EFFECTS OF CASE BASED LEARNING, TEAM BASED LEARNING AND REGULAR TEACHING METHODS ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT AND SELF- CONCEPT IN CHEMISTRY IN MAARA SUB-COUNTY, THARAKA NITHI COUNTY, KENYA

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DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been presented in this university or any other for the award of a degree.

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DEDICATION

This thesis is dedicated to my beloved parents; John and Martha, my wife; Stella Maris and my children; Ruth, Rufina, Raphael, Rita and Roderick

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ABSTRACT

Most concepts in Chemistry are abstract creating major challenge in the achievement of the subject learning objectives. Inadequate mastery of Chemistry concepts might have a negative impact on a student's self-percept. Therefore, learners who have a positive self-concept in Chemistry may regard themselves as being capable, whereas those with a negative self-concept may perceive themselves as being incapable. The use of Regular Teaching Methods, Team Based Learning and Case Based Learning can enhance level of achievement in students' studies and self-concept in Chemistry. The positive contribution of Case Based Learning, Team Based Learning, and Regular Teaching Methods in terms of how well they did in school and self-concept of secondary school students in Chemistry in Maara Sub County, Kenya was examined in this study. The pre-test, post-test quasi-experimental factorial design with three factors, each with two levels was employed during the study. The survey focused on a total of 18,611 students who were attending 52 secondary schools in Maara Sub-County. Purposive sampling was used to pick three co-educational secondary schools in Maara Sub-County that shared comparable characteristics. A sample of 106 Form Two students studying Chemistry were chosen for the research. The groups were assigned to the experimental and control groups using the simple random sampling approach. The experimental groups learned through Case Based Learning and Team Based Learning, whereas the control group were taught through Regular Teaching Methods. The three groups were compared in pairs to identify any differences in achievement and self-concept in Chemistry. The Chemistry Achievement Test and Students Self-Concept Questionnaire (SSCQ) were given to the students in all three groups as both pre-tests and post-tests. A pilot research was conducted in Meru South Sub-County, involving three schools that shared similar features with those in the main study. The study had six objectives. Descriptive and inferential statistical techniques were applied to the data, with significance testing conducted at a 0.05 level. The analysis revealed statistically substantial disparities in the mean performance of students in Chemistry. The variations in students' self-concept were statistically significant. The study findings indicate that CBL outperformed TBL and RTM concerning the enhancement of academic achievement in chemistry. TBL demonstrated greater success in improving students' self-concept in chemistry. The study concludes that curriculum writers may consider including TBL and CBL into Chemistry education, alongside traditional teaching approaches. Valuable insights for policy makers and those teaching Chemistry, highlighting the need of focusing on students' Chemistry self-concept is offered in this study. The study results address a knowledge gap on the efficacy of different approaches to teaching Chemistry.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANCOVA	Analysis of Covariance
ANOVA	Analysis of Variance
CAT	Chemistry Achievement Test
CBL	Case Based Learning
CIEM	Curriculum, Instruction and Educational Management
EU	Egerton University
KCSE	Kenya Certificate of Secondary Education
KICD	Kenya Institute of Curriculum Development
KNEC	Kenya National Examinations Council
MDG	Millennium Development Goals
MOHEST	Ministry of Higher Education, Science and Technology
NACOSTI	National Commission for Science, Technology and Innovation
RAP	Readiness Assurance Process
RAT	Readiness Assurance Tests
RTM	Regular Teaching Methods
SDG	Sustainable Development Goals
SPSS	Statistical Package for Social Sciences
SSCQ	Students' Self - Concept Questionnaire
TBL	Team Based Learning
UNESCO	United Nations Educational Scientific and Cultural Organization

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Education is a social process for society transformation (Samaresh & Kausik, 2019). It is well known that implementing education in accordance with students' aptitude and local context has always been a golden rule in teaching practice (Liao *et al*., 2020). Formal education changes adult's role in the society by transferring obligation from parents and family to teachers and schools. Accordingly, societies adapt their efficient utilization of education in the planning, creation, production, implementation, and assessment of curriculum. Formal education emphasizes the teaching and acquisition of knowledge in a structured classroom environment. It enhances educational outcomes, students' performance, decreases student dropping out, and also alleviates students' workload, stress, anxiety, and dissatisfaction. Hence, it is imperative to foster the creation of innovative instructional methodologies to facilitate comprehensive growth in students. Chemistry is an important subject in many scientific fields of human endeavours and therefore, it should be given serious attention in secondary school education (Agboola & Oloyede, 2007). Chemistry education needs to be enhanced if a nation is to advance in science and technology. Reasonable weight should be given to the strategies that equip a future teacher with skills in readiness to tackle the challenges of teaching modern chemistry while and the public sector should hire professionally trained master trainers to train educational administrators and master trainers to promote modern teaching techniques in actual classroom settings (Faiza & Musarrat, 2022).

Chemistry is the study of the composition, structure, properties, and interactions of matter. The focus is on atoms and their interactions, which ultimately result in changes in states or reactions. The discipline of Chemistry encompasses a wide array of subjects, including organic Chemistry, inorganic Chemistry, metals and non-metals, and applied Chemistry (Francis & Mabel, 2015). Christensen *et al*. (2019) state that instructors encounter the difficulty of instructing students with diverse abilities in comprehending highly abstract subject matter, which some students find especially challenging. One aspect of the task is to change students' unfavourable attitudes by providing captivating material and inspiring circumstances. Chemistry encompasses a diverse range of topics that must be comprehended during the learning process. This is a challenge in deciphering complex concepts in Chemistry. This challenge leads to a lack of confidence in the process of studying Chemistry, resulting in a decline in students' enthusiasm for the subject and therefore they may feel disengaged, uneasy, and lacking motivation to study Chemistry (Ucu *et al*., 2019). According to Mercy and Edward (2015) students find secondary school chemistry relevant in the courses they are pursuing but proper coverage of syllabus, more practical and more projects would make it more relevant and appropriate. Furthermore, chemistry educators should refocus student preparation in secondary schools and equip them with requisite understanding and abilities to assist individuals in resolving common challenges rather than just passing exams and fitting in prestigious careers. Chemistry teachers should redesign instructions and provide students with enriching activities designed to ignite the interest, motivation and imaginations of the learners to promote active learning.

Science has been instrumental to the solutions of the socio-economic problems facing developing nations such as Kenya. Thus, Chemistry among other sciences, plays a key role in national development. A key goal of teaching chemistry is for students to understand the ideas behind it, not just memorize facts (Macson, 2013). Extensive efforts have been made to identify fundamental issues in the instruction of Chemistry at secondary schools (Ikechukwu & Akeem, 2015). In order to facilitate successful instruction and acquisition of knowledge, it is necessary to have adequate teaching resources and facilities, such as a well-equipped laboratory, as well as highly skilled and knowledgeable teachers (Adefunke, 2008). The teacher's instructional technique significantly influences the process of obtaining educational materials and acquiring necessary skills for effective learning (Isiaka *et al*., 2013). Various approaches to active learning have been suggested in different scientific fields to tackle pedagogical difficulties (Kulak & Newton, 2015). Masood and Kajal (2021) contended that in recent years, several instructional approaches have been employed to shift from passive learning to active learning and augment students' capacity for critical thinking. Passive learning is mostly teacher-oriented, involving the transmission of information from teachers to pupils and relying on memorization through repetition. Active learning, in contrast, is a student-centered approach that actively involves and engages learners.

Zafar and Ismail (2018) state that the primary goal of teaching is to ensure that students achieve the predetermined course goals at the desired level. Educators employ a diverse range of instructional tactics, methodologies, and educational resources that are suitable for the course content and disciplines to accomplish this objective. The use of diverse pedagogical approaches, methodologies, and resources in the instructional process, which cater to the distinct sensory faculties of students, has a beneficial impact on the learning process. A large body of evidence has shown that lecture-dominated teaching does not promote critical thinking among most students (William *et al*., 2005). There is need for Chemistry teachers to utilize strategies that can assist in enhancing the abilities of learners in Chemistry in order to serve the increasing societal demands in solving problems that require Chemistry knowledge. According to Kenya National Examinations Council Reports for years 2009 to 2019 Chemistry performance in public secondary schools throughout all counties in Kenya was below average in the Kenya Certificate of Secondary Education (KCSE). The performance of students in Chemistry in KCSE was shown in Table 1.

Table 1: Performance in Chemistry, in KCSE at National Level between Years 2009 to 2019

Year	**% Mean score**	**Grade**
2009	19.30	D-
2010	24.91	D-
2011	23.66	D-
2012	27.93	D
2013	24.84	D-
2014	32.16	D
2015	34.36	D
2016	23.71	D-
2017	24.05	D-
2018	26.88	D
2019	26.09	D-

Source: KNEC (2010, 2011, 2012, 2013, 2014, 2015,2016,2017,2018 &2019)

Table 1 shows that students' mean scores in Chemistry in KCSE was below the average percentage mean scores for the period from 2009 to 2019. Poor performance in Chemistry may deny students entry into science courses such as medicine and engineering. A careful analysis of the performance of students in Chemistry reviewed that, students' performance in Chemistry, in KCSE in Sub-Counties in Tharaka Nithi County for the period 2016 to 2020 was also below the average percentage mean scores as shown in Table 2.

Table 2: Performance in Chemistry, in KCSE in other Sub-Counties in Tharaka-Nithi County between Years 2016 to 2020

Year	2016	2017	2018	2019	2020
Meru South	24.93	21.54	26.62	22.82	18.92
Tharaka North	16.40	15.28	16.28	15.43	12.62
Tharaka South	20.56	16.00	18.94	18.64	16.72

Source: Tharaka Nithi County Director of Education Office (Years 2016 to 2020)

The Table 2 above indicates that the performance in Chemistry in Meru South, Tharaka North and Tharaka South were below the average percentage mean scores. Meru South had higher performance than Tharaka South and Tharaka North in the last five consecutive years. The performance of the three sub counties was compared with those of Maara Sub County in Table 3.

Table 3: Performance in Chemistry in KCSE in Maara Sub- County in Years 2009 to 2020

Year	Chemistry Mean	Grade
2009	28.07	D
2010	42.01	C-
2011	30.70	D
2012	30.95	D
2013	38.16	D+
2014	41.17	C-
2015	42.16	C-
2016	25.48	D
2017	23.30	D-
2018	27.35	D-
2019	26.31	D-
2020	18.47	D-

Source: Maara Sub- County Director of Education Office (Years 2009 to 2020)

Table 3 indicates that the learners' performance in the Kenya Certificate of Secondary Education (KCSE) Chemistry exam in Maara Sub-County was likewise below the average percentage mean scores. The outcome of the study could also be useful in informing Sub-County education officers and curriculum developers on the impact of Team-Based Learning and Case-Based Learning on learners' achievement and self-concept in Chemistry hence it could be applied in schools nationally. The current practice of applying the Regular Teaching Methods (RTM) only could be responsible for much of the ineffectiveness of instruction in schools (Ihendinihn, 2013). In his work, Elvis (2013) contends that in order to optimize the procedure of knowledge creation, teachers should utilize appropriate pedagogical methods that align with specific learning objectives. Other researchers have observed that many students fear Chemistry as is often perceived as challenging to comprehend due to its abstract nature and the regular teaching methods utilized by the majority of Chemistry teachers (Daniel & Awokoya, 2010). Additional research has demonstrated that students who were instructed using Advanced Organizers experienced notable enhancements in their Poetry performance, in contrast to learners who received instruction through conventional teaching methods. Hence, a notable disparity was observed in the average scores of students instructed when learners receive instruction with advance organizers as opposed to standard classroom instruction. The fundamental principles in Chemistry are crucial as a solid understanding of these concepts is necessary for students to progress in their study of Chemistry (Wamukuru *et al*., 2016). The research findings demonstrated that students who were instructed utilizing the Generative Learning Method achieved significantly higher performance in comparison to learners who were not instructed utilizing traditional methods. Students who were instructed in Chemistry utilizing the generative instructional style achieved higher average scores compared to students who were taught using the traditional way (Chinasa *et al.*, 2021). The primary cause of the challenges students face in learning Chemistry can be attributed to a lack of comprehensive comprehension of the subject matter (Fatokum *et al*., 2016). Students fail to achieve the stated learning objectives probably due to the teaching methods applied in Chemistry classrooms.

Teaching techniques encompass a variety of strategies, methodologies, and modes that a teacher can utilize in order to achieve different objectives. Teaching techniques encompass various aspects such as the method of delivering information, the organization of learning circumstances, the development of student groups, the facilitation of activities, and the provision of instructional materials to enhance learning. Teaching techniques play a crucial role in the teachers' objective to enhance the learning environment for students. The learning environment refers to the combined physical and mental surroundings in which a student is immersed at a given time. Enriching the environment involves creating conditions that are more favourable for learning in both the physical and mental aspects. Consequently, contemporary teachers must employ inventive instructional approaches to enhance the academic achievement of secondary school students studying Chemistry (Chinasa *et al*., 2021). Some scholars have recommended from their studies that Chemistry teachers utilize contemporary and effective teaching methodologies, such as case-based learning, that enable learners to independently develop their understanding and actively engage in the process of learning. Those who make policies and curriculum planners ought to evaluate and enhance the Chemistry curriculum to incorporate additional learner-centred teaching methodologies. Science teachers should have both moral and financial incentives to participate in science workshops and seminars in order to enhance their expertise in the field of science, technology, and inventions. (Chabo *et al.,* 2021).

Typically, different methods of teaching are derived from recognized theories of learning. It is upon the teachers to choose desirable teaching approaches that can best suit the topic, nature of learners and objectives. In view of this, Chemistry should best be taught using constructivist approaches (Izueg *et al.,* 2018). Research by Uwalaka and Offorma (2015) demonstrated a substantial disparity in the average achievement scores between students who received instruction in listening comprehension utilizing the constructivist technique were compared to those who were taught using the traditional teaching style. According to the results, it is recommended that teachers should utilize the constructivist teaching style in their instruction, since it has been proven to enhance students' academic performance. The constructivist approach to teaching posits that information is individually generated and constantly reconstructed by learners, drawing upon their existing knowledge and experiences. The constructivist education technique allows students to build ideas, skills, and knowledge by drawing on their prior experiences. Samaresh and Kausik (2019) discovered that the pupils that were exposed to the constructivist model achieved much better than regular teaching methods. The constructivist approach has the ability to enhance students' proficiency in understanding and applying complex concepts. Using a constructivist technique in scientific teaching is highly suggested to enhance students' academic performance in science at the secondary level.

Jong (2005) asserted that there exist three key distinctions between constructivist education and alternative instructional approaches. First and foremost, learning is a dynamic and creative activity, rather than simply acquiring knowledge. Additionally, teaching involves facilitating the learner's active and reflective engagement in the process of constructing their own understanding, rather than simply transmitting information to them. Furthermore, teaching is primarily an idea of learning and teaching, rather than a concept of teaching and learning. It entails prioritizing the learner above teaching, ensuring that the learner is at the core of the learning process. Piaget (1976) and Vygotsky (1978) contended that constructivist teaching is founded upon the principles of constructivist learning theory. According to this notion, learning is always based on the existing knowledge of a pupil. Constructivists submit that studying is more effective where a learner engages actively in the learning process rather than simply taking knowledge passively. Constructivist teaching is founded upon the approach of discovery learning, in which the teacher minimizes direct instruction and instead guides students via questioning and activities to let them independently find, explore, understand, and articulate new knowledge. The constructivist learning theory posits that the acquisition of knowledge is reliant on pre-existing knowledge. Consequently, learners achieve optimal learning outcomes when they have the opportunity to develop their own comprehension by actively engaging with and contemplating their experiences. The constructivist classroom is characterized by active involvement of the learner, democratic environment, interactive activities and the teacher creates a learning process in which pupils are motivated to take responsibility and become independent. Constructivism classroom encourages activities such as experimentation, research project; field trips, film and class discussion (Helen, 2017). In a constructivist approach, meaningful learning occurs when the learner is socially engaged. Teaching strategies that promote the understanding of subject content and encourage active engagement between students, as well as between students and teachers, can enhance achievement. This is because learners can gain understanding of concepts from one another that they may not fully comprehend directly from teachers. Constructivist learning methodologies are ideal for the instruction and acquisition of scientific concepts.

Kwaku (2018) states that science learning entails the development of theories and explanations to account for observed phenomena, and all proposed explanations are subject to scrutiny and questioning. It is now well acknowledged that science learning can be enhanced when students express their existing knowledge and clarify their understanding to one another, resulting in a shift in their understanding. Several investigations on students' comprehension of science rely on constructivist learning theories and the hypothesis that preexisting ideas impact learning results as learners connect new information with their prior knowledge. Constructivism posits that knowledge is formed through the active engagement of the individual, who constructs cognitive structures by engaging with their surroundings. Cognitive interaction arises when the subject constructs their own cognitive structure to shape their perception of reality. The cognitive structure must continuously undergo modification and adaptation to meet the requirements of the environment and the evolving organism. Adjustment is a continuous process that occurs through reconstruction (Amineh & Asi, 2015). Learners should have the opportunity to actively engage in all aspects of the learning process, particularly in problem-solving and critical thinking, while interacting with their peers in a constructivist classroom. Students who receive effective guidance when the teacher implements the constructivist teaching technique will have a significant advantage (Ulawaka & Offorma, 2015). According to Andang and Purwarno (2018), the teaching and learning process should be connected to the practical real world. This means that the classroom should be constructed in a way that allows teachers and students to actively exchange their knowledge and experiences. The key element in constructivism philosophy is that the learner should be given priority in the learning process. It is imperative for learners to actively cultivate their knowledge and take accountability for their learning results. Their ingenuity and vitality will enable them to thrive independently in their cognitive existence. Piaget (1976) advocated for an active role of learners in his constructivism theory, emphasizing the importance of developing cognitive structures, assimilating new information, and finally accommodating it into existing knowledge. In contrast, Vigotsky (1978) recommended that students collaborate in a single group and apply their knowledge through practice.

