below?



a. 4-bromo-3-methyl-5-hexene

b. 4-methyl-2-bromo-2-hexene

c. 3-methyl-5-bromo-4-hexene

d. 2-bromo-4-methyl-3-hexene

SECTION B

Instructions: *Read each of the following statement carefully and indicate whether it is true or false*

18. Alkyl groups are named by replacing the "ane" ending of the alkane with "yl". True/False

19. The systematic name of the compound below is 3-pentyne. True/False

20. An alkyne has three fewer hydrogens than an alkane with the same number of carbons. True/False

21. When naming alkyne, the chain is numbered from the end closest to the triple bond. True/False

22. Alkynes with triple bonds located at the end of the chain are internal alkynes. True/False

23. ethyne contain four hydrogen. True/False

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SECTION C

Write down the condensed structure formula of the following compounds

24. 2, 2-dimethyl-4-propyloctane.
25. 2-methylheptane
26. 2-bromo-4-methylheptane
27. 2-haxene
28. 2-propyl-1-hexene
29. 4-methyl-2-hexyne
30. 2-pentyne

SECTION D

31. What are alkenes
32. Write down two examples of alkynes
33. Write down two chemical properties of alkenes
34. What are alkynes
35. Write down two examples of alkanes
36. State one chemical properties of alkanes
37. In which way are alkynes useful?

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APPENDIX D

LESSON PLAN FOR LESSON ONE

NAME OF SCHOOL:

SUBJECT:

YEAR:

NAME OF THE TEACHER:

DURATION	TOPIC/ SUBTOPIC	LEARNING OBJECTIVES	TEACHER S ACTIVITY	LEARNER'S ACTIVITY	EVALUATION
70 minutes	**TOPIC** Hydrocarbons **SUBTOPIC** Classification of Hydrocarbons	By the end of the lesson the learner should be able to 1. Explain the term hydrocarbons 2. State the three groups of hydrocarbons 3. Classify the three groups of hydrocarbons into saturated and unsaturated hydrocarbons 4. Explain the term functional group and state the functional group of alkanes, akenes and alkynes	1. Teacher convey the objectives of the lesson to learners. 2. Teacher presents the lesson for the period 3. Motivates and encourage, learners to help their team members to learn the material	Learners join their heterogeneous group. Learners discuss the material presented by the teacher and help team members to master the material. Learners answer questions on work sheet	

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APPENDIX E

LESSON PLAN FOR LESSON TWO

NAME OF SCHOOL:

SUBJECT:

YEAR:

NAME OF THE TEACHER:

DURATION	TOPIC/ SUBTOPIC	LEARNING OBJECTIVES	TEACHER S ACTIVITY	LEARNER'S ACTIVITY	EVALUATION
70 minutes	**TOPIC** Hydrocarbons **SUBTOPIC** Nomenclature of alkanes	By the end of the lesson the learner should be able to 1. Tell what alkanes are 2. State the general 3. formula of alkanes 4. state at least two uses and two properties of alkanes 5. Give the IUPAC nomenclature of alkanes by following the IUPAC guidelines	4. Teacher convey the objectives of the lesson to learners. 5. Teacher presents the lesson for the period 6. Motivates and encourage, learners to help their team members to learn the material	Learners join their heterogeneous group. Learners discuss the material presented by the teacher and help team members to master the material. Learners answer questions on work sheet	

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APPENDIX F

LESSON PLAN FOR LESSON THREE

NAME OF SCHOOL:

SUBJECT:

YEAR:

NAME OF THE TEACHER:

DURATION	TOPIC/ SUBTOPIC	LEARNING OBJECTIVES	TEACHER S ACTIVITY	LEARNER'S ACTIVITY	EVALUATION
70 minutes	**TOPIC** Hydrocarbons **SUBTOPIC** Alkenes	By the end of the lesson the learner should be able to 1. Tell what alkenes are 2. State the general formula of alkenes 3. state at least two uses and two properties of alkenes 4. Give the IUPAC nomenclature of alkenes by following the IUPAC guidelines	7. Teacher convey the objectives of the lesson to learners. 8. Teacher presents the lesson for the period 9. Motivates and encourage, learners to help their team members to learn the material	Learners join their heterogeneous group. Learners discuss the material presented by the teacher and help team members to master the material. Learners answer questions on work sheet	