Epiphania (2022) recommended that more research should be undertaken to ascertain suitable pedagogical approaches that have the potential to improve learners' success in school in the chemistry classroom. One among the instructional methods strategies that is grounded on constructivism theory is the Case Based Learning. It entails instructing students about the idea by utilizing cases. A case refers to a situation that is derived from everyday life, accompanied with study inquiries that are connected to the case, enabling students to engage in discussions and share their thoughts (Wassermann, 1994). Optimal constructivist training offers novel experiences by facilitating collaborative work. Case Based Learning enables learners to assess their current knowledge by comparing it with that of their peers and engaging in group discussions and exercises that align with the constructivist perspective. According to Patricia and Hellen (2012), this approach to learning involves integrating new information from experiences into existing mental frameworks. Cases offer students ample practical experience that can be applied in their future daily lives. They enable the teacher to direct the learner's focus to a particular issue and give the learner a chance to demonstrate their understanding by responding to the presented case scenario (Jarz *et al*., 1997). Cases are narratives based on real-life situations that convey an instructive or informative message. Originally, case-based education involved using self-contained stories as the basis for analysis and discussion in the classroom (Herreid, 2005). A case is designed to enable pupils to assume the role of an actor in a specific setting. The case approach of teaching allows students to combine knowledge with practical application and apply what they have learned (Jones, 2003).

In recent times Case Based Learning has emerged as a powerful teaching tool in reforming science education. Case Based Learning is fundamentally students centred, acknowledging the importance of actively engaging students engaging in self-directed. As the responsibility of learning shifts towards students, the role of the instructor also shifts from the conventional authority who dispenses the final form knowledge to an expert guide while promoting the individual development of learning skills. In orienting more toward students' perspectives and motivation. Case Based Learning focus on concreate specific occasions where the target knowledge is relevant. Providing context for learning enhances both the student's motivation and their ability to understand and apply the information. The cases are not merely supplemental illustrations but function centrally as the occasion for learning. This learning style resonates with the views of the cognitive theorist that our minds reason effectively through the analogy and models as much as through the interpretation (Douglas, 2013). Teaching approaches that provide a chance for individual interaction and concentrated feedback are essential to provide an active learning environment for case-based teaching (Michele *et al*., 2009).

Maia *et al*. (2023) discovered a significant and pertinent impact of Case Based Learning and suggested that this instructional approach can be effectively incorporated into educational curriculum. Logan *et al*. (2022) argued that instructors who want to incorporate case-based methods into their courses should consider starting with a lecture to present some material, followed by case studies that allow students to interact with their peers and the instructor. Generally, students value case-based teaching for its discussion and problem-solving elements but prefer receiving course content through a lecture before engaging in a case study. Chaplain (2009) assessed the impact of case studies in an introductory Biology course and found out that students in the case-based course showed more improvement over the course as well as slightly higher overall success at answering questions correctly than the students in the lecture-based course but the study did not focus on high school students in

Chemistry achievement and self-concept. Case Based learning is highly efficient approach to enhance students' motivation and spark interest in Chemistry (Yalcinkaya *et al*., 2012). Mayo (2002) found that case-based learning fosters an environment that promotes increased student engagement and satisfaction in the learning process. Sendur (2012) argued that while the roll out of case-based learning has gained a strong foot holds in science education, there are an inadequate studies in Chemistry education that focus on case-based learning. Previous studies examined the impacts of Case Based Learning on students' drive, interests, and enjoyment in Chemistry, as well as their achievement in Biology. However, there is an absence of evidence regarding the influence of case-based learning on the academic performance and self-concept of secondary school students, particularly in the domain of Chemistry. Nevertheless, the existing study offers insufficient data to support the effectiveness of using published case studies in achieving specific learning goals (Kelvin, 2015). Therefore, it was important to investigate whether innovative pedagogical approaches like case-based learning would be useful in enhancing achievement and self -concept in sciences and Chemistry. Team-based learning can be useful in improving the acquisition of knowledge in the field of Chemistry.
Team Based Learning is an organized approach to small group learning that can be modified for application in large classes (Preman *et al*., 2018).

The existing compilation of literature on Team-Based Learning (TBL) in secondary schools is limited. However, study findings indicate that TBL in secondary schools yields comparable results to those observed in higher education settings (Stella *et al*., 2023). TBL is a way of teaching that emphasizes student involvement that maximizes the potential of small groups by modifying the course structure to harness the unique characteristics consisting of results-focused learning groups (Michaelsen *et al*., 2004). Team Based Learning is founded on four fundamental principles: forming and maintaining the group, allocating individual and group tasks to students, delivering timely feedback, and devising team methods to optimize learning and promote teamwork (Allen *et al*., 2013). The utilization of TBL is most suitable in courses that fulfill two specific criteria. First, students are obligated over the duration of the course to comprehend a substantial amount of material. The second objective of the course is to employ or use the provided content through problem-solving, addressing intricate inquiries, and resolving obstacles (Sisk, 2011). Team-Based Learning makes it efficient for a single instructor to oversee multiple student groups collaborating within a single classroom (Brttta *et al*., 2007). The TBL strategy regularly enhances school achievement by redirecting the emphasis of education from knowledge transmission to knowledge application. In addition, it also focuses on specific professional skills that cannot be achieved or evaluated by traditional educational methods (Dean & Larry, 2010). By utilizing contemporary teaching methodologies, students not only achieve greater academic success but also develop the essential professional competencies required for future performance.

Many studies have addressed Team Based Learning on the factors that affect one's, problem solving skills and academic success and self -directed learning. However, there are few studies that investigate the effects of integrated learning strategies and their cognitive behavioural consequences. It is necessary to use methods that will provide students with a better understanding of the problems and encourage them to analyze the issues (Zohreh *et al*., 2016). The Team Based Learning paradigm allows for the redesign of lab sessions as active learning exercises. Peer evaluation in teams enhances student responsibility towards one another. Laboratory sessions are crucial components of Chemistry courses as they serve to demonstrate chemical principles, develop practical laboratory skills, and teach scientific methodologies. (Aires-de-sousa *et al*., 2017). According to Faiza and Musarrat (2022) instructors are putting more focus on enhancing student engagement and learning. One teaching strategy that can be utilized to engage, excite, and motivate learners throughout the educational path is team-based learning. An interactive learning environment where students learn through collaborative technique known as team-based learning (TBL) blends learning in fewer and large groups through merging several small groups into a big group environment.

Team-based learning (TBL) is successful chemistry teaching method while strengthening the knowledge and abilities of students across various levels. The small-group tasks dramatically improve student accountability and teamwork, enabling them to perform to their potential. Group and collaborative tasks have become more common in school settings during the past few decades. TBL enhances academic performance and boosts attendance. Additionally, TBL encourages ongoing, self-directed learning, improves the learning environment in the classroom, and encourages collaboration, group projects, and interactions among many students. Every student grows much more aware of their capacity for learning and rate of knowledge expansion. Christensen *et al*. (2019) ascertain that educators can enhance their students' competency in various areas by creating a pedagogical environment that emphasizes the cultivation of skills such as collaboration, interpersonal communication, cross-cultural understanding, active listening, interviewing techniques, negotiation strategies, conflict resolution, and analytical problem-solving. Therefore, the adoption of TBL as a teaching method is appealing to educators worldwide due to its efficacy in imparting students with the essential competencies required for their prospective careers. Moreover, the process of implementing TBL is important for academics who aim to cultivate collaborative abilities in their students by adopting an alternative method to student learning

A Team Based Learning approach would require advance reading or self- directed study by the learners with a readiness assurance process at the beginning of the sessions in form of the handouts (Paul *et al.*, 2002). One fundamental principle of TBL is that students remain at the school for the full term, collaborating with the same group of students to address substantial challenges linked to the course during class hours. The learning activities in TBL are meant to provide students with the essential skills needed to address the challenges they will encounter, encourage collaboration in solving real-world problems, foster interdependence within teams, and hold students accountable for their contributions to group tasks (Michaelsen *et al*., 2004). The study on the application of Team Based Learning techniques and their impact on critical thinking, student involvement and subject mastery for school-age students is insufficient (Jeanne *et al*., 2014). It is expected that Team Based Learning will enhance not just the students' capacity to comprehend and excel in the subject matter but also facilitate the enhancement of interpersonal and team skills (Hurbert *et al.*, 2009). To improve student collaboration and self-directed learning, it is necessary to restructure the learning approach. Team-based learning integrates the principles of flipped teaching and collaborative learning to optimize learning outcomes and cultivate a spirit of teamwork among students. Team-based learning is a dialectic pedagogical approach that fosters student engagement in critical thinking and self-reflection to evaluate their capacity to utilize acquired knowledge. In contrast to teacher-oriented didactic teaching, team-based learning promotes a more interactive and student-centered approach.

Team Based Learning is a comprehensive teaching style that goes beyond simply adding group projects to the curriculum. It involves making systematic changes to the curriculum designs in order to foster a team-oriented learning approach. It necessitates that students allocate classroom time on applying knowledge rather than merely acquiring it. The personal learning effect in Team Based Learning is intricately linked to the team's overall establishment, progression, and achievement. The Team Based Learning methodology revolutionizes the learning and teaching methods employed by both students and teachers. In addition to acquiring new knowledge, students also have increased opportunities for debate, actively engage with their peers, demonstrate higher levels of participation in learning, develop effective interactive skills, and enhance their thinking abilities (Chin-Hsiang *et al*., 2015). Students' critical thinking skills is enhanced through Team Based Learning as a teaching method. Through Team Based

Learning, the students' capacity for analytical thinking is enhanced, and they consistently participate in collaborative learning activities. Moreover, the students’ exhibit heightened curiosity and a greater desire to acquire pertinent knowledge in order to tackle intricate difficulties (Zeb *et al*., 2022).

Yang *et al*. (2022) established that the use of Team Based Learning resulted in a notable enhancement in participants' comprehension of the community and their ability to evaluate and meet its requirements. The TBL performance, learning attitude, and skills of the experimental and control groups exhibited significant differences. The individuals who participated in TBL demonstrated superior performance in comparison to individuals who participated in Lecture across all community matters. The TBL method seems to be increasingly efficacious than Teacher Lecture considering the achievement of students' knowledge goals. Epiphania (2022) attributes students' low accomplishment in the chemistry course to the challenge of comprehending chemical principles and establishing meaningful connections with the subject. Consequently, students have shown a lack of interest and passion in learning chemistry. Teachers are actively seeking methods to change students' perspectives on chemistry and enhance their chances of excelling in the subject. Case studies are essential for achieving the learning objectives of the chemistry course because of their inherent characteristics. Utilizing a case-based discussion as part of an active learning approach can provide learners with the essential skills and information to effectively address actual-life situations.

Thomas and Bowen (2011) reported that constructivist learning theories, like as TBL, provide the ability to create advanced lifelong learning skills that are very applicable in chemical learning contexts. However, there is not enough studies comparing TBL to other teaching methodologies. There is a limited amount of research on the effects of Team Based Learning (TBL) on learning outcomes, specifically in relation to performance on exams (Paul *et al*., 2010). Studies have shown a beneficial impact of TBL in the areas of the relationship between teacher-learner experiences and attitudes and academic accomplishment in graded examinations compared to traditional lectures (Reimschisel *et al.*, 2017). The attractiveness of team-based learning (TBL) among students may be attributed to several factors. Firstly, TBL promotes deep learning. Secondly, it stimulates self-directed learning and discourages mere memorization. Lastly, it equips students with problem-solving skills and cultivates teamwork. While traditional lecture-based learning is suitable for big groups, Team-Based Learning (TBL) can also be effectively employed with large groups, particularly when students have access to relevant materials. TBL fosters critical thinking and fosters collaboration among students (Karim *et al*., 2021).

Christensen *et al*. (2019) conducted an investigation which found that the introduction of Team-based learning had mostly adverse effects on students' perspectives and attitudes towards studying accounting. The Team based learning experience had a beneficial impact on students' judgments of their competence and preference in executing the leadership positions of task leader and socio-emotional leader, which were the most notable outcomes. Universities and other training institutions can effectively create a learning environment that focuses on problem-solving and delivers emotional support by fulfilling their promise to developing graduate attributes in leadership and teamwork. In addition, Team-based learning boosts students' self-assurance in assuming crucial leadership positions, therefore improving their prospects for employment. This is reinforced by improved student assessments of their proficiency in the position of providing information, where a crucial aspect of this function is to deliver precise and dependable data, which is essential for professionals in this field. Despite the long-standing application of Team Based Learning, further research is needed to establish its impact on teaching effectiveness and its acknowledgment by both teachers and students. This research will provide more conclusive data to validate and support its use. Team Based Learning demonstrated immediate teaching effectiveness comparable to traditional lecture-based learning, and exhibited superior sustained teaching effectiveness compared to lecture-based learning.

The students enthusiastically embraced the Team Based Learning strategy, which led to enhanced enthusiasm and independent study. Additionally, this technique led to a significant rise in information acquisition, as evidenced by the short-term exam scores, when compared to lecture-based learning. TBL is considered to be a very effective teaching style that is worth encouraging (Rui *et al*., 2017). The study about Team based learning may offer a proof that using Team based learning may be a helpful instructional strategy for many students who are at the stage of college and career preparedness. The impacts of Team based learning may also give teachers crucial knowledge about the key components of the instruction. Additionally, it could give a better indication of the impacts of TBL as well as additional information about who and under what circumstances TBL can be beneficial (Faiza & Musarrat, 2022). With an overwhelming amount of research and a demand for collaborative learning in the classroom, teachers are tackling challenges at all educational levels that often accompany the social aspects of group work. Team-Based Learning is an instructional sequence that shifts instruction from teacher lecture to small-group learning. Through the use of teams and social learning students are actively engaged and learn through critical-thinking tasks. Students' ability to assume responsibility for their own learning and for their peers as learners and fellow human beings enables instructors to create opportunities for students to demonstrate their knowledge and skills in the classroom with the topic (Virginia *et al*., 2020).

To assess the effectiveness of Team-Based Learning (TBL), Jeanne *et al*. (2014) conducted a study where participants were randomly assigned to either a TBL group or a comparable comparison group. The study ensured that the content and difficulty level of the material were consistent across both groups, accounted for instructor effects, and administered the identical subject knowledge examination to both groups. Their research yielded evidence supporting the use of TBL as an instructional approach, which can lead to marginal improvements in students' acquisition of knowledge and long-term retention of information. Furthermore, the findings provided the initial data indicating that the application of TBL in college-readiness, high-school-level courses can lead to enhanced learning. According to Stella *et al*. (2023), the advantages of implementing Team-based Learning in secondary schools outweigh the difficulties, making it a valuable investment of teachers' time and energy. Although the challenges teachers encountered in terms of allocation of time for preparation, institutional demands, and student team dynamics supervision, the benefits of increased student engagement, enhanced learning quality, skill enhancement, and teacher job satisfaction outweighed these issues. As such Team based learning training for secondary-level teachers ought to be encouraged.

The implications of Team-Based Learning on secondary schools' students and their academic success and self-concept in Chemistry has not been sufficiently proven. and in particular Maara Sub County, Kenya. The current study sought to investigate the effects of TBL on student's achievement and self-concept in Chemistry in Maara Sub County, Kenya where performance is below average. The strategies employed in teaching students may impact positively or negatively the self-concepts of students learning in Chemistry. Chemistry educators and institutions of learning ought to investigate the role of self-concept in students' learning since it is a useful variable in education. Self-concept can be explained as a holistic understanding of oneself across several domains, formed by self-awareness and assessment of values acquired from experiences in relation to one's environment (Eccles, 2005). According to Marsh and Mara (2008), some scholars have proposed that interventions targeting self-concept in Chemistry could be advantageous in providing teachers with insights as to how to improve their students' self-concept in the subject. Teachers can gain valuable insights into students who may want extra assistance by examining low self-concept scores (Sara & Ellen, 2016). Several schools have yet to assess or evaluate students' self-concept, resulting in many teachers who teach without considering their students' self-concept. Prior to want their pupils to attain high levels of learning, a teacher must determine the students' understanding and viewpoints regarding the subjects. Subsequently, the instructor can identify the methods, approaches, or media that correspond with the students' self-concept. Most students focus on memorizing formulas and minimal study materials with the goal of passing exams, rather than developing a meaningful understanding of Chemistry concepts and principles (Ucu *et al*., 2019).

Researchers utilized many methods to ascertain the correlation between an individual's self-concept and their academic achievement. The reciprocal impact model of self-concept suggests that academic accomplishment and self-concept exert a reciprocal influence on one another. Conversely, the internal/external frame of reference model proposes that achievement has a favourable influence on an individual's academic self-concept within the same area, but an unfavourable influence on self-concept in different areas. According to Chen *et al.* (2013), in the skill enhancement model, academic self-concept is a factor that influences academic achievement. María and Pegalajar (2017) state that the purpose of education is to equip students with essential skills, knowledge and attitudes to promote their independence and integration in both academic and social environments. Additionally, education should also contribute to the improvement of personality development. Education should prioritize the inclusion and safeguarding of students' emotions, self-esteem, and sentiments. It should also expand the range of options open to them and recognize their distinctiveness, shared identity, personal traits, and cultural differences. The significance of self-concept rests in its pivotal role in shaping one's character. Inmaculada *et al*. (2022) suggested the creation and execution of intervention programs to support students who are not performing well. These programs should focus on resilience-based strategies to enhance self-concept and ultimately improve achievements in their studies.

Sandeep and Rashmi (2017) proposed that there exists a direct and substantial correlation between the academic self-perception and academic performance of secondary school pupils. The students' favourable self-perception of their abilities and academic aptitude plays a crucial role in their educational success. Their findings underscore the importance played by students' positive feelings about their academic ability, effort and academic interest in their educational program. However, their study did not assess the impact of different teaching methodologies on students' self-concept and their academic achievements in Chemistry. A study investigating the impact of skills related to scientific processes on self-concept in Chemistry found that the Science Process Skills Teaching Approach had a substantial influence on students' self-concept in Chemistry. They contended that the results of their study could offer valuable guidance for developing instructional approaches that seek to improve students' self-perception in Chemistry and contribute to the advancement of how Chemistry is taught in Kenya's secondary schools (Hesbone *et al.*, 2014). Another study by Helen (2017) found out that constructivist method was significant on student's self-concept in Biology. The self-concept of students instructed through the constructivist approach exhibited significantly greater levels compared to pupils instructed through the lecture method. The implementation of constructivist teaching methods resulted in higher academic performance among students in the researcher-developed Biology topics, while also improving students' self-perception.

In their study, Sandeep and Rashmi (2017) determined that focusing just on enhancing students' academic performance without also nurturing their self-efficacy in academic pursuits, the achievement gains may not be sustained. If a teacher focuses solely on developing a learner's belief in their individual academic abilities without also working to improve their actual academic performance, any improvements in self-concept are likely to be temporary. Enhanced academic self-perception will result in improved academic performance, while a positive academic self-perception will lead to higher academic achievement. Teachers should prioritize both the academic self-concept and academic achievement of students. The study proposes that teachers and parents should make efforts to enhance academic performance in order to guarantee enduring and favourable progress in children' scholastic results. Mehmet and Hanifi (2015) concluded from their study that constructivist learning approach makes more significant contribution to learners' achievement than traditional learning methods. Therefore, teachers may use the constructivist learning approach to improve students' academic achievement. Hence prompting the need to investigate the impact of Case Based Learning and Team Based Learning on students' academic performance and self-concept in Chemistry which had not been established in Maara Sub- County.

1.2 Statement of the Problem

The average percentage mean scores of students in Chemistry at the national level and in Maara Sub-County in the Kenya Certificate of Secondary Education have been consistently below between 2009 and 2019. This may be due to students encountering conceptual challenges stemming from how knowledge is acquired in the classroom, along with difficulties in problem-solving. The poor academic performance in Chemistry may be linked to the absence of utilization of cutting-edge methodologies in Chemistry classrooms. This is not different in Maara Sub-County where percentage mean scores in Chemistry in KCSE have been consistently below par for a number of years. The problem could be exemplified by regular teaching methods being employed in Chemistry which are not learner centred. When Chemistry teachers fail to use appropriate teaching strategies in Chemistry, the students may not clearly acquire the Chemistry concepts which may lead to poor performance. According to Liao *et al. (*2020**)** the Case Based-Team Based Learning approach combined with some forms of conventional teaching structure would be a superior way of guiding students' development compared with traditional approaches. However, it is not clear how the CBL and TBL methods would affect the students' academic performance and self-concept in Chemistry. Thus, the objective of this study was to determine the influence of TBL and CBL on students' academic performance and self-perception in Chemistry in Maara Sub-County.

1.3 Purpose of the Study

The purpose of this study was to compare the effects of using the Case Based Learning, Team Based Learning and Regular Teaching Methods on secondary school students' achievement and self-concept in Chemistry in Maara Sub-County, Kenya.

1.4 Objectives of the Study

The specific objectives of the study were:

i To determine whether there was a difference in students' achievement in Chemistry between those exposed to CBL and those exposed to RTM.

ii To determine whether there was a difference in students' achievement in Chemistry between those exposed to TBL and those exposed to RTM.

iii To compare students' differences in chemistry outcomes between students taught using CBL, TBL, and RTM.

iv To find out whether there was a difference in students' Chemistry self-concept between those exposed to CBL and those exposed to RTM.

v To compare the students' Chemistry self-concept between those exposed to TBL and those exposed to RTM.

vi To compare the difference in students' Chemistry self-concept among those exposed to CBL, TBL and those exposed to RTM.

1.5 Hypotheses of Study

The following research hypotheses were formulated and tested at α =0.05 level of significance.

H_O1: There is no statistically significant difference in students' achievement in Chemistry between those taught using CBL and those taught using RTM.

H_O2: There is no statistically significant difference in students' achievement in Chemistry between those taught using TBL and those taught using RTM.

H_O3: There is no statistically significant difference in students' achievement in Chemistry among those taught using CBL, TBL and those taught using RTM.

H_O4: There is no statistically significant difference in students' Chemistry self-concept between those taught using CBL and those taught through RTM.

H_O5: There is no statistically significant difference in students' Chemistry self-concept between those taught using TBL and those taught through RTM.

H_O6: There is no statistically significant difference in students' Chemistry self-concept among those taught using CBL, TBL and those taught using RTM.

1.6 Significance of the Study

The outcomes of the study are important to education quality assurance and standards officers with expansion of knowledge on the effects of CBL and TBL on learning outcomes and self-concept in Chemistry. Enhancing students' performance in their studies and self-perception in Chemistry is crucial for Kenya's vision 2030 goal of achieving industrialization, since Chemistry is essential in the fields of science and technology. It is crucial to revamp the education curriculum by prioritizing the cultivation of character, instilling values, identifying and nurturing talent, and acquiring the knowledge, competencies, and skills necessary for both economic progress and societal change. Vision 2030 mandates the development of a curriculum that incorporates both individual and corporate social responsibility, as well as moral and ethical ideals. It also requires the cultivation of technical and entrepreneurial capacities, proficiencies, abilities, and talents. The curriculum of basic education should be carefully crafted to equip all students with relevant knowledge, skills, competencies, and values. This will enable students to reach their maximum potential, improve their quality of life, make well-informed decisions, and cultivate a lifelong desire for learning. There is need for the education system to produce scientists who will participate in propelling the economy, towards a Kenya that is internationally competitive and economically successful (Republic of Kenya, 2015). Chemistry is a mandatory subject in schools worldwide. A significant proportion of students in educational institutions disregard the study of Chemistry as a result of a lack of enthusiasm and drive, which then leads to subpar academic performance. The majority of teachers often adhere to conventional instructional approaches in educational institutions. The traditional pedagogical approach of teachers serving as the primary disseminators of information to passive students seems antiquated. Scientific principles taught at the secondary level should be based on everyday experiences. Secondary school serves as the foundation for subsequent education and equips students with the necessary skills and knowledge for higher education (Samaresh & Kausik, 2019).

Reforms are necessary in chemistry education at all levels to integrate its historical accomplishments and current capabilities within the broader framework of global growth. This modification would not only serve as a source of motivation for Chemistry students to apply their knowledge, but also contribute to the overall improvement of Chemistry literacy among the general community. Enhanced comprehension will result in heightened recognition of Chemistry's capacity to address forthcoming concerns, rather than solely being perceived as a cause of issues. Significantly, Chemistry plays a crucial role in achieving the Sustainable Development Goals by collaborating closely with other fields to find practical, cost-effective, and sustainable solutions (Stephen *et al*., 2015). The Sustainable Development Goals (SDGs) include objectives such as eradicating poverty in all its forms worldwide, eliminating hunger, achieving food security, improving nutrition, and promoting sustainable agriculture. Other goals include ensuring good health and well-being for people of all ages, providing inclusive and high-quality education for all, ensuring access to affordable, reliable, and sustainable energy for everyone, developing resilient infrastructure, promoting sustainable industrialization and innovation, creating inclusive, safe, and sustainable cities, fostering environmentally friendly development and innovation, establishing inclusive, secure, and sustainable urban areas, encouraging sustainable consumption and production practices, and promptly addressing climate change and its repercussions (MDGs Report, 2015). Masood and Kajal (2021) posit hat employers in today's job market place a major emphasis on effective communication, the ability to collaborate in teams, the skills of problem-solving, increasing content knowledge and the ability to be an independent thinker. As such it is important to encourage learners in a school to learn through teams and collaboration as well as solve related case situations.

One of the goals of education in Kenya is to foster creativity and entrepreneurship in education and training. The core values of the Ministry of Education include among others, integrity, teamwork, excellence and innovativeness and creativity (Ministry of Education, Sessional Paper no. 1 of 2019). Teaching methodologies such as Case Based Learning and Team Based Learning may be important in improving team work and excellence among students in the school and the community at large hence fostering integration. CBL and TBL may also be economical to the teacher regarding oversight, time and resources for students learn as a group. Teacher training colleges and universities may benefit hence train more effective Chemistry teachers capable of using new innovations in teaching. Furthermore, the outcomes of this study may contribute new knowledge into the previous studies to the scholars on the impacts of Case Based Learning, Team Based Learning and Regular Teaching Methods in Chemistry education.

1.7 Scope of the Study

This study was done in Maara Sub County, Kenya because the achievement in Chemistry is below the average percentage mean scores in Kenya Certificate of Secondary Education. The content area covered during this study was a selected topic in Form Two Chemistry syllabus. Salts refer "salt, in chemistry, substance produced by the reaction of an acid with a base. A salt consists of the positive ion (cation) of a base and the negative ion (anion) of an acid. The reaction between an acid and a base is called a neutralization reaction"(*Encyclopedia Britannica | Britannica*, n.d.). Salts are applied in agriculture as fertilizers, in medicine as anti-acid drugs, making of plaster of Paris, making explosives among others. In addition, Form Two students can apply the knowledge acquired in Chemistry at this level in laying a firm foundation for further learning and understanding of Chemistry concepts. Furthermore, the acquired skills in salts are appropriate for chemistry practical in chemistry in higher level of learning. The topics were salts, types of salts, solubility of salts in water, methods of preparing salts, action of heat on salts and uses of salts. The treatment of the study took a period of eight weeks. The study specifically targeted Form Two Chemistry students from three selected co-educational secondary schools in Maara Sub County, Kenya. The schools were selected purposively using a suitable exclusion and inclusion criteria. The total number of students was about 106 from three public co-educational secondary schools in Maara Sub County.

1.8 Assumptions of the Study

In this study the learners were assumed to belong to the same academic ability since they were in the same level and had similar scores in Kenya Certificate of Primary Education. The respondents were assumed to give honest responses indicating their perceptions on Case Based Learning and Team Based Learning regarding the topic of self-concept in the context of learning Chemistry. The Chemistry teachers were assumed to follow the instruction manual to teach Chemistry the way they were trained before they undertook the study by the same researcher. During the study both teachers and the students adhered to the set guidelines that were established.

1.9 Limitations of the Study

The interaction of students during the interschool activities such as sports and games were beyond the researchers' control. Most of the students were day scholars and therefore their interactions outside of the school could not be controlled. These limitations were addressed by ensuring participating schools were from different zones within Maara Sub-County to reduce students' interactions. In addition, the experiment was done during third term of school calendar which ensured less interschool activities hence reducing levels of student interactions.

1.10 Definitions of Terms

Academic Achievement: It refers to standardized test scores and overall academic ability and performance outcomes (Bacon, 2011). In this study it was determined through Chemistry Achievement Tests (CAT) scores.

Case Based Learning: It refers to an educational approach that use case studies as interactive learning instruments. In this study cases studies were used as a learning strategy to teach students Chemistry (Brian *et al*., 2007)

Effect: According to Oxford English Dictionary the term effect is defined as the results of a particular influence. In this study it referred to the results of the influence of CBL and TBL in Chemistry achievement and Chemistry self-concept in students.

Gender: According to Oxford English Dictionary it is the physical and or social condition of being a male or a female. In this study it referred to a boy or a girl in the same classroom environment.

Regular Teaching Methods: Teaching methods is defined as the processes which tend to promote specific strategies of teaching. In this study it involved regular teaching methods that are largely teacher-centred and commonly applied by teachers such as discussion, demonstration or use of lectures in teaching of Chemistry without the use of CBL or TBL (Githua *et al*., 2009).

Self -Concept: According to Sanchez and Roda (2006), self-concept refers to "the collection of information and characteristics that an individual possesses regarding their own identity. In this study self-concept is defined as students' perception of him/herself with respect to achievement in chemistry". The study utilized the students' self-concept questionnaire (SSCQ) to determine the results.

Teaching Strategy: It refers to "the overall way in which the teaching process is organized and executed (Githua *et al.,* 2009). In this study the teaching strategies were the Case Based Learning and Team Based Learning".

Team Based Learning: Michaelsen and Michael (2008) defined Team Based Learning as **"**a set of practices that support one another for a powerful instructional effect. In this study it referred to the use of a sequence of learning activities such as individual test, group work and assessments in teaching Chemistry".

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of the relevant literature on academic performance in the field of Chemistry, self- concept, Case Based Learning, Case study, Team Based Learning, principles of Team Based Learning and structure of team-based learning. The chapter also contains literature on the theoretical and conceptual frameworks for the study.

2.2 Achievement in Chemistry

Academic accomplishment refers to an individual's exceptional performance in a specific academic domain. Academic achievement holds significance since it equips students with the necessary skills and knowledge for their future professions and those aspiring to pursue a career in academia must possess a solid track record of academic achievement (Chinasa *et al*., 2021). Chemistry is an essential subject in the physical sciences, as well as in sectors such as agricultural, biomedical sciences and engineering. The study of Chemistry involves acquiring knowledge of concepts, established principles, laws, and theories, as well as engaging in practical laboratory work. Although Chemistry's significant promise and ongoing efforts to improve how it is taught, the recent academic performance of secondary school learners in the subject has been unsatisfactory. Therefore, to enhance performance, it is important to try more innovative strategies in teaching chemistry.

According to Joje (2019) leading economies in Asia namely: Hong Kong, Japan, Singapore, South Korea and Taiwan have their Chemistry achievement significantly higher than the world's mean achievement. Learners from those countries perform better than is normally performed in the world. These economies value education, provide great effort in reshaping and reforming their science curricula and school systems including Chemistry programs. Chemistry achievement was positively and significantly associated with student's prior achievement which implied that spiral progression in science curriculum could provide effective delivery of the science concepts and skills. Chemistry achievement had positive and significant correlation with home educational resources, science laboratory resources and computer use, availability to references, science experiments, online search, particulate animations and theoretical simulations are essential to improved chemistry instructions as well as enhanced critical and creative thinking. On the other hand, Malaysia and Thailand had average and below average achievements in Chemistry respectively which are attributed to the nature of teaching- learning process since schools have paid attention to lower order thinking skills which are strongly teacher-dominated pedagogy. (Oluwatosin & Bamidele (2014). Similar trend has been reported in Nigeria where the statistics obtained on the performance of candidates in senior secondary whole nation attested to students' underachievement in Chemistry to the utilization of unsuitable or inefficient instructional approaches by Chemistry teacher (Fatokum *et al.*, 2016).

An evaluation on achievement of education attainment some African countries has showed that successive governments of Ghana have made several efforts to improve the standards of learning through infrastructural development at the educational sector among other policy initiatives. Despite the many efforts the standards of high school education still remain low in Ghana. It is significant to note that the trend in Chemistry achievement in Kenya is similar to other countries like Zanzibar, South Africa and Uganda (Affum-Osei *et al.,* 2014). A recent study in Zanzibar showed that the performance in Chemistry is also below average percentage mean scores. There was a better performance in the academic year 2009/2010. Otherwise, poor performance persisted in the subsequent years with mean average scores rarely surpassing 30% clearly indicating that performance in the subject is far below from the normal expected average of 50%. Generally, the observed teaching of Chemistry at these lower Secondary Government Schools in Zanzibar is well fashioned to mainly classroom activities and less laboratory work. A lot of emphasize should be given to chemistry students in African countries by their governments in terms of resources and adoption of innovative teaching strategies among others to improve learner's performance in chemistry (Ochieng *et al*., 2019). Science education is crucial because it is fundamentally important in motivating students to pursue technology vocations that are regarded essential in modern societies for addressing the issues of scientific advancement. Attaining a high level of achievement in science education and fostering favorable attitudes towards science pose a significant challenge for formal education (Paulo et al., 2017). Typically, students' performance in science subjects falls short of what is expected (Olatoye, 2008). According to a report by Olatoye *et al*. (2011), students' performance in Chemistry is inconsistent, despite attempts to enhance their cognitive abilities and personal development in the field of science. There is abundant research evidence to support the view that when Chemistry is taught in an enabling environment, a lot of enjoyable learning takes place, although students' achievement in Chemistry still continue to dwindle (Aderonke *et al*., 2013). Within the context of science, the incorporation of chemistry in the secondary school curriculum is justified by its substantial impact on society (Ogunleye, 1999).

According to Narmadha and Chamundeswari (2013) Science education aims to achieve high standards by engaging in competition with peers, surpassing personal achievements, and generating distinctive contributions in diverse scientific disciplines. The performance of students in Chemistry ought to be high because of the central role it plays in many scientific careers such as medicine and engineering. The high performance in Chemistry can be indicated by high mean scores in the subject. According to other researcher school grades are an effective indicator of academic success as they encompass data on academic performance over a specific duration, derived from sources such as class participation and written exams (Roth *et al.,* 2015). Although there may be other factors that influence achievement in Chemistry, teachers may help students achieve higher mean scores in the Chemistry by using appropriate teaching strategies. It has been suggested that students' academic achievement is a crucial factor to consider when defining and planning educational intervention, both at the national and classroom stages. However, despite the recognition that academic achievement is a multifaceted and multivariate matter influenced by multiple variables, many studies tend to examine each element individually (Ozel *et al*., 2013). There are also indications from research findings that that students' academic achievement plays a significant role in developing or enhancing scientific creativity in Chemistry. Studies have showed a positive correlation between learner's Chemistry scientific creativity and Chemistry academic achievement. Educational institutions should strive to improve students' academic achievement in Chemistry in Chemistry (Kamonjo *et al*., 2015).

According to Marissa and Elizabeth (2014) on an evaluation of performance in Chemistry in South Africa students performed poorly in the subject when various concepts were analyzed. The study highlighted that there is a general agreement in the academic literature that these challenges in studying Chemistry are prevalent among students from various nations, including those in the final year (Grade 12) of the South African Secondary Schools system. The causes of the poor achievement have been ascribed among other things not only due to poor school management, but more prevalently to poor teacher preparation and thus poor understanding of content by teachers. Amir and Habiba (2016) reported similar poor performances in Chemistry as compared to other sciences in Uganda. The major challenge facing science educators in Uganda is the poor achievement in science subjects among secondary school students. Among the three sciences, Physics was best performed while Chemistry was least performed in year

2011. However, though Chemistry was not lowest performed science in year 2012 and year 2013, the percentage mean scores are below average. This implies that Chemistry teachers ought to address the factors that lead to this low performance. The performances in sciences for Uganda are not in any way different from Kenya situation where performances are also below 50 %.