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APPENDIX G

LESSON PLAN FOR LESSON FOUR

NAME OF SCHOOL:

SUBJECT:

YEAR:

NAME OF THE TEACHER:

DURATION	TOPIC/ SUBTOPIC	LEARNING OBJECTIVES	TEACHER S ACTIVITY	LEARNER'S ACTIVITY	EVALUATION
70 minutes	**TOPIC** Hydrocarbons **SUBTOPIC** Nomenclature of alkynes	By the end of the lesson the learner should be able to 1. Tell what alkynes are 2. State the general formula of alkynes 3. state at least two uses and two properties of alkynes 4. Give the IUPAC nomenclature of alkynes by following the IUPAC guidelines	10. Teacher convey the objectives of the lesson to learners. 11. Teacher presents the lesson for the period 12. Motivates and encourage, learners to help their team members to learn the material	Learners join their heterogeneous group. Learners discuss the material presented by the teacher and help team members to master the material. Learners answer questions on work sheet	

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APPENDIX H

PRE-TEST MARKING SCHEME

SECTION A

1. B (1 mark)
2. C (1 mark)
3. A (1 mark)
4. C (1 mark)
5. A (1 mark)
6. A (1 mark)
7. C (1 mark)
8. 8 (1 mark)
9. B (1 mark)
10. B (1 mark)
11. A (1 mark)
12. A (1 mark)
13. A (1 mark)
14. B (1 mark)
15. A (1 mark)
16. A (1 mark)
17. A (1 mark)

SECTION B

18. False (1 mark)
19. False(1 mark)
20. True(1 mark)
21. True (1 mark)

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22. True (1 mark)

23. True (1 mark)

SECTION C

24. $CH_3CH(CH_3)CH_2\ CH_2CH_2\ CH_2\ CH_2CH_3$ (1 mark)

25. $CH_3CH_2\ (CH_3)CH_2\ (CH_2CH_3)CH_2\ CH_2CH_2\ CH_3$ (1 mark)

26. $CH_3C\ (CH_3)CH_2\ CH_2\ CH_3$ (1 mark)

27. $CH_3CH_2\ (CH_3)\ CHCH\ CH_2\ (CH_3)\ CH_2CH_3$ (1 mark)

28. $CH_3C(CH_3)\ CH(CH_3)CH_3$ (1 mark)

29. $CH_3\ C\ C\ CH_2\ C(Cl)_2CH_2CH_3$ (1 mark)

30. $CH_3CH\ (CH_3)\ C\ CCH_2\ CH(Br)CH_3$ (1 mark)

SECTION D

31. Homologous series is a group of organic compound with similar chemical properties and same functional group but differ from successive member by CH_2 (2marks)

32. Hydrocarbons are compound containing carbon and hydrogen only (1marks)

33. Alkenes are unsaturated hydrocarbons containing carbon to carbon double bond with a general formula of $C_n\ H_{2n}$ (1marks)

34. They are used as source of fuel

    Liquid alkanes are used as solvent (2 marks)

35. They undergo addition reaction

    They have low melting and boiling point (2marks)

36. Butyne, pentyne (1marks)

37. Functional group is an atom or group of atom in an organic compound that gives the chemical properties of the organic compound (1marks)

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APPENDIX I

POST-TEST MARKING SCHEME

SECTION A

1. B (1mark)
2. C (1mark)
3. A (1mark)
4. C (1mark)
5. A (1mark)
6. D (1mark)
7. B (1mark)
8. A (1mark)
9. A (1mark)
10. C (1mark)
11. C (1mark)
12. C (1mark)
13. C (1mark)
14. A (1mark)
15. A (1mark)
16. D (1mark)
17. D (1mark)