2.3 Self-Concept in Chemistry

According to Majere (2013) academic self-concept pertains to an individual's self-perception of their own competence and value in an academic setting, based on their abilities and accomplishments in school. Self-confidence, effort, and self-perception of students are all determinants that influence their self-concept in a certain academic area. Academic self-concept refers to the cognitive and psychological representation of a self-perception of an individual as it pertains to their academic abilities and performance. According to Viviane and Amanda (2021) "accessing the students' chemistry self-concept can be a means to understand their performances in the face of the educational content. How a subject perceives his or her ability to learn the content can positively and negatively impact his or her relationship with that content and, consequently, impact his or her performance". The authors further explain that the "the chemistry self-concept can be conceived as a generalization of the subject's confidence when exercising the student's role to learn the content, that is, his or her confidence to learn chemistry". This construct encompasses a structured system of beliefs, including perceptions of the content's significance in an individual's life, the reasoning methods employed, and the affective and behavioural relationships with the content, among other factors. The aforementioned research highlights the crucial role self-concept can play in students' academic success or failure. Students' self-perception, which is shaped throughout their educational journey, can significantly influence future opportunities, such as career choices. Sánchez and Rhoda (2006) define self-concept as the collection of knowledge and attributes that an individual possesses about themselves. It is the perception and understanding that a person has of their own identity, including the characteristics and qualities they use to identify themselves. In experimental investigations, social interaction typically occurs between students and their teacher, as well as among the students themselves. Hence, it is crucial to take into account a moderating variable such as self-concept, which has the potential to impact students' engagement and participation within the classroom setting.

Self-concept is a variable that can be improved in students through the deliberate efforts of a teacher and a counsellor (Olatoye *et al*., 2011). Michael and Nicol (2020) posited that Self-concept is created throughout life, especially in social interactions. Its important components are social comparisons and feedback that the child receives especially in the family background. The issue of self-concept is proving to be currently a highly recognized paradigm in relation to school, and later academic and life success. Every child who enters compulsory school attendance is a specific personality. Children come from a certain social environment, with certain preconditions and dispositions. Since childhood, individuals are affected by various influences and a healthy self-concept is the result of various processes, often due to the social environment influence can help the child to form a healthy self-concept, which is important for the further growth and development of social, work, emotional, intellectual and moral abilities. It is important to strengthen especially parenting and pedagogical competencies in terms of strengthening the positive self-concept of the pupils.

Cognitive capabilities are often given primary importance by schools and society when determining school curricula or assessing pupils' achievements or shortcomings (Kahveci, 2015). Researchers should prioritize the investigation of the influence of self-concept on the acquisition of knowledge in the field of Chemistry. Research has substantiated the significance of accomplishment motivation and academic self-concept. It has also provided valuable insights and recommendations to education stakeholders on how to assist students in boosting their motivation and self-concept, hence enhancing their academic performance. A strong and meaningful correlation existed between the student's self-concept and their academic accomplishment. Students with a strong self-concept had outstanding achievements on the mathematics achievement test and had ambitions to be accepted into higher educational institutions. The study recommended that academic counsellors should organize guidance programs periodically for high school students to be equipped with needed skills to enhance their self-concepts (Affum-Osei *et al*., 2014). Johannis and Anderson (2020) propose that individual self-concepts can be developed through group interactions. Teachers have the ability to cultivate an environment and perception among pupils regarding their own self-concepts, which can be either positive or negative. Competent educators should possess the ability to cultivate a favourable self-perception in pupils by demonstrating respect for their viewpoints, offering avenues for inquiry, stimulating intellectual debate among students, and delivering commendation using language that encourages learning.

When students optimistic attitude on both self-concept in Chemistry and in their academic capabilities, they are in a position to effectively solve problems in a discussion group. Four indicators can be utilized to analyse students' self-concept in relation to the utilization of mobile learning media. These indicators include the Chemistry self-concept indicator, which is influenced by group learning. In this context, the effectiveness of the discussion process plays a crucial role. It is observed that students who interact with peers possessing a high Chemistry self-concept tend to have lower self-concept in this subject. The development of indicators for academic capability self-concept is facilitated by the use of mobile learning media, specifically through test simulations. These simulations are beneficial in training students' comprehension of non-electrolyte and redox solution materials. By frequently practicing with these test simulations on mobile learning platforms, students can improve their Chemistry grades (Ucu et al., 2019). Based on the findings of previous studies, the inquiry-based science teaching strategy has a major impact on students' self-concept, which is one of the learning outcomes. This approach allows students to independently engage in activities, leading to the development of inner confidence in their learning abilities. The majority of students expressed confidence in their ability to learn and indicated a willingness to engage in more reading on topics that they found challenging. The inquiry-based science teaching technique fostered a strong desire in the students to participate in the various activities associated with this approach, as they found them both captivating and compelling. An educational setting that fosters critical thinking skills, provides satisfaction, and enhances students' self-concept was found to be beneficial (Gathege *et al*., 2021).

Some studies have found that learners' self-concept remained consistently strong and steady, whereas their interest levels were initially low but experienced a significant rise during the lower-secondary school stages. Nevertheless, there was no correlation between interest and self-concept when it came to predicting students' science desired outcomes (Jingoo *et al*., 2021). According to Rodell (2019), there is a direct correlation between students' problem-solving achievement and their academic self-concept. A direct relationship exists between a student's academic self-concept and their ability to solve problems. In other words, the greater a student's self-concept of their academic abilities, the higher their problem-solving skills tend to be. Accordingly, their problem-solving achievement goes hand in hand on the extent of their used learning strategies rather than their beliefs and thoughts. The teachers should introduce and develop effective instruction and strategies that will improve the students learning capacity and ability to deal with different solving problems. A strong self-concept in academics and effective usage of learning strategies in solving mathematical problems lead to high problem-solving achievement. As the utilization of techniques increases, so does the level of problem-solving achievement experienced by learners. Olatoye (2008) argued that student attributes that are subject to modification through training and exposure to counselling can significantly contribute to improving students' academic performance. It may be significant for the researchers to investigate whether innovative teaching strategies may be effective in enhancing the self- concept of learners in chemistry. An essential endeavour in increasing the students pursuing science and ensuring their continued engagement in scientific disciplines is to appreciate the aspects that influence students' self-perception in science, as evidenced by previous studies. The findings of a Structural Equation Model (SEM) indicated that among the factors considered in the model, being taught by enthusiastic science teachers during high school was the primary determinant of science self-concept for a group of science students. Additionally, the presence of peers who hold science in high regard was also found to be significant. Science-related resources and parental attitudes towards science did not have a significant impact on scientific self-concept. However, the number of generations in the family was positively correlated with science self-concept. According to Steven *et al*. (2020), students who identified themselves as male had elevated levels of science self-concept, even when considering social and cultural elements in our theoretical framework.

Sanjeev (2016) posits that an individual's self-concept serves as a driving force behind their behaviour. The self-concept is the primary component of the personality pattern. It influences how individuals react to people and situations and ultimately shapes the quality of their behaviour. Self-concept is the alignment of the collection of the most individualized interpretations that a person assigns to himself, which they consider to be of utmost importance. Rogers (1951) proposed that self-concept comprises three distinct components: Self-image is how we see ourselves, which may not always align with objective fact. Individuals with anorexia nervosa, despite being slim, may possess a distorted self-image where they perceive themselves as overweight. Various influences, such as parental influence, friends, and the media, can significantly impact an individual's image. This encompasses how we perceive ourselves, including notions of goodness, badness, beauty, ugliness, and the like. Secondly, self-esteem or self-worth which is a degree of evaluation which could be either positive or negative. Third, ideal self refers to the image or concept of oneself that may not align with the reality of one's life and experiences. It represents what a person aspires to be, their objectives, or their ambitions. A study conducted by Oluwatosin and Bamidele (2014) found that a significant number of students studying Chemistry possessed a moderate to high level of self-concept. The findings also demonstrated a correlation between self-concept and academic performance in the field of Chemistry. Chemistry students demonstrated self-efficacy demonstrating confidence in their ability to excel in the subject. The student's lack of proficiency in the subject may not be due to their sense of its difficulty, but rather to pedagogical reasons. Science teachers should consistently assess their students' self-confidence levels through suitable teaching and learning methods to attain the intended educational results. Having a positive self-concept of their Chemistry skills indicates that pupils would be encouraged to persevere and achieve success, regardless of any challenges they may encounter. A student with limited conceptual understanding would likely have a tendency to quickly give up when faced with challenging scientific tasks. Another discovery of this study revealed that there was no notable disparity between genders. The knowledge on self-concept is vital for counsellors and educators in fostering and advancing the cultivation of a positive self-concept in students, particularly in relation to aligning their career aspirations with science-oriented subjects. The studies clearly indicate that female students are equally capable as their male counterparts in Chemistry. The disparity in performance is solely attributed to one's self-perception of their ability to succeed in the task. Additionally, this study highlights the variation in students' self-concept based on the type of school they attend. The school setting and facilities can significantly boost an individual's self-assurance in their capacity to excel in academic tasks, particularly in science topics that heavily rely on laboratory work. When these amenities are accessible, pupils may feel hopeful and confident, believing that achieving success is attainable. The study indicates a positive correlation between students' self-concept and their chemistry achievement. Therefore, improving a student's self-concept is likely to result in better performance in Chemistry, independent of gender differences. Science professors and school counsellors should help pupils cultivate a positive self-concept towards their courses, particularly Chemistry.

Sanjeev (2016) defines self-concept as a complex system of beliefs and perceptions about oneself, with self-consistency and self-enhancement being key components of this construct. This hypothesis posits that the perception of oneself in a positive light is widely seen as beneficial for one's overall well-being. The notion of self-concept comprises three primary elements: perceptual, intellectual, and attitudinal. The perceptual component is sometimes referred to as the physical self-concept. It encompasses the individual's perception of their physical appearance and the impact they have on others. The conceptual component, also known as the psychological self-concept, consists of qualities related to life adjustment, such as honesty, self-confidence, independence, courage, and their corresponding opposites. It refers to an individual's subjective understanding of their unique qualities, skills and limitations, as well as their personal history and heritage, and their outlook on the future. Attitudinal components encompass an individual's self-perception, attitude towards their current situation and future prospects, feelings of self-worth, self-esteem, pride, shame, as well as their views, convictions, values, ambitions, aspirations, and commitments. According to Marsh and Martin (2011), self-concept refers to an individual's conviction about their talents in specific areas. Students assess their competence in a particular subject, such as Chemistry, by evaluating their previous achievements in that field. The correlation of self-concept and cognitive domains is regarded as one of the most significant qualities. Chemistry has a positive correlation with student achievement, as stated by Nieswandt (2007). The relationship between self-concept and accomplishment has been demonstrated (Marsh *et al*., 2005). While the notion of self has been frequently examined in educational psychology research across many student age groups, its exploration in the context of Chemistry education literature has been rather limited, particularly in relation to high school pupils (Sara & Ellen, 2015). Academic self-concept refers to a student's assessment of their own academic talents. Different empirical studies have discovered significant disparities between pupils who possess a strong academic self-concept and those who have a weak academic self-concept. Students that possess a strong academic self-concept value their own capabilities, embrace challenges, are willing to take risks, and are open to trying new experiences (Gabriella *et al*., 2014).

Evaluating students' self-concept in Chemistry can provide insights into their performance with educational content (Melo & Amantes, 2021). Thus, students' perceptions of their ability to learn can significantly affect their relationship with the subject, either positively or negatively. Chemistry self-concept can be seen as a reflection of students' overall confidence in their ability to learn the subject, encompassing their belief in their ability to understand and engage with Chemistry. Self-concept represents an organized system of beliefs, including ideas about the content's importance, reasoning methods used, and affective and behavioral relationships with the subject. This highlights the critical role self-concept can play in students' academic success or failure. Self-perception, formed during the schooling process, can be pivotal in shaping future opportunities, such as career choices. Being aware of their self-concept can help students overcome learning obstacles and develop strategies to improve performance (Viviane & Amanda, 2021). According to Shalveson and Rogers (1981) the improvement of learners' self-concept is highly regarded as an objective of education. The researchers propose that self-concept can be more precisely characterized by three crucial attributes. Firstly, the information is systematically organized or structured by individuals who classify and establish relationships between various groups. Secondly, it is characterized by multiple aspects that correspond to the classification system chosen by an individual or embraced by a collective. Thirdly, it follows a hierarchical structure where impressions of conduct at the lowest level lead to judgments about oneself in certain academic subjects (such as chemistry, English, and history), followed by non-academic areas, and finally, to one's overall self-concept. Furthermore, self-concept encompasses both a descriptive and evaluating aspect, where individuals can provide descriptions of themselves (e.g., "I am happy") and evaluate their own abilities (e.g., "I perform well in school"). It is important to note that self-concept is distinct from other conceptions, such as academic accomplishment. Shalveson and Rogers (1981) affirm that the structure of self –concept has four dimensions as shown in figure 1.

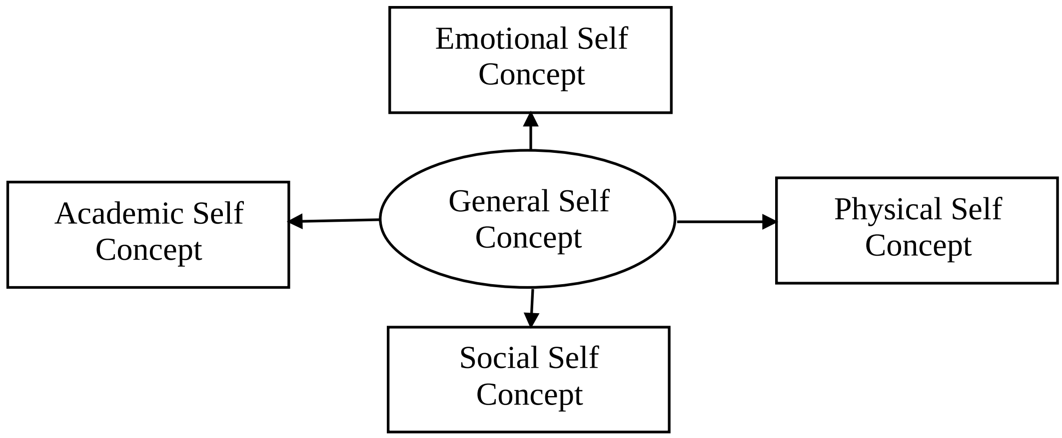


Figure 1: The Structure of Self-Concept (Shavelson & Rogers, 1981).

Figure 1 illustrates that the overall self-concept encompasses various dimensions, including academic, social, emotional, and physical self-concept. Academic self-concept pertains to an individual's view of their academic ability in a specific academic domain (Lawrence *et al.,* 2013). Whilst research on students' self-concept is valuable, there is lack of sufficient research that focuses on academic self- concept in Chemistry in Maara Sub County, Kenya. Psychologists have recognized the significance of self-concept in an individual's personal adaptation, while educators are increasingly recognizing that students' self-perceptions can greatly impact their academic achievement in school (Joyce & Shirley, 2007). The structure of students' "self-concept" is defined by integrating cognitive, emotional, and behavioral elements. The cognitive component include beliefs and thoughts regarding one's identity as an individual. Self-esteem and value orientations are part of the affective component. The behavioural component consists of educational and professional motivation, as well as personal and professional aspirations. During the process of learning, personal and professional motivations converge, and these are most evident in the cultivation of crucial attributes that are needed for the future specialist. The motivation of educational activity can be categorized into two distinct categories of motives: the primary ones, which drive the main dynamics of motivation in educational activity, and the secondary ones, which have a lesser representation and are relatively stable. As learning advances, the significance of cognitive and professional incentives grows. The findings indicated that the students' personal assets are directly influenced by their self-perception, self-worth, and their "Self-concept". To achieve success in various aspects of life, a student must possess certain personal attributes, including sufficient self-esteem, a strong self-image, determination, emotional depth, and efficient interpersonal skills. To attain successful professional self-actualization, individuals must possess personal attributes and skills that enable social and professional advancement, flexibility, and the ability to adapt effectively to societal transformations (Berik *et al*., 2021).

Julia and Jelena (2019) argue that academic self-concepts of ability play a crucial role in fostering education and learning throughout students' academic journey. However, there is limited knowledge regarding the composition and alterations in their composition when pupils transition from high school to encounter unfamiliar academic challenges. The results confirm the belief that there are multiple dimensions (i.e., separate self-concepts) and a hierarchical structure with a general self-concept for a certain field of study at the highest level. Indicating both subject-specific and discipline-specific questions, specifying a method factor for generic field-of-study-specific self-concept was most congruent with theoretical assumptions. The structural model remained unchanged during the initial months. The formation of general field-of-study-specific self-concept and subject-specific self-concepts occurred separately and without much influence from each other. The findings highlight the proposed understanding of generic self-concept as a factor that represents the hierarchical structure of self-concept. Self-concepts remained consistent in their structure over time. Multiple notable horizontal effects indicate that students closely harmonize their self-concepts with the curriculum they encounter in educational settings. As a result, they may benefit from receiving abundant feedback on their performance to develop suitable subject-specific self-concepts.

Understanding how self-image shapes behaviour and growth allows educators to actively incorporate strategies that boost students' self-concept in all their interactions (Louise, 2011). The significance of self- concept in students and performance in Chemistry is vital and therefore it is necessary to find out whether Chemistry self- concept in students can be enhanced by using appropriate teaching strategies. The academic self-concept has a favourable impact on academic achievement, indicating that it can be used as a predictor of academic success. Academic self-concept can impact students' choice of learning strategies and also contribute to their academic success. There is limited research on the connection between academic self-concept and learning methods. However, it is important to extensively study the impact of academic self-concept on learning strategies in order to enhance students' academic performance (Bryan *et al*., 2014). The researchers found that students who have a positive view of themselves as learners are more likely to prefer a deep learning approach, which involves critical thinking and self-reflection. This deeper learning style is important because it helps students build confidence, improve their learning abilities, and achieve better academic results.

According to María and Pegalajar (2017), the school years are essential in shaping the self-concept of students. This is because during this period, learners develop a heightened consciousness of their academic accomplishments, their social standing among their peers, and the reactions of their teachers towards their behaviour, attitudes, achievements, and setbacks.. Research has indicated that the deep approach to learning does not appear to have a substantial positive impact on academic performance. Students that choose a deep approach to learning often dedicate a significant amount of time to thoroughly investigating and immersing themselves in the fundamental features of subjects in order to establish a strong academic foundation. As a result, they generally lack proficiency in the technical components that are crucial for achieving good scores in exams. This indicates that the deficiency in academic accomplishment is attributed to the reliance on exam scores as the main measure to assess performance. The findings of their study also demonstrated a positive correlation between academic self-concept and both the strategic approach and academic accomplishment (Bryan *et al*., 2014). In his study, Jong (2005) discovered that constructivist teaching does not effectively enhance student self-concept or bring about general changes in student learning strategies. However, it does have some impact on motivating students to learn academic tasks, albeit with the side effects of causing anxiety during the learning process and promoting selfmonitoring specifically for test preparation. However, students exhibit a preference for a classroom atmosphere that follows the principles of constructivist teaching. The current study sought to find out whether Case Bases Learning and Team Based Learning would influence the self- concept of students in chemistry.

2.4 Regular Teaching Methods in Chemistry

A teaching method refers to a way a teacher uses to bring about desirable changes in behaviour of a learner. Caliskan (2004) asserts that technique plays a vital role in science education. The conventional instructional techniques employed in Chemistry education at numerous institutions pose a significant obstacle to attaining success in the subject. This is mostly due to their limited efficacy in enhancing students' comprehension and long-term retention of crucial topics. These strategies are not conducive to promoting critical and creative thinking (Akpoghol *et al*., 2016). Historically, learning has been perceived as a monotonous task, where pupils just mimic and reproduce newly acquired information during assessments. Conventional teaching approaches instil in students the perception that they lack interest in specific topic areas (Helen, 2017). The most commonly used methods of transmission in classroom are lecture, narrations and demonstration. A lecture is an instructional technique where an engaged teacher imparts material to relatively learners who listen passively and attentively and write down notes (Githua *et al*., 2009). According to researchers, the lecture style continues to be widely used by instructors, trainers, and speakers as a means of conveying information and ideas. According to Snezano *et al*. (2011), the quality of a lecture can vary based on the level of participation from the audience and the presenter's delivery style and clarity. This variability can result in lectures that are either instructive, uninteresting, or overwhelming.

According to Monica *et al*. (2004), students who engage in 'surface' learning tend to memorize information without fully understanding it, with the goal of simply duplicating it. Conversely, students who actively participate in 'deep' learning strive to comprehend the significance of the material they are studying and connect it to their prior knowledge and personal experiences. According to research critique have been raised against lectures. Here are assertions that during lectures, students frequently exhibit passivity, resulting in a drop in their attention and a higher likelihood of fast forgetting the information presented. Furthermore, lectures are predicated on the assumption that all students possess an equal level of comprehension, progress at an identical rate, and exhibit identical learning preferences

(Marlies *et al*., 2012). Some scientists have contended that despite the existence of various teaching methods, students continue to learn in a passive manner by just following the traditional approach of doing what the teacher instructs (Chin-Hsiang *et al*., 2015).

Regular teaching methods are inefficient in improving student's performance and therefore teachers need to employ other superior teaching strategies which may be more useful in enhancing learning. According to Jasmin *et al*. (2017), rather than actively engaging students in the learning process, the conventional teaching approach positions the teacher at the centre, with little to no integration of horizontal and vertical subject matter. The conventional method used to teach Chemistry often oversimplifies the subject and does not align with the latest scientific models. A key goal of teaching Chemistry is to empower students to apply their knowledge to scientific investigations and connect it to current issues like vaccines, incurable diseases, and power supply during natural disasters. Science education should aim to develop inquisitive individuals who critically analyse the world around them and evaluate ideas. The primary objective of science teaching is to ensure that learners have a solid grasp of concepts and the ability to apply this knowledge to new situations. By fostering scientific inquiry, students are encouraged to approach problems with an open-minded quest for answers, utilizing their highest cognitive abilities and engaging their full range of cognitive skills (Francis & Mabel, 2015).

The regular teaching methods encompass a variety of approaches employed by educators to deliver lessons, typically with a focus on the teacher's role. Common examples include the lecture approach and the chalk and talk method. The lecture method is a pedagogical strategy in which the teacher assumes the role of an authoritative figure, imparting knowledge to students who have minimal or no active participation in the learning process. Adegoke (2011) has criticized the lecture format, arguing that it mainly benefits hardworking learners. In Nigeria, the classrooms predominantly employ traditional teaching approaches that do not foster student-student interactions. The known fact is that it is efficient for instructing a substantial number of students, resulting in significant time savings and requiring less skills in the process. Another crucial reason that drives teachers to follow the standard teaching approach of an institution is the duration of the session and the excessive amount of subject matter content. To manage the perceived overloaded curriculum, using a traditional teaching method becomes the simplest approach. The regular teaching methods as teacher centred approaches contribute to the apathy of students sometimes results in poor academic accomplishment. The issue of poor academic achievement in science appears to be the primary area of concern in contemporary scientific education research. The majority of researchers are focused on discovering a solution to the persistent issue of students' underperformance in science, including Chemistry. Regular teaching methods do not encourage student-material interaction (Fatokom *et al.,* 2016). Additionally, it obstructs the progress of activities aimed at cultivating scientific reasoning and skill development. Chemistry education should incorporate contemporary concepts and advancements, particularly in the present era where young people acquire knowledge through mobile devices and computers. Chemistry education should be enriched with hands-on activities as alone instructing the basic principles in the classroom may not suffice to attain the appropriate level of proficiency in these ideas. Another common method used in teaching students is discussion. The discussion technique is a systematic approach to teaching specific parts of a subject in order to achieve desired outcomes. This strategy is particularly appropriate for topics that are very contested and challenging. The strategy employs guided interaction to facilitate the participants' engagement (Vighnarajah *et al*., 2008). In addition to its time-consuming nature, the constructivist method promotes learning by allowing learners to cultivate their communication abilities, as well as mental skills such as critical thinking, reflective thinking, and the evaluation of multiple perspectives (Jeyede, 2010). Research conducted over time has consistently demonstrated that the implementation of effective instructional models greatly enhances the learning process. Students instructed using the constructivist approach demonstrate a greater sense of self-concept compared to those instructed using the lecture method. The primary responsibility of instructors is to provide a conducive environment that promotes learning and the creation of knowledge. The constructivist perspective views education as a process that occurs naturally and is driven by the individual. According to this viewpoint, education is not solely dependent on what the instructor imparts, but rather on the experiences that individuals have within their environment (Hellen, 2017).

A study conducted by Efe (2015) revealed that there were variations in the performance of secondary school learners when they were taught using the discussion approach as opposed to the lecture method. The learners’ excelling in the lecture group was inferior to that of the discussion technique, since they had difficulty in comprehending the selected concepts. Male students demonstrated a notably higher level of performance compared to their female counterparts when instructed using a combination of both discussion and lecture techniques. It is advisable to prevent secondary school teachers from relying heavily on the lecture style when teaching Chemistry, as this approach has been found to negatively impact students' performance in the subject. Discussion was used in the present study as a useful technique in experimental groups. At present times it is imperative to structure the learning environments in student-centred and democratic methods to facilitate the multifaceted growth of students. The regular teaching methods are applied in educational settings where students just memorize knowledge without engaging in critical thinking or conducting research, which can lead to adverse outcomes. A number of the issues associated with this type of learning environment is that the acquired knowledge is not retained in the long term, but rather memorized temporarily for exams and is prone to being lost easily (Agogo & Naakaa, 2014).

2.5 Case Based Learning

Case-based learning involves teaching learners concepts by presenting them with specific cases as illustrations. Case Based Learning entails the utilization of a real-life event, known as a case, together with accompanying study questions. This approach enables students to engage in meaningful discussions and share their thoughts. Cases consist of two primary components: the case scenario and the corresponding questions pertaining to the scenario (Yalcinkaya *et al*., 2012). Several Research has demonstrated that Case Based Learning is effective in student learning in a number of variables such as motivation and attitudes and academic achievement. Researchers have indicated that Case-based learning in science is a highly successful method for students to acquire knowledge about biological processes within meaningful real-world contexts, leading to substantial learning outcomes. (Brian *et al*., 2007). A study conducted by Mohammad *et al*. (2021) indicated that the utilization of the Case Based Learning method yielded positive outcomes in terms of improving learners perceived problem-solving abilities and motivation to learn. According to their study, there was a notable disparity in the alterations of the overall average score of perceived problem-solving capability and its individual components at the three measurement intervals: before lectures (pre-test), after lectures (mid-term test), and after Case Based Learning (final test). Following the implementation of the Case Based Learning intervention, a significant difference was observed between the Lecture Based Learning and Case Based Learning groups in terms of the students' total learning motivation score and its specific components. Logan *et al*. (2022) assert that science students must employ the knowledge they have gained in practical situations relevant to their future professions.

According to Michèle *et al*., (2009) key elements of success is to adopt Case-based teaching scenarios which adopts small students groups that allow interaction, focussed feedback and engagement. Logan *et al*. (2022) determined the implications of Case Based and Lecture Based teaching approaches regarding the accomplishments of learners and how it is assessed the views of learners on these methods in a senior dairy cow management course. Case-based teaching techniques exhibited a propensity to enhance the alteration in multiple-choice quiz results. There was no significant difference in the change in total quiz scores and the change in short-answer quiz scores between the Case Based and Lecture Based groups. Students found the teaching style that utilized cases more enjoyable compared to the lecture-based method. However, they still preferred to initially absorb material through lectures. Students expressed a preference for engaging in peer discussions during the learning process. Therefore, incorporating small peer discussion groups into Case Based techniques could enhance student satisfaction. Prospective educators should contemplate integrating pedagogical strategies that address students' preference for real-time engagement with both the teacher and their peers, while also evaluating the effectiveness of Case Based teaching approaches.

In another study Sendur (2012) investigated the effects of Case Based Learning on freshmen students' Chemistry achievement and the results showed that the experimental academic achievement was higher when Case Based Learning was used than in the control group although his study did not involve academic self- concept in Chemistry. Bennet (2010) states that engaging in case analysis tasks enhances learners' awareness, while discussions and reflections play crucial roles in fostering their understanding. Many studies regarding students' achievements and motivation in science have been done but less attention has been given on students' self –concept and achievement. Based on the recent research findings, Case Based Learning approach can be a useful strategy in enhancing students' understanding of Chemistry concepts. Kantar and Massouh (2015) emphasized that in a Case Based Learning classroom, students must go through the case, try to master the details, develop a supporting analysis and come up with solution. Students should engage in a dynamic discussion, interact and cooperate with fellow colleges, whereas the educator facilities their learning. Research findings indicate that incorporating case-based learning in education allows students to engage with real-life scenarios and promotes greater interaction between instructors and students. Exposing learners to genuine situations rather than hypothetical challenges enhances their critical thinking and analytical skills. According to the academic literature, there is a lack of research on the effects of case-based learning on student engagement, motivation, and performance, despite its widespread use in teaching strategies. Furthermore, previous research have been inadequate in elucidating the effects of implementing the Case Based Learning strategy on student engagement, academic performance, and learning motivation in the curriculum (Syed *et al*., 2019).

Research cases provide students with the opportunity to apply their theoretical knowledge to practical circumstances in a supportive setting, without having to worry about the consequences of their actions. Additionally, they have been discovered to enhance students' abilities in critical thinking, problem-solving, higher-order thinking, conceptual shift, and their motivation to acquire knowledge. Their findings additionally indicate that students had a generally favorable disposition towards the utilization of case studies. The survey findings offer evidence that Case Based Learning can be advantageous for students by actively involving them and demonstrating the practical application and relevance to the actual world (Yadav *et al*., 2014). According to Julie and Kathrine (2010) the case study method engages students in analyzing, evaluating, conceptualizing, and discussing applications. Holkeboer (1993) affirm that when students work with case studies, a three-step critical-thinking process develops wherein students identify a core problem, brainstorm possible solutions, and agree on the best solution. Aylin and Omer (2016) argued that in the Case Based Learning Students collaborate with their peers in a group setting to analyze the case and deliberate on the solutions to the questions pertaining to the case. Subsequently, all students in the class discuss the case to determine the answers to the questions. When using Case Based Learning instruction, students' preconceptions can be changed by incorporating real-life cases. According to Douglas (2013) Case Based Learning aids in developing thinking skills and comprehension of the fundamental principles of science, surpassing the traditional conceptual material. As student work on cases, they typically exercise and hone skills in research, analysis, interpretation and creative thinking. Students may also reflect explicitly on their experiences and thereby deepen their understanding of scientific practice. The cases that contextualize knowledge may be drawn from real life or may be imaginatively assembled for an educational context. Constructed cases may be created to fit particular needs. They may be as simple or complex as one wants. They may be freely edited and streamlined to highlight key concepts or learning aims.

Case Based Learning enhances students' learning motivation by increasing their interest and promoting self-regulated learning, ultimately resulting in improved learning achievement. Case-based content should be created to facilitate student self-contribution and promote active learning. The notable discoveries regarding the utilization of Case Based Learning and its influence on student engagement indicate that instructors should select a suitable case and provide guidance to students in analyzing their situation, drawing on their learning. In addition, instructors should encourage active participation from students through the submission of suggestions, questions, and action plans (Syed *et al*., 2019). In their study, Kusumantoro *et al*. (2022) examined the efficacy of case-based learning in increasing learners' motivation and academic performance in the field of chemistry. They also contrasted this approach with the conventional lecture-style method of delivering knowledge. Their research determined that the implementation of case-based learning led to notable improvements in the motivation of students enrolled pursuing chemistry subject. Students that were exposed to case-based learning had higher levels of motivation towards the subject of chemistry in comparison to their peers who did not have the same learning experience. By establishing connections between real-world events, conditions, and activities and the concepts taught, students develop a deeper understanding and value for chemistry in their personal lives and future careers. The students' initial perception of chemistry as too theoretical eventually transforms into a heightened sense of curiosity, enthusiasm, and attentiveness during the sessions, thereby fostering a genuine passion for understanding chemistry. Case-based instruction enhances how students excel in chemistry; students who received case-based instruction achieved higher results compared to those who were taught using the lecture method. It fosters the development of critical thinking skills and enhances comprehension, while also increasing motivation and cultivating good attitudes, resulting in improved learning outcomes. Hence, case-based instruction seems to be a highly effective approach for improving the motivation and academic performance of students in the field of chemistry.

Sendur (2012) put the following as the considerations for good cases: cases should be short; tell a story; are related to current problems relevant to students and have related questions at the end. There are two possible approaches: either cases can be developed first and then questions can be asked, or questions can be asked first and then cases can be developed to answer these questions. After each case, students are provided with study questions that allow them to evaluate the results, ideas, and topics of the inquiry. The study questions were designed to guide learners in enhancing their comprehension, as opposed to solely focusing on memorizing names, dates, or labels, while assessing the data and proposing answers. The study questions, together with the cases, enhance class discussion. Some researchers have suggested from their studies that Case-based learning enhances subject retention, enhances student engagement, and boosts student attendance (Hoag *et al*., 2005). Kusumantoro *et al. (*2022) posited that learning is designed as a way of enhancing learners' engagement in the learning journey by presenting real problems to be solved by students. The assessment results by experts show that the interactive e-module based on the case method is feasible to use in the learning process. The results of statistical tests showed that there was a significant difference in the average student learning motivation between the experimental and control classes. Thus, the case-based interactive e-module has been confirmed to be effective in teaching Microeconomics and can be developed for other courses.

Case Based Learning integrates elements from both the cognitive and social constructivist models of teaching and learning by highlighting the active and interactive aspects of the learning process (Joseph, 2010). Cobb (1996) posited that learners engage in cognitive constructivism by personally constructing information through reflective thinking and conceptual analysis. Simultaneously, they also participate in social constructivism by sharing knowledge through enlightened classroom debate. This is the reason why in Case Based Learning classroom, groups' formation as well as discussions within the groups are encouraged. Fasko (2001) argued that cases are advantageous for teachers as students are fond of narratives. However, teachers must exercise caution to prevent the loss of control over the intended transformation of the desired objective of the case. Various applications of cases can enhance the interactivity of the classroom setting. Implementing Case Based Learning education in the Chemistry subject has the potential to improve students' progress in Chemistry. Case Based Learning involves utilizing real-life scenarios and tales to facilitate students' learning by encouraging active engagement in instruction.

Suvarna and Singh (2014) found out that Case Based Learning had significant positive impact and is superior to traditional lecture format with regards to attaining learning objectives, comprehending course content, and retaining information of information. There were several positive outcomes like improved learning skills, independent learning abilities, analytical skills etc. indicating that Case Based Learning is an efficient technique in a large classroom setting than didactic lecture. In his study, Herreid (1997) observed that Case Based Learning shares certain similarities and distinctions with problem-based learning, scenario-based instruction, narrative-based instruction, and context-based learning. Case Based Learning and problem-based learning share similarities and distinctions. They both utilize an inductive method, but they are not identical. An issue is a specific instance or situation that presents difficulties or challenges, while a case refers to a general situation or scenario that may or may not have difficulties or challenges. A case refers to a narrative that conveys a message for learning purposes, such as a dialogue, newspaper excerpt, or a courtroom scenario. A case might also be as intricate as a problem that necessitates extended periods of time to explore.