SECTION B

18. True (1mark)
19. False (1mark)
20. False (1mark)
21. True(1mark)

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22. False (1mark)

23. False(1mark)

SECTION C

24. $CH_3CH_2(CH_3)_2\ CH_2\ CH_2\ (CH_2\ CH_2\ CH_3)CH_2\ CH_2\ CH_2\ CH_3$ (1 mark)

25. $CH_3CH_2(CH_3)\ CH_2\ CH_2\ CH_2\ CH_2\ CH_3$ (1mark)

26. $CH_3CH_2(Br)\ CH_2\ CH_2\ (CH_3)\ CH_2\ CH_2\ CH_3$ (1mark)

27. $CH_3CH\ CH\ CH_2\ CH_2\ CH_3$ (1mark)

28. $CH_2CH(CH_2\ CH_2\ CH_3)\ CH_2\ CH_2\ CH_2\ CH_3$ (1mark)

29. $CH_3C\ C\ CH(CH_3)\ CH_2CH_3$ (1mark)

30. $CH_3C\ C\ CH_2\ CH_3$ (1mark)

SECTION D

31. Alkenes are unsaturated hydrocarbon containing carbon to carbon double bond with a general formula of $C_n\ H_{2n}$ where n is number of carbon atom (1marks)

32. Butyne, Pentyne (1mark)

33. They undergo additional reaction

    They burn in excess air to produce carbon dioxide and water (2marks)

34. They are unsaturated hydrocarbons containing carbon to carbon triple bond with a general formula of C_nH_{2n-2} (2marks)

35. Methane, ethane (2marks)

36. They undergo substitution reaction

    They undergo complete combustion reaction in the presence of excess oxygen to produce carbon dioxide and water (1marks)

37. Alkynes are used in the manufacturing of polyvinylchloride (PVC)

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APPENDIX J

RETENTION ACHIEVEMENT TEST (RAT) QUESTIONS

SECTION A

Instructions: ***Read each of the following statements carefully and indicate whether it is true or false***

1. Alkyl groups are named by replacing the “ane” ending of the alkane with “yl”. True/False
2. The systematic name of the compound below is 3-pentyne. True/False

$CH_3C{\equiv}CCH_2CH_3$

3. An alkyne has three fewer hydrogens than an alkane with the same number of carbons. True/False
4. When naming alkyne, the chain is numbered from the end closest to the triple bond. True/False
5. Alkynes with triple bonds located at the end of the chain are internal alkynes. True/False
6. ethyne contain four hydrogen. True/False

SECTION B

Write down the condensed structure formula of the following compounds

7. 2, 2-dimethyl-4-propyloctane.
8. 2-methylheptane
9. 2-bromo-4-methylheptane
10. 2-haxene
11. 2-propyl-1-hexene
12. 4-methyl-2-hexyne
13. 2-pentyne

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SECTION C

Instruction: In this section, each of the questions is followed by four options.
Choose the option that answers the question correctly.

14. what is the name of the compound $CH_3CH_2CH_2CH_2CH_2CH_3$

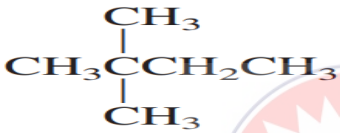
    e. butane

    f. pentane

    g. hexane

    h. octane

15. Give the IUPAC name of the compound below



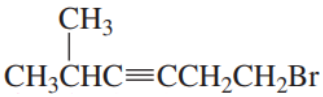
    e. 2,2-dimethylbutane

    f. 3,3-dimethylbutane

    g. 2,2-methylbutane

    h. 2-methyl-2-ethylbutane

16. The IUPAC nomenclature of the compound below is



    e. 1-bromo-5-methyl-3-hexyne

    f. 6-ethyl-3,4-dimethyloctane

    g. 2,2,4-trimethylpentane

    h. 5-ethyl-2-methyloctane

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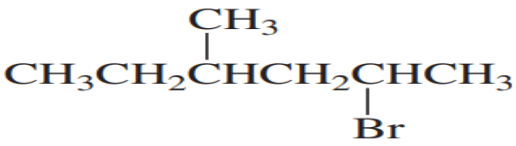
17. Which compound is represented by the structural formula below?