2.6 Case Studies in Chemistry

Inna (2011) states that case studies are derived from actual scenarios and serve as powerful pedagogical tools that foster active learning, stimulate the development of critical thinking abilities, facilitate student-centered education, and aid in issue resolution, analysis, and problem identification. Case studies are employed as instructional tools for students studying nursing, health care, law, business, and social science. They provide advantages for both students and teachers. The literature and research studies clearly demonstrate the cultivation of critical thinking abilities through the utilization of case studies as a pedagogical approach. According to Herreid (1994), a case study consists of a captivating or contentious narrative, typically including a predicament that necessitates a fundamental comprehension of scientific principles. Teachers can employ case studies by initiating class discussions with open-ended questions that have clear and concise answers. Although this approach may pose challenges, students are able to respond to the question and engage in subsequent discussions, ultimately leading to the creation of a tangible outcome. During the implementation of Case-Based Learning, teachers form small groups of students who collaboratively analyze and understand a given case. Subsequently, the students independently solve questions pertaining to the case. Other researchers have argued that there are eight characteristics of excellent cases: Focus, thoroughness (providing enough narrative and data to address the questions), clarity and brevity (organized and targeted detail), engagement, controversy (depth of conflict and issues), complexity (multi-layered dilemmas without clear solutions), robustness (demanding analysis, rigor, and well-supported assumptions), and intellectual richness (offering opportunities for insights and discovery) (Austin *et al*., 2015).

Zafar and Ismail (2018) asserted that Case Based Learning guarantees that real-life problems related to a certain subject are analyzed and solved in the classroom setting, taking into account cause-and-effect relationships. Hence, the instructor has the autonomy to select cases for instructional purposes, either by bringing them to the classroom or by choosing from the events that students witness and encounter. Utilizing instances that students directly watch or experience enhances their awareness of the events occurring in their surroundings and fosters long-lasting, advanced learning. This approach requires students to actively engage in the learning activity. The use of case study method facilitates the bridging of the disparity between theory and practice in educational settings by implementing previously acquired concepts and principles. Additional research has demonstrated that utilizing dialogue and case study construction as means of promoting student growth are highly beneficial for both students and educators. Students enhance their professional repertoire by improving their skills to cooperate with others from varied backgrounds, while educators have access to a captivating method to facilitate discussions on diversity and equity. Through the incorporation of dialogic case study production into their course designs, educators have the ability to foster the growth of student knowledge in relation to equity concerns and enhance student understanding of other views. Students employ Case Based Learning in their personal professional growth to acquire a deeper comprehension of intricate matters. Several departments in the field of education are currently offering staff training on matters of fairness and diversity that fall within their areas of responsibility. Training might involve the preparation of case studies that are based on the problems individuals' face, with the aim of linking ideas and notions of fairness to their personal experiences. When considering departments as a whole, these approaches can also be valuable in fostering and promoting interdisciplinary collaboration (Thandi *et al*., 2022). Additionally, other researchers have noted a substantial disparity in the academic performance of students instructed in Chemistry through Case Based Learning compared to those taught using traditional teaching methods. The reason for this was because the learners in the group being experimented received clear guidance in Chemistry through the use of storytelling, in which the concepts were connected to everyday life, therefore making them more tangible and engaging. The data revealed a substantial disparity in the attitude of senior secondary school students towards Chemistry. The rationale for this phenomenon is that when the subject matter being taught is connected to the students' existing knowledge and experiences, particularly when presented in the form of a narrative, it tends to capture their interest and influence their attitude towards the topic (Chabo *et al*., 2021).

Case-based learning facilitates a more thorough comprehension of how chemical principles are relevant in practical situations and the specific competencies needed. Engaging in case discussion fosters the cultivation of proficient listening and speaking abilities, as well as the cultivation of critical and analytical thinking skills. Additionally, it promotes an understanding and recognition of the significance of chemistry's ideals. Epiphania will occur in 2022. Tsekhmister (2023) argued that Case-based learning has garnered significant interest in education due to its student-centric instructional approach, which immerses students in authentic scenarios that require them to employ their reasoning skills and pre-existing theoretical knowledge. Case-based learning is an interactive teaching approach that places students as the focal point, using cases as a means of connection, and utilizes inquiry as a motivating factor to enable students to link theoretical knowledge from textbooks to intricate scenarios, so facilitating the integration of their knowledge. Conventional teaching methods are presently insufficient to fulfil the requirements of education. Teachers are always evaluating and enhancing novel pedagogical methods. In addition, case-based learning is continuously developing, encompassing many formats and the potential for integration with other instructional approaches.

Several authors have recommended that subsequent research should examine the efficacy of utilizing case studies in a set of lessons, specifically as an in-class exercise, out-of-class task, or online evaluation. It should also investigate whether Case Based Learning promotes enduring retention of subject matter, and determine the most optimal approach to designing case studies in order to better tackle misconceptions (Brian *et al*., 2007). Mayo (2004) employed case narratives featuring authentic characters to establish links with real-world situations. Cheng (1995) used case studies to teach environmental Chemistry and found out that students could reach different solutions for eliminating pollutions, students actively discussed in class, were enthusiastic about learning although they could not develop verbal presentation skills and that students' achievement in that course had increased. Clements and Batista (1990) argue that frequently acts as a catalyst for classroom debate, highlighting the need of collaborative thinking and the cooperative aspects of problem-based learning that align with a social constructivist perspective. Indeed, as Prince and Felder (2006) suggested that the research on the efficacy of case studies is restricted, with existing studies mostly concentrating on students' impressions of their learning rather than actual learning outcomes. Therefore, it was important to investigate the impact of CBL as a teaching strategy on different subjects, grade levels and cognitive and affective domains such as self- concept among students in Maara District, Kenya where a similar study had not been carried out. This study used the Case Based Learning method according to Sendur (2012) and Sikula (1996) which comprises of three phases as shown in Figure 2.

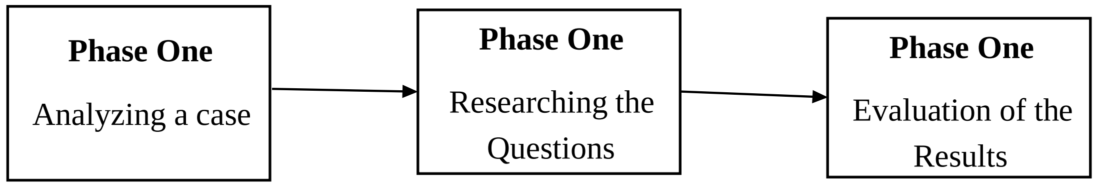


Figure 2: The Structure of Learning using Case Based Learning (Sendur 2012; Sikula 1996).

In the first phase, the students are presented with a scenario that involves a problem related to everyday life. The students and the teacher engage in collaborative reading of the cases. Students identify significant subjects and present-day issues. During the second phase, the students are provided with the main concepts in order to effectively address the case problem. Students independently do research on their chosen subject using various sources. They then answer the main questions using the relevant materials based on what they have learned. The last phase of Case Based Learning involves evaluation of what the students have learned. The teacher tightly controls the problem-solving process, guiding students' work and soliciting their input. Student solutions are presented to the class, with the teacher ultimately determining the best approach (Sendur, 2012; Sikula, 1996). Case Based Learning offers opportunities to support diverse communities of learners, engage students, and improve the persistence of educational attainment. A Case Based Learning lesson engages students with stories that enliven concepts, pose open-ended questions with human consequences, or present problems with social tasks. A case challenges learner to map theories to situations and behaviours. The task of the educator goes beyond translating textbooks, explaining abstractions, and unpacking theories. Educators seek ways to bring abstractions to life and make theories coherent, memorable, and meaningful. Cases can meet this challenge, provide ways to widen the conversation, prompt new questions, invite quiet voices to speak up, and enrich the educational experience for all (Erin,2020).

2.7 Team Based Learning

TBL emphasizes teamwork and collaboration among students in order to yields predominantly favourable outcomes when compared to conventional lecture-based classrooms (Carmichael, 2009). Faiza and Musarrat (2022) findings demonstrated a considerable improvement in the students' academic performance and motivation both prior to and subsequent to the using team based learning intervention, indicating a relationship between these variables. As the motivation of the students increased, their academic performance also increased. Christopher *et al*. (2021) found a notable disparity in student connectivity between in-person and online programmes that do not use TBL. There was a notable disparity in how students perceived the sense of community in traditional in-person courses compared to online courses that did not include TBL. There were no significant differences in learning outcomes between online and in-person modalities of training. There were no significant differences observed between online TBL and face-to-face courses, irrespective of TBL implementation. These findings indicate that students enrolled in online TBL courses had a comparable level of classroom community and connection to students in traditional in-person courses. Yang *et al*. (2022) states that after a 6-week intervention, the participants in the Team based learning group showed significant improvement in their ability to work together as a team and their attitudes towards learning. Further analysis comparing the two groups in terms of their performance in Team Based Learning revealed that the TBL group received significantly higher scores in community comprehension and assessment competence.

According to Michaelson and Michael (2008) Team-Based learning likely depends on small group interaction more extensively than any other commonly used method in post-secondary education. The main educational goal in Team Based Learning is to surpass the mere coverage of content and instead concentrate on providing students with the chance to use course concepts in problem-solving. While a portion of the class in the Team Based Learning environment is dedicated to ensuring students have a solid grasp of the course material, the majority of the time is devoted to team tasks that centre on applying the course knowledge to solve real-world problems that students might face in their career. In a TBL course, students are intentionally grouped into fixed teams for the whole duration of the course, and the course material is divided into significant units, usually ranging from five to seven. Prior to engaging in classroom activities, students are required to thoroughly review the prescribed materials, as each unit commences with the readiness assurance procedure. The RAP, or Reading Assessment Program, involves an initial solo test where students are assessed on the main concepts from the readings. Subsequently, they take the same test as a team, working together to reach a consensus on the answers. After completing the team test, students are promptly given feedback. If they believe they can provide good explanations for their incorrect answers, they have the chance to submit evidence-based appeals. The concluding phase of the RAP involves a concise and focused lecture, aimed at allowing the teacher to address any misunderstandings that may arise during the team test and subsequent appeals. After the completion of the RAP (Reading and Practice) component, the remaining portion of the learning unit is dedicated to in-class activities and assignments that necessitate students to apply and reinforce their understanding of the course material. According to Christopher *et al*. (2021), instructors should prioritize their accessibility to students and the promptness of their communication and feedback, independent of their usage of TBL. This is because it has been found to foster a sense of closeness between students and their teacher.

2.7.1 Principles of Team Based Learning

Michaelson and Michael (2008) highlight the four fundamental concepts of TBL. First, it is necessary to establish and effectively manage group. They should be created in ways that allow them to effectively accomplish their assigned tasks. This includes reducing obstacles to group unity and providing the necessary resources. Secondly, students must be held accountable. Unlike traditional teaching methods, where students are only accountable to the instructor, accountability can be reasonably ensured by assigning grades to their work. Students are responsible for: independently preparing for collaborative tasks, dedicating time and energy to finish group projects, and engaging with one another in constructive manners. Thirdly, it is essential that team tasks are designed to facilitate both the acquisition of knowledge and the growth of the team as a whole. Assignments that necessitate group decision-making and facilitate the reporting of those decisions in a concise manner typically result in elevated levels of group engagement.

Assignments that need intricate deliverables, such as lengthy documents or oral presentations, often result in groups dividing the workload and team members independently completing their assigned duties. Consequently, these projects hinder group engagement by creating challenges in assessing team performance comparatively. Ultimately, it is imperative that students are provided with regular and prompt feedback. In order for teams to function optimally and progress as a cohesive unit, it is imperative that they get consistent and prompt evaluations of their collective performance. The feedback obtained from the Readiness Assurance Tests (RATs) facilitates learning by providing individual students and groups with information on the effectiveness of their present learning strategies. High scores indicate that individuals are effectively engaging in the necessary learning activities, while conversely, low scores suggest the opposite. RATs also aid in the team building process in two significant ways. Since the group scores are publicly disclosed, group members are strongly incentivized to work together in order to safeguard their public reputation. Additionally, due to the promptness of the feedback, students are not only aware of instances where the group failed to utilize the knowledge of certain members, but are also highly motivated to take action to rectify the situation (Watson *et al*., 1991). Minna and Thomas (2020) described Team Based Learning as a special form of collaborative learning that involves the use of permanent working teams throughout the term. In this highly structured and interactive teaching method, students perform preparatory activities outside of class to gain factual knowledge and understand basic concepts. In class, students collaborate with peers to apply content, analyze findings, and synthesize new ideas. The analysis revealed that the Team Based Learning taught classes had significantly higher levels of self-reported learning in the areas of gaining, understanding, and synthesizing knowledge. The proposed that these gains are driven by the Team Based Learning readiness assurance process and peer evaluations. Both of these structural components increase student accountability, motivation, and engagement with course content.

When constructing teams, it is recommended that teachers aim to diversify them by taking into account various viewpoints, opinions, and strengths. Introducing Team Based Learning in the beginning of the curriculum, before teacher-centred instruction, is more favourably welcomed by students. This approach gives students the opportunity to understand the advantages and helps them develop teamwork-related abilities. Team Based Learning necessitates a fundamental change in the way learning is approached. Student accountability is greatly enhanced as students are expected to work independently in a bid to prepare for collaborative sessions, during which they will collaborate with their peers to resolve challenges. Pre-class learning, guided by the instructor, may involve reading textbooks, articles from primary literature, and/or materials provided by the instructor. Students are responsible for mastering this content during the readiness assurance phase of the TBL session and are then expected to use that knowledge during an application session (Tracy *et al*., 2015). Following their participation in Team Based Learning, students reported a notable enhancement in their teamwork skills, specifically in relation to cultural diversity. According to Christensen *et al.* (2019), students reported a considerable improvement in their capacity to fulfil the roles of task leader, socio-emotional leader, and information giver. Additionally, their preferences for performing these two leadership roles also increased.

The researchers conducted a synthesis and meta-analysis of intervention studies to examine the impact of Team Based Learning, which is a specific set of instructional components commonly employed in higher education settings. According to the authors of Team Based Learning evaluations, Team Based Learning has been found to enhance students' final grades, performance on tests, and active participation in the classroom. According to Elizabeth *et al*. (2017), students have stated that Team Based Learning is captivating, facilitates a more profound comprehension of the subject matter, and better equips them for evaluations and overall performance in the course. The Team-Based Learning (TBL) method has a long history. Initially, the adoption of Team Based Learning was gradual, mostly within the realms of business education and the health community. The University of Oklahoma had a significant role in its early promotion, as many of its faculty members were enthusiastic advocates of this approach. During the late 1990s, Team Based Learning started to gain popularity among educators from other fields who recognized its advantages and suitability for the evolving educational landscape. This was partially driven by a significant increase in utilization within health sciences settings. The TBL literature shares similarities with the literature on other instructional methods and technology (Paul *et al*., 2014). The current period is highly opportune for doing scholarly research on TBL, as the literature has reached a significant stage of development. The study technique has great potential and there is initial data indicating enhanced learning outcomes in various domains.

Levent and Mustafa (2017) discovered that TBL outperformed traditional-based instruction in long-term retention assessments. Students expressed a high level of satisfaction when team-based learning is used, and their involvement during in-class activities was notably improved in team-based learning lessons. The results indicated that team-based learning was a superior option to lecture for instructing ethics in medical education. The students' satisfaction with TBL appeared to be high. The satisfaction of learners in the TBL and lecture groups could not be statistically compared due to the use of various data collection methods. A small number of students expressed dissatisfaction with TBL exercises in the classroom, likely because their learning style preferences varied. The TBL technique shown favourable outcomes in teaching medical ethics, specifically in terms of long-term information retention, in-class engagement, and learner reactions. Maia *et al*. (2023) state that Team Based Learning is an instructional approach that involves students actively participating in a series of activities, including individual and team work, to apply their conceptual knowledge. This approach also provides rapid feedback to students. This approach utilizes a testing component that assesses the individual knowledge of students both before and after group cooperation. A commonly used testing tool for this purpose is the Readiness Assurance Test. Team Based Learning commences with students engaging in pre-class preparation through the use of designated resources or active research. At the commencement of the lesson, students' knowledge is assessed individually, followed by a team-based evaluation. Following the examination, the instructor promptly offers comments and clarification on the team's answers. Team Based Learning stimulates active inter peer collaboration. In Christensen *et al*. (2019) study, the teams collaborate throughout the whole course, allowing sufficient time for members to establish their roles and organize themselves into an efficient unit, without any direction from the teacher. Moreover, the roles assumed by each team member are likely to arise naturally and may change throughout the fulfilment of team assignments.

2.7.2 The Structure of Learning using Team Based Learning

Fink (2004) suggests TBL should start by reorganizing the entire course into units that concentrate on the key topics of the discipline. Each thematic unit follows a three-part structure implemented by the teacher: preparation, application, and assessment as shown in Figure 3.

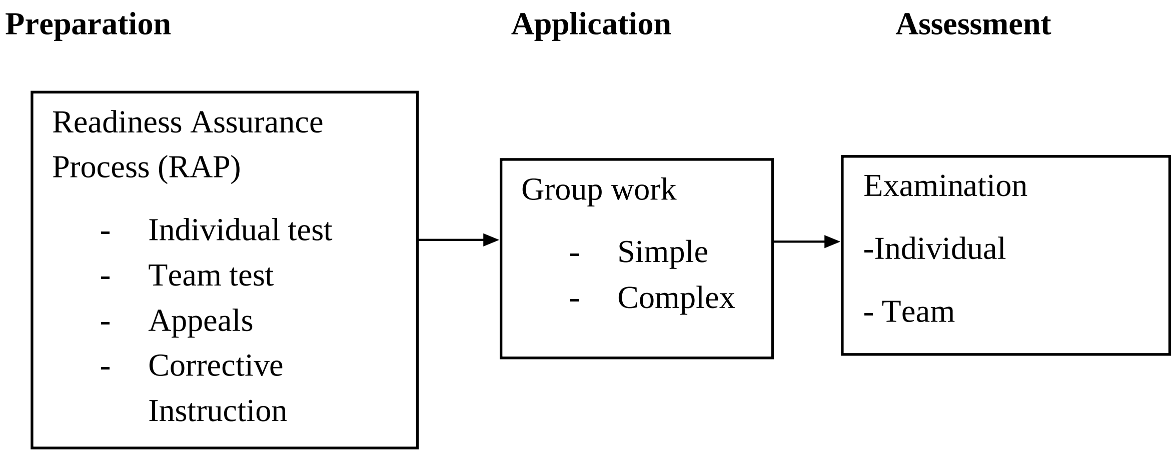


Figure 3: Sequence of Learning Activities in Team Based Learning (Fink, 2004).

During the preparation phase, students are tasked with reading a specific piece of content related to a topic, which is to be done outside of class. In the RAP program, students start by individually taking a test on the assigned readings during class. They then proceed to complete the same test as a group, and the group tests are graded during the class session. If any of the groups believe that their answers should have been considered accurate, they have the option to submit a written appeal. This appeal should include references to the relevant information from the reading assignment that supports their answer. The teacher provides remedial education once the students have demonstrated their individual and group learning abilities. During the application phase, students utilize the provided content to respond to inquiries, resolve issues, generate explanations, or formulate predictions. The upcoming class sessions will focus on a series of small group application activities. These exercises will involve more challenging questions and issues that will be delivered to the groups. In their study, Jeanne *et al.* (2014) suggested that conducting further research on the specific components of Team-based learning could offer valuable insights to teachers about the key factors that contribute to effective education. Conducting additional study, which involves analyzing different grade levels and subject areas, would offer a more accurate assessment of the impact of TBL. It would also provide further insight into the specific groups of people and circumstances in which TBL can be successful.

2.8 Theoretical Framework

Case Based Learning and Team Based Learning are instructional approaches that are grounded in the constructivism theory. This theory is an advancement of the cognitive learning theory and emphasizes the learner's ability to construct their own understanding of material. Bada (2015) states that the constructivist theory of learning is based on the ideas of Bruner (1961), Dewey (1929), Piaget (1980), and Vygotsky (1962). Maia *et al*. (2023) argue that Case Based Learning relies on a constructivist approach, which highlights the active involvement of students in constructing their own knowledge through discovery learning. This technique enables students to develop their comprehension of medical topics. From a constructivist perspective, Case Based Learning is considered more efficacious in fostering critical thinking abilities compared to didactic lectures. This is because it enables students to establish links between their acquired knowledge and real-life situations. In group-based Case Based Learning, social constructivism is evident since knowledge is constructed through social interaction and communication while collaborating and debating the cases. Case Based Learning can include aspects of cognitivism by enhancing students' cognitive capacities through tasks that require them to analyze and apply information. Students utilize their pre-existing cognitive models, which are mental representations of knowledge, to comprehend the provided information. During the process of working on the case, students have the opportunity to improve or broaden their existing cognitive models as they acquire new knowledge and develop a deeper understanding of their decision-making process. Through the analysis of real-world situations and the application of their acquired knowledge to novel contexts, students can develop their own comprehension of subjects, rather than relying solely on rote memorization.

2.8.1 Constructivism Theory

Constructivism is an educational paradigm that posits that learning occurs via the process of mental construction. Constructivists believe the learning process is influenced by the specific circumstances in which an idea is presented, as well as by the individual students' beliefs and attitudes. The constructivist hypothesis posits that humans actively create knowledge and derive meaning from their personal experiences. Piaget's Constructivist learning theory has significantly influenced learning theories and teaching approaches in education (Bada, 2015). Jonassen (1990) and Kim (1993) enumerated the subsequent theoretical presumptions of constructivist instruction. Initially, knowledge is formed through the sensory and perceptual experiences of the learner. Secondly, knowledge refers to an individual's comprehension of the external world based on their own personal encounters, as opposed to relying on the experiences of others. Furthermore, internally encoded knowledge serves as the foundation for additional knowledge structures and contributes to the development of a new cognitive framework for the individual. Furthermore, learning is a dynamic process that involves the active construction of meaning through personal experiences. Learning is a progressive process in which the learner gains comprehension of the actual world. Furthermore, individual interpretations give rise to diverse viewpoints. The perspectives formed within an individual's cognitive framework strive to encompass all conceivable viewpoints. Ultimately, learning is the acquisition of knowledge in a particular and applicable setting. Knowledge is the comprehension of significance derived from situational situations, rather than from objective reality.

Bada (2015) outlined some advantages associated with constructivism. Initially, children acquire knowledge and derive enjoyment from the process of learning to a greater extent when they are actively engaged, rather than being merely consumers of information. Furthermore, education is most effective when it prioritizes critical thinking and comprehension, rather than relying solely on recollection through repetition. Furthermore, constructivist learning can be applied to other contexts or situations. Within constructivist classrooms, students generate organizing principles that may be applied in various learning environments. Furthermore, constructivism empowers students by granting them ownership of their learning. This is achieved by placing emphasis on students' inquiries and investigations, and frequently involving them in the creation of assessments. Constructivist assessment involves encouraging students to take initiative and invest personally in their journals, research reports, physical models, and artistic representations. Encouraging the cultivation of creative instincts enhances students' capacity to articulate knowledge through diverse means. The students are also more inclined to retain and apply the newly acquired knowledge to real-life situations. Furthermore, constructivism enhances student engagement by incorporating learning activities within a genuine, practical framework. Students in constructivist classrooms have the ability to critically analyze and inquire about various subjects, utilizing their innate curiosity to explore and understand the world. Constructivism enhances social and communication skills by fostering a classroom atmosphere that prioritizes collaboration and the sharing of ideas. Students must acquire the ability to express their thoughts coherently and engage in efficient teamwork by actively participating in collaborative assignments. Students engage in the exchange of ideas, engage in negotiation with others, and assess their contributions in a socially acceptable manner. It is crucial for success in the real world, since individuals will consistently encounter diverse experiences that require them to collaborate and navigate through the perspectives of others. Piaget (1976) posited that the acquisition of knowledge is a consequence of the cognitive processes undertaken by learners in constructing their own understanding. He argued that the existing state of knowledge is transient, evolving throughout time just as knowledge in the past has evolved. It is an ongoing process of constant construction and restructuring. He regarded constructivism as a means of describing the process by which individuals acquire knowledge about their surroundings.

Ulawaka and Offorma (2015) assert that the constructivist theoretical framework argues that learning is always based on the existing information that a learner possesses. This occurs because all learning is processed through pre-existing schemata. Their research revealed that learners in the productive group achieved better results than their peers in the conventional instruction group. Nevertheless, there was a notable disparity in the average achievement scores of students who were instructed in listening comprehension using the constructivist teaching approach compared to those who were taught using traditional teaching methods. The constructivist group's exceptional achievement may be attributed to the method's facilitation of active student participation and the exploration of new concepts based what they have previously learned. It may have additionally inspired the students to retain their acquired knowledge. The study presented tangible proof evaluating the effectiveness of the constructivist teaching approach on student achievement. It also provided valuable input on the comparative effectiveness of the constructivist teaching approach. Research from other studies concluded that there are a lot of performance enhancements in using constructivist approaches in teaching and learning mole concept since it improved conceptual understanding and also there was a positive effect on students' attitudes towards mole concept. The researchers recommended that the use of constructivist approaches in teaching and learning Chemistry at the Senior High School should be encouraged by Curriculum developers and education implementers for students to have a hands-on experience with mole concept in learning Chemistry (Kennedy *et al.,* 2020).

The study conducted by Hellen (2017) revealed that students who received instruction based on Constructivist-Based Instructional Models achieved greater scores on the researcher-made Biology Test in contrast to individuals who received instruction through conventional teaching methods. Similarly, the self-perception of students who were taught using Constructivist-Based Instructional Models was greater than that of their peers who were taught using the Lecture technique. The possible explanation for this outcome may be that the learners in the group utilizing Constructivist-Based Instructional Models had a high level of engagement with the materials, which provided them with opportunities for active, cognitive, and emotional experiences. This is because the fundamental components that impact the learning process in this paradigm - the learners, teachers, tasks, and context - are not separate entities. Students instructed using the constructivist approach provide greater evidence of information retention compared to those instructed using the lecture method. The study suggests that Science Teachers should utilize Constructivist-Based Instructional Models in their teaching in order to establish a stimulating, dynamic, and informative learning environment. Some other scholars have suggested that Team Based Learning is founded on the principles of constructivist learning theory. Grounded in the ideas of student-centered learning and supportive scaffolding, this approach places the responsibility for learning on the learner. The learner is expected to identify their own educational requirements, manage the learning process, and actively engage in problem-solving within the group. Team Based Learning involves the synthesis of prior knowledge and the integration of new information to reorganize one's cognitive framework. The importance of supportive scaffolding is highlighted as a means of assisting peers in small groups, allowing learners to engage in discussions about difficult topics during Team Readiness Assurance Tests and group application exercises (Seyedeh *et al*., 2018).

Additional research has demonstrated that students who were exposed to Team Based Learning (TBL) and then returned to a traditional learning format reported enhanced perceptions of teamwork and expressed a greater preference for the TBL format compared to students who initially experienced a traditional format and then transitioned to TBL. Students unanimously acknowledged that the TBL format facilitates the development of critical-thinking skills, problem-solving abilities, and effective examination preparation. According to Tracy *et al*. (2015) learners concurred that groups are supposed to be composed of persons with diverse personalities and different approaches to studying. According to Vaishali (2020), there is a widespread societal and educational policy expectation that teachers should employ various teaching methods in classrooms in order to adequately educate students to meet the demands of the 21st century. Expectations are that teachers should possess knowledge of developing learning approaches and effectively use them in classroom settings, including constructivist approaches to learning. Constructivist ideas diverge from traditional approaches to instruction and knowledge acquisition. These techniques highlight the necessity of transforming the teacher's position from being a traditional authoritative figure to becoming a supportive facilitator. A teacher who is knowledgeable in constructivist methodologies is anticipated to motivate learners to actively engage in the teaching and learning process, so enhancing their analytical thinking, creativity, and problem-solving abilities. Hellen (2017) suggest that learning has traditionally been perceived as a repeating task where pupils just mimic freshly presented material during assessments. Conventional teaching methods cause students to develop a lack of interest in specific topic areas. Contrarily, the constructivist teaching approach facilitates the process of learners internalizing and transforming new information. The process of transforming information involves the development of fresh comprehension that arises from the production of novel cognitive structures. Teachers have the ability to encourage changes, but they cannot require or stop them.

Research has further shown that students who were exposed to TBL and then switched back to a traditional learning format reported improved perceptions of teamwork and expressed a stronger preference for the TBL format compared to students who initially experienced a traditional format and then switched to TBL. Students universally recognized that the TBL format enhances the cultivation of critical-thinking skills, problem-solving capabilities, and successful exam preparation. Tracy *et al*. (2015) found that students agreed that teams should consist of individuals with varied personalities and learning styles. Vaishali (2020) states that there is a prevalent societal and educational policy expectation for instructors to utilize diverse teaching approaches in classrooms to effectively educate pupils and prepare them for the challenges of the 21st century. Teachers are required to have expertise in implementing various teaching methods, including constructivist approaches, to enhance learning in the classroom. Constructivist concepts deviate from conventional approaches to instruction and acquisition of knowledge. These strategies emphasize the importance of shifting the teacher's role from a traditional authoritative figure to a supporting facilitator. An educator proficient in constructivist pedagogy is expected to inspire learners to engage proactively in the process of instruction and learning so strengthening their abilities in critical thinking, creativity, and problem-solving. According to Hellen (2017), the conventional view of learning is that students just imitate newly supplied information during examinations, treating it as a repetitive chore. Traditional pedagogical approaches lead to pupils' apathy towards particular subject areas. In contrast, the constructivist teaching technique enables learners to internalize and transform new material. The process of changing information entails the creation of new understanding that emerges from the building of innovative cognitive frameworks. Teachers has the capacity to stimulate alterations, but they lack the authority to mandate or impede them.

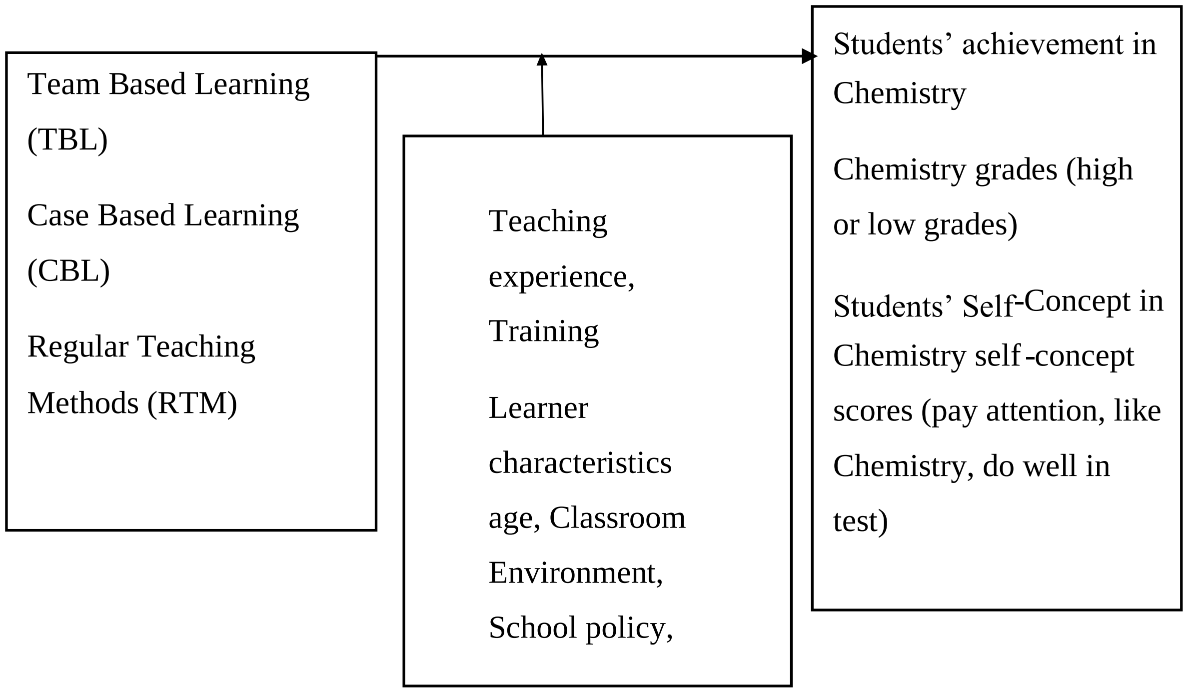
Hunter (2008) noted that there are four main principles of applying constructivist theory to education. First, the teachers' role is one of the expert facilitators where students take central role in learning. The teacher's responsibility is to offer opportunity for students to question and expand their existing beliefs and knowledge. Secondly, the challenges must be directly applicable to the learner's needs and interests, and they should push the learner to go beyond their prior experiences. Solving these difficulties necessitates the learner's capacity for self-direction. The teacher or fellow learners can provide guidance to encourage individuals until they reach complete self-direction, which is referred to as scaffolding (Davies, 2000). Thirdly, there is a significant focus on acquiring knowledge by active conversation and engagement with fellow learners, as well as fostering a shared comprehension that is attained through collective experiences. Finally, the learner must engage in reflection in order to assess and determine the appropriate adjustments to their existing knowledge. In Case Based Learning and Team Based Learning, the teacher assumes the role of a facilitator by establishing educational goals and creating instructional materials, assessments, and conversations. This approach aims to minimize passive learning practices. The student-centred principles and supporting scaffolding that are crucial in constructivist theory are intrinsically consistent in Team-Based Learning and Case-Based Learning (Patricia & Hellen, 2012). TBL is an approach that integrates Collaborative learning across group sizes by include several small groups inside a larger group environment. Over the past twenty years, there has been a growing utilization of it in higher education and professional training. With the growing utilization of TBL, numerous academic institutions are curious in the impact it has on learning outcomes. The writers conducted a thorough examination and integration of the educational literature on TBL in order to assess the accuracy and completeness of their descriptions of the fundamental components of TBL. Subsequently, they created narrative summaries of specific articles. The investigation provided initial proof indicating positive educational results in terms of acquiring knowledge, involvement and engagement, and performance among teams. The authors assert that the TBL literature has reached a crucial stage of development, necessitating more thorough examination and investigation of further inquiries pertaining to the method, as well as more precise documentation of TBL application (Paul *et al*., 2014).

2.8.2 Self- Concept Theories

Three distinct and well accepted models exist that explain various cause-and-effect correlations between students' opinions of themselves, that is, self-concept and their academic performance. According to Jeffrey *et al*. (2010), academic self-concept in the skill development model is a result of previous academic achievements. Academic self-concept plays a crucial role in determining learning outcomes, and improving academic self-concept leads to better academic performance (Chen *et al*., 2013). The development of academic self-concept, whether it is on a global scale or in respect to a single academic topic, occurs as students receive feedback on their academic performance (Guay *et al*., 2003). Furthermore, under the self-enhancement model, the pre-existing self-concept has a significant role in determining academic accomplishment. The reciprocal-effects paradigm serves as a middle ground between the self-enhancing model and the skill development approach. According to the reciprocal-effects model, prior academic accomplishment is a predictor of subsequent self-concept, and prior academic self-concept has an impact on subsequent achievement. This means that there are reciprocal effects between these two factors (Marsh & Craven, 2006). The External frame of reference model posits that academic self-concept in a specific domain is shaped in connection to a frame of reference. The external reference model involves students comparing their own perceived performance in a specific subject with the perceived performances of other students in that same domain. If individuals regard themselves as more capable than other students, they are likely to have a strong academic self-concept in that particular area (Chen *et al*., 2013). This study integrated the reciprocal-effects model with the external reference model. The study includes the self-concept as it is considered significant in Chemistry among secondary school learners.

2.9 Conceptual Framework

In this study Case Based Learning and Team Based Learning were used as interventions during the pedagogical process in a selected topic in Form Two Chemistry syllabuses. The independent variables were the Case Based Learning, Team Based Learning and Regular Teaching Methods while the dependent variables were students' achievement and self- concept in Chemistry. Appropriate use of Case Based Learning and Team Based Learning by teachers can improve the achievement and self-concept in Chemistry among students as compared to the use of Regular Teaching Methods. The variables are interrelated as shown in Figure 4.