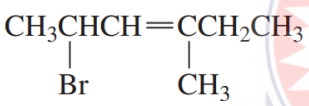
e. 2-bromo-6-methylhexane

f. 4-methy-5-bromohexane

g. 3-methul-2-bromohexane

h. 2-bromo-4-methylhexane

18. What is the systematic name of the compound with the structure shown below?



e. 4-bromo-3-methyl-5-hexene

f. 4-methyl-2-bromo-2-hexene

g. 3-methyl-5-bromo-4-hexene

h. 2-bromo-4-methyl-3-hexene

19. The general formula for alkanes is

E. C_nH_{2n+2}

F. C_nH_{2n+3}

G. C_nH_{2n+4}

H. C_nH_{2n+5}

20. Select the correct IUPAC name for

$CH_3\,CH_2\,CH\,(CH_3)\,CH_2\,CH\,(CH_3)_2$

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E. 1,1,3-trimethylpentane

F. 1-ethyl-1,3-dimethylbutane

G. 2,4-dimethylhexane

H. 3,5-dimethylhexane

21. The correct name of the compound $CH_3CHCHCH_2CH_3$ is

e. 2-Pentene

f. 3-Pentene

g. 4-Pentene

h. 5-Pentene

22. All the following are alkanes except

E. $CH_3CH_2CH_3$

F. CH_3CH_3

G. $CH_3CH_2CHCH_2$

H. CH_3CH_2Cl

23. The general formula of alkynes is

E. C_nH_{2n-2}

F. $C_{2n}H_{2n-3}$

G. $C_{3n}H_{3n-4}$

H. $C_{4n}H_{4n-5}$

24. A group of atoms that is attached to the main longest continuous chain is known as

e. Substituent

f. Homologue

g. Alkanols

h. Functional group

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25. What is the name of three carbon atom substituent?

    e. Methyl

    f. Butyl

    g. Propyl

    h. ethyl

26. Which of the items below is used to separate numbers and letters when writing the IUPAC name of organic compounds?

    e. Colon

    f. Semi colon

    g. Hyphen

    h. comma

27. C_XH_{2x-2} is the general formula of

    e. Alkanes

    f. Alkenes

    g. Alkynes

    h. alcohols

28. Which of the following is an example of unsaturated hydrocarbons?

    E. Butane

    F. Propane

    G. Pentane

    H. Ethene

29. …… are compounds composed of hydrogen and carbon only

    E. Functional groups

    F. Hydrocarbons

    G. Inorganic compounds

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H. fertilizers

30. Which of the following is not part of aliphatic hydrocarbons?

e. Alcohol

f. Alkynes

g. Alkenes

h. Alkanes

SECTION D

31. What are alkynes?

32. Write down two examples of alkanes

33. State two chemical properties of alkanes

34. What are alkenes?

35. Write down two examples of alkynes

36. Write down two chemical properties of alkenes

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APPENDIX K

MARKING SCHEME FOR RETENTION ACHIEVEMENT TEST (RAT)

1. True (1mark)
2. False (1mark)
3. False (1mark)
4. True (1mark)
5. False (1mark)
6. False (1mark)

SECTION B

7. $CH_3CH_2(CH_3)_2\ CH_2\ CH_2\ (CH_2\ CH_2\ CH_3)CH_2\ CH_2\ CH_2\ CH_3$ (1 mark)
8. $CH_3CH_2(CH_3)\ CH_2\ CH_2\ CH_2\ CH_2\ CH_3$ (1mark)
9. $CH_3CH_2(Br)\ CH_2\ CH_2\ (CH_3)\ CH_2\ CH_2\ CH_3$ (1mark)
10. $CH_3CH\ CH\ CH_2\ CH_2\ CH_3$ (1mark)
11. $CH_2CH(CH_2\ CH_2\ CH_3)\ CH_2\ CH_2\ CH_2\ CH_3$ (1mark)
12. $CH_3C\ C\ CH(CH_3)\ CH_2CH_3$ (1mark)
13. $CH_3C\ C\ CH_2\ CH_3$ (1mark)

SECTION C

14. C (1mark)
15. A (1mark)
16. A (1mark)
17. D (1mark)
18. D (1mark)
19. B (1mark)
20. C (1mark)
21. A (1mark)

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22. C (1mark)

23. A (1mark)

24. A (1mark)

25. C (1mark)

26. C (1mark)

27. C (1mark)

28. D (1mark)

29. B (1mark)

30. A (1mark)

SECTION D

31. They are unsaturated hydrocarbons containing carbon to carbon triple bond with a general formula of C_nH_{2n-2} (2marks)

32. Methane, ethane (2marks)

33. They undergo substitution reaction

They undergo complete combustion reaction in the presence of excess oxygen to produce carbon dioxide and water (2marks)

34. Alkenes are unsaturated hydrocarbon containing carbon to carbon double bond with a general formula of $C_n H_{2n}$ where n is number of carbon atom (1marks)

35. Butyne, Pentyne (1mark)

36. They undergo additional reaction (1marks)

They burn in excess air to produce carbon dioxide and water (1marks)

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APPENDIX L

RELIABILITY COEFFICIENT OF PRE-TEST INSTRUMENT

		First pretest score	Second pretest score
First pretest score	Pearson Correlation	1	.839**
	Sig. (2-tailed)		.000
	N	41	41
	Pearson Correlation	.839**	1
Second pretest score	Sig. (2-tailed)	.000	
	N	41	41

**. Correlation is significant at the 0.01 level (2-tailed).

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APPENDIX M

RELIABILITY COEFFICIENT OF POST-TEST INSTRUMENT

		First posttest score	Second posttest score
First posttest score	Pearson Correlation	1	.941**.
	Sig. (2-tailed)		.000
	N	41	41
	Pearson Correlation	. .941**	1
Second posttest score	Sig. (2-tailed)	.000	
	N	41	41

**. Correlation is significant at the 0.01 level (2-tailed).

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APPENDIX N

RELIABILITY STATISTICS OF LIKERT SCALE ITEM

RELIABILITY STATISTICS

Cronbach's Alpha	N of Items
.838	10

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APPENDIX O

STUDENTS' WORK SHEET

SECTION A

1. What is the general formula of alkenes?
2. Write down the rules of naming alkenes
3. What is the functional group of alkenes?
4. State three uses of alkenes
5. List two chemical properties of alkenes
6. Explain the term substituent
7. Name the following compounds
   I. $CH_3CH_2(CH_3)_2CH_2CH_2(CH_2CH_2CH_3)CH_2CH_2CH_2CH_3$

   II. $CH_3CH_2(CH_3)CH_2CH_2CH_2CH_2CH_3$

SECTION B

1. What are hydrocarbons?
2. Define homologous series
3. State the guidelines for naming alkanes
4. Define the term functional group
5. What are saturated hydrocarbons?
6. State 2 chemical properties of alkanes
7. State 2 reasons why alkanes are important
8. Name the following compounds
   I. $CH_3CH_2(Br)CH_2CH_2(CH_3)CH_2CH_2CH_3$
   II. $CH_3CH\ CH\ CH_2CH_2CH_3$
   III. $CH_2CH(CH_2CH_2CH_3)CH_2CH_2CH_2CH_3$

SECTION C

1. What is the general formula of alkynes?
2. What rules are followed in naming alkynes?
3. Write down 2 uses of alkynes
4. State 2 chemical properties of alkynes
5. Draw the structural formula of 4-methyl-1-yne