Independent variables **Intervening variables** **Dependent variables**

Figure 4: Conceptual Framework showing Relationship among the Effects of TBL, CBL and RTM on the performance and self-perception of secondary school students in Chemistry.

Case Based Learning, Team Based Learning and Regular Teaching Method influenced students' performance and self-concept in the subject of Chemistry. The study includes intervening variables such as learner and teacher characteristics, age of the learner interfered with the learning since the older students were laughed at or ridiculed by the rest when they made a mistake, while the younger ones were treated as a pet of the class. The impact of age was managed by exclusively selecting Form Two Chemistry students. Teachers also ensured that the students did the assignments on time, ensured participation in class and conducted roll call during every lesson. To reduce the effect of test sensitization the items in the pre-test were reorganized for the post-test. The teachers' level of training and experience may influence the use of teaching strategies and consequently affect the achievement and self-concept in Chemistry. In order to control the effects of teacher variable in this experiment in terms of mastery of content, experience, level of qualifications in professional practice Chemistry teachers of either a diploma holder or University graduate degree holder with at least 3 years teaching experience in Chemistry at secondary school level were involved in the research. The researcher provided training to the Chemistry teachers on the implementation of Case Based Learning. Team Based Learning and Regular Teaching Methods. In addition, the participants teaching chemistry and involved in the groups being experimented were allocated teaching manuals on TBL and CBL for use in teaching along with corresponding schemes of work for the during the duration of the study. The teachers were also assessed from time to time to ensure that they followed the teaching manuals and applied other materials. Since learners were Form Two's, they were assumed to have no effect. School policies such as rewards and punishments for performance, learner repetition may have influenced learning of chemistry. The selected schools offered chemistry as a compulsory subject for all students. This was controlled by ensuring similar conditions for the groups under experimental treatments. Classroom environment such as availability of learning resources was ensured by providing handouts to the learners.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the research design, target population, sampling procedure and sample size, treatment and instrumentation. The chapter also describes validity and reliability of instruments, teaching manual, the data collection procedures and data analysis.

3.2 Research Design

This study utilized a Quasi-Experimental Factorial Design. The Quasi-Experimental Factorial Design is utilized when a study incorporates experimental groups as well as a control group (Kothari, 2004). A quasi-experiment is a type of study that is employed to ascertain the causal impact of an intervention on a specific group without employing random assignment of participants. Quasi-experimental research is comparable to true experimental design or randomized controlled trials, but it expressly does not include the random assignment of participants to treatment or control groups. Quasi-experimental designs, in contrast, enable researchers to manipulate the assignment to the treatment condition, but not by random assignment. Instead, they employ a different criterion for determining the assignment (Dinardo, 2008). The first experimental group utilized Case Based Learning, the second experimental group employed Team Based Learning (TBL), and the third group served as a control by using Regular Teaching Methods (RTM). The three groups were pairwise compared to identify the groups responsible for the observed discrepancy. Next, the three groups were compared to see whether group had higher achievement and self-concept in Chemistry. Prior to the treatment, a preliminary assessment was given to the Chemistry students in all three groups. The therapy was administered over a duration of eight weeks. After the completion of an eight-week treatment, a post-test was conducted for all three groups. The approach entailed a random allocation of complete classes to three groups. The Research Design is shown in Table 4.

Table 4: Quasi - Experimental Factorial Design

Group	Pre-test	Treatment	Post-test
1st Experimental	O_ICBL	XCBL	O_2CBL
2nd Experimental	O_ITBL	XTBL	O_2TBL
Control group	O_IRTM		O_2RTM

Key:

O_ICBL represents the pre-test scores for the CBL group

O_2CBL represents the post-test scores for CBL group

XCBL represents the treatment for the CBL group

O_ITBL represents the pre-test scores for the TBL group

O_2TBL represents the post-test scores for the TBL group

XTBL represents the treatment of the TBL group

O_IRTM represents the pre-test scores for the RTM group

O2RTM represents the post-test scores for the RTM group

3.3 Location of the Study

The study was located in Maara Sub- County in Tharaka Nithi County in Eastern region of Kenya. Tharaka Nithi County has four sub counties namely Maara, Meru South, Tharaka North and Tharaka South. Maara Sub County was selected through simple random sampling method. Maara Sub- County has five zones namely Chogoria/Murugi, Kiera, Ganga, Muthambi and Mitheru.

3.4 Population of Study

According to Mugenda & Mugenda (2003), a “population is defined as the entirety of humans and objects that possess similar observable characteristics”. The target population encompasses the individuals or events that the researcher intends to apply the study findings to, whether they are hypothetical or actual. The population for this study was all secondary school students in Maara Sub-County, Kenya. The target population consisted of 18,611 students from all 52 secondary schools in Maara Sub County, including 38 co-educational schools. The schools with classes smaller than 30 students per class were 6 while 15 schools had between 30 to 40 students per class. There were also 17 co-education schools with more than 40 students per class. In addition, 12 schools had a gender disparity of more than 10 students while 4 schools had more than 60 students per class. Accessible population is the portion of the target population reasonably accessed. The accessible population consisted of 2,378 Form Two Chemistry students enrolled in co-educational secondary schools in Maara Sub-County.

3.5 Sampling Procedure and Sample size

According to Kothari (2004) a sample size is a "sub set of the total population that is used to give general views of the target population". Maara Sub County was selected randomly from among four Sub Counties in Tharaka Nithi County. The researcher selected three co-educational secondary schools to participate in this study using purposive sampling method. Purposive sampling was used to ensure that the choice of schools had similar characteristics of study. The sampling frame had seven schools as shown in Table 5.

Table 5: Distribution of Form Two Students in the Sampling Frame

School	Zone	Male	Female	Total
A	Chogoria	19	26	45
B	Chogoria	26	29	55
C	Chogoria	20	25	45
D	Kiera	20	27	47
E	Kiera	25	27	52
F	Ganga	23	20	43
G	Ganga	25	33	58

Source: Sub- County Director of Education Office, Maara Sub- County

Table 5 shows the sampling frame from which the sample was drawn. It also shows that the distribution of students of either gender was less or equal to ten in each school. In addition, the schools had adequate teaching facilities and Chemistry University experienced teachers who have completed their studies and have at least three years of teaching experience. The schools in Mitheru and Muthambi zones were excluded from the study because none of the schools met the set criteria. If a school had more than one stream both streams were taught in the same way but simple random sampling was then used to select the stream for which data would be analyzed. If sampling was done and schools picked belonged to the same zone, random sampling was repeated to select a school from another zone. The allocation of participants into either experimental or control groups was performed using a simple random method (Qureshi, 2005). Table 6 shows the distribution of students in the three groups.

Table 6: The Distribution of Students in the Three Schools

Group	Male	Female	Total	Zone
School One	19	26	45	Chogoria
School Two	23	20	43	Ganga
School Three	20	27	47	Kiera
Total	62	73	135	

Table 6 displays the student enrolment across the three schools. School one was taught using CBL, School Two was taught using TBL while school Three were taught using RTM. The pre-test involved a total of 112 students while those who took post-test in this study was 106.

3.6 Instrumentation

In this study the items in Chemistry Achievement Test were based on what the students covered during the study period in Chemistry. The items in Chemistry Achievement Test were developed using a test blue print that included the topics covered alongside the domains of learning. The items tested knowledge, comprehension, application, analysis, synthesis, and evaluation. The Students' Self- Concept Questionnaire (SSCQ) was used by the researcher to assess the academic Self- concept in Chemistry. To compare the effects of CBL, TBL and RTM on achievement and self-concept, a similar content was covered in the three groups. This was accomplished by examining the teaching materials of the instructors to confirm that the students were exposed to comparable content in the CBL, TBL, and RTM classes, and that the themes were in line with the questions on the pre-test and post-tests.

3.6.1 Chemistry Achievement Test (CAT)

To assess student's performance in Chemistry in Form Two Kenya Institute of Curriculum Development (KICD) Chemistry syllabus, The Chemistry Achievement Test (CAT) was utilized. The CAT was developed using a test blueprint in for the purpose of testing one's knowledge, understanding, and ability to apply, analyse, synthesize, and evaluate information. The total number of structured items were 10 comprising 30 marks. The CAT focused exclusively on the Salts topic, which was covered during the study period. The CAT comprised exclusively of materials pertaining to the topic of Salts that were studied over the designated period. A pre-test and a post-test were administered at the commencement and conclusion of the study, respectively.

3.6.2 Students' Self- Concept Questionnaire (SSCQ)

To evaluate students' self-concept in Chemistry, a self-concept questionnaire was employed. A five-point Likert scale was employed to measure the items. The students were instructed to express their ideas by selecting one of the following options: Strongly Agree (SA=5), Agree (A=4), Undecided (U=3), Disagree (D=2), or Strongly Disagree (SD=1) in front of each item. The items consisted of the schooling self-concept only. A modified self –concept scale was adapted from Joyce and Shirley (2007).

3.6.3 Validity of Instruments

The two instruments were verified by Chemistry teachers who were examiners for the Kenya National Examinations Council (KNEC) and science educational experts from Egerton University in the Department of Curriculum, Instruction and Educational Management. The experts checked the language used in items, difficulty of test items, ambiguity, test length and arrangement of items. Their input were taken into account to enhance the instruments. The tools were tested in order to check content, construct and face validity. Content validity was done to ensure it had adequate domain of content it was supposed to test. Face validity included formatting the instruments on aspects such as clarity of printing, font size or type and appropriateness of language. Construct validity examined the nature of psychological characteristics measured by the instruments. This was done to ensure that the items in the CAT corresponded with topic Salts in Chemistry and that SSCQ items comprised of academic self-concept only.

3.6.4 Reliability of Instruments

A pilot test was conducted in Meru South Sub-County in co-educational secondary schools which exhibited comparable traits to the schools that were sampled. The results of the pilot test were used to estimate the reliability using the Cronbach's coefficient Alpha method. This is because the test was based on a range of scores. The items in CAT were structured. The scores of the items ranged from 0 to a maximum of 4 marks. The internal consistency of CAT and SSCQ was measured with Cronbach's alpha coefficient. The items in the SSCQ had scores ranging from 1 to 5 on the Likert scale. The reliability coefficient for SSCQ was 0.81 while that for CAT was 0.79 and hence were accepted for these instruments.

3.7 Treatment of Study

The researcher provided training to chemistry teachers on the utilization of CBL and TBL in Chemistry teaching for one week. The schemes of works, lesson plans and teaching materials were prepared by both the researcher and the Chemistry teachers. The experimental groups were presented with CBL and TBL separately. Chemistry teachers in CBL and TBL played the role of the researchers. The Chemistry teacher in the CBL experimental group had the responsibility of providing guidance to students on challenging questions to stimulate critical thinking. Additionally, they were tasked with reading out the presented instances to the students. The students in CBL experimental group read individually the presented cases and answered questions. A total of 5 cases were used to teach a selected topic in Chemistry. The learners recorded the responses to the study questions on the given worksheets. The role of the teacher was to move from one student to another and assist the students when they required assistance in comprehending the provided cases or associated questions. Upon completion of the students' explanations of their answers to the questions, the teacher proceeded to consolidate and present the accurate responses. The function of the Chemistry teacher in the TBL was to assign learners to heterogeneous teams of between 5-7 members. Teachers gave individual and team quizzes based on readings to be taken prior to every class instruction, developed related in-class application exercises, and created individual and team assignments. Students did quizzes individually and as a team. When students completed their individual quizzes, they turned in their answer sheets and joined their teammates to take the same quiz as a team. The teacher was responsible for recording the individual and team quizzes in their team's folders. Appeals were granted based on the strength of the teams' written appeals. The majority of class time was devoted to in-class application exercises. This provided the teams with opportunity to apply their learning from the pre-class readings. This procedure was repeated in the remaining class sessions.

3.8 Data Collection Procedures

The authority to undertake research was first sought with the approval by Egerton University Board of Postgraduate Studies. Subsequently, the researcher requested authorization to do research in the chosen schools from the National Commission for Science, Technology and Innovation. At the onset of the experiment, a preliminary evaluation was administered to each of the three groups. The initial experimental group was instructed using CBL, while the second experimental group was instructed using TBL. The control group received instruction utilizing the RTM method. Following the completion of eight weeks of instruction, a post-test was administered to all of the groups. The data was gathered through the utilization of the Chemistry Achievement Test (CAT) and the Self-concept Questionnaire (SSCQ). The data was obtained from the self-concept questionnaires qualitatively based on academic aspects of self-concept domain on a five-point Likert scale which was later transformed to quantitative data for analysis. The data obtained by use of CAT was quantitative. The researcher administered the instruments with the aid of Chemistry teachers at the schools that had been selected. The researcher employed the test scores as quantitative data for the purpose of data analysis.

3.9 Data Analysis

Data analysis involved the use of descriptive statistics, such as mean, standard deviation, and percentages, as well as inferential statistics, including ANOVA, ANCOVA, and t-test.. Descriptive statistics summarize the characteristics of a data set while inferential statistics allow the researcher to test the hypothesis. Although descriptive statistics were done it was necessary to carry out inferential statistics so as to test the null hypotheses. The one-way ANOVA was used to investigate differences in the mean scores for self-concept and achievement in Chemistry among three groups. The Tukey's HSD post hoc analysis was employed to determine the most productive method. The KCPE marks of the sampled students were used as the covariates. Covariates were used in order to minimize within-group error variance as well as to eliminate the confounding variables in order to account for the influence of an outside variable that might affect the results of the experiments in the ANCOVA.

ANOVA allows for the comparison of more than two groups at different points in time (Thorne & Giesen, 2000). ANOVA was employed in order to determine if there were statistically significant disparities among the means of three groups. Distinct sets of samples t-test was employed to determine whether there were statistically significant disparities in the average scores of the experimental and control groups. The assumptions of ANOVA and t-test are that there was normality of population, data was independent and that there was homogeneity of variances. The data analysis was performed utilizing SPSS Version 25, a software application designed for statistical analysis in the field of social sciences. The significance level for accepting or rejecting null hypotheses was set at $\alpha = 0.05$.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Description of the Study Subjects

The subjects for this study were Form Two Chemistry students selected using purposive sampling method in Maara Sub-County. The study randomly selected three co-educational secondary schools from a sampling frame of seven public secondary schools. The sampling frame had a total of 135 students who included 62 males and 73 females. 112 Form Two Chemistry students took part in the pre-test which comprised of 52 males and 60 females. This represents a decline of 17.037% in the sampling frame population. A total of 106 students took part in the post-test that comprised of 51 males and 55 females. This represented a percentage decline of 5.34% who dropped in the course of experiment. The six students who withdrew from the experiment were excluded for the examination of post-test scores. The intervening variables for this study such as learners age was controlled by using Form Two Chemistry students only.

The level of training, experience, and mastery of content of the teachers was controlled by selecting Chemistry teachers who held either a diploma or a university graduate degree. These teachers were required to have at least 3 years of teaching experience in Chemistry at the secondary school level. The Chemistry teachers underwent training from the researcher on the use of Case Based Learning, Team Based Learning, and Regular Teaching Methods. The chemistry teachers participating in the experimental groups were provided with teaching materials on Team Based Learning and Case Based Learning, as well as schemes of work, to be used for the entire study duration. The teachers were assessed from time to time to ensure that they followed the teaching manuals and other materials provided. School policies such as rewards and punishments for performance, learner repetition may have influenced learning of chemistry. These effects were minimized by ensuring that the schemes of work included main school programmes during the experiment. Classroom environment such as availability of learning resources was minimized by providing handouts to all the learners in experimental groups. The learning groups were also of mixed ability. In order to minimize interaction effects among students in the study, the experiment was conducted during the third term since there were less inter school activities. The sampled schools were several kilometres apart.

4.2 Effect of Case Based Learning on Student's Achievement in Chemistry.

The first objective of this study was to determine whether there was a disparity in the academic performance of students in Chemistry who were exposed to CBL compared to those exposed to Traditional Teaching Methods (RTM). The hypothesis posited that there was no statistically significant disparity in the academic performance of students in Chemistry when comparing those instructed by CBL with those instructed through RTM. The results in Table 7 shows the descriptive statistics for the pre-test mean scores in CAT for RTM and CBL groups.

Table 7:Pre-test CAT Mean Scores of students in CBL and RTM

Groups	N	Mean	Std Deviation	Std Error Mean
RTM	39	16.00	7.34	1.18
CBL	36	19.92	10.47	1.75

Table 7 shows that the mean scores of CBL was 19.92% while the mean score for RTM was 16.00%. The standard deviation (SD) of RTM was 7.34 while that of CBL was 10.47. The standard error mean for RTM was 1.18 while that of CBL was 1.75. An independent samples t-test was conducted to determine if there was a significant difference between the pre-test mean scores of RTMs and CBL in CAT. The results of the pre-test CAT comparison between CBL and RTM are shown in Table 8.

Table 8: t-test Results for the Pre-test CAT Mean Scores of Students in CBL and RTM

	F	Sig	t	df	Sig (2tailed)	Mean Difference	Std – error Difference
Equal Variances Assumed	4.04	0.05	1.89	73	0.063	3.92	2.08

Table 8 shows that the mean differences between RTM and CBL was 3.92 while the standard error difference was 2.08 when equal variances were assumed between RTM and CBL. The mean difference was statistically insignificant at $\alpha = 0.05$ significant level, t (73) =

1.89, $p > 0.05$. After eight weeks of the intervention, the results for the post-test CAT were analyzed. Data on Table 9 shows the descriptive statistics in post-CAT mean score in CAT between RTM and CBL.

Table 9: Post – test CAT Mean Scores of Students Exposed to CBL and those Exposed to RTM

Groups	N	Mean	Std Deviation	Std Error Mean
CBL	34	37.15	18.82	3.23
RTM	36	23.50	11.39	1.90

The results indicated that CBL had a higher mean score (37.15%) while RTM had lower mean score (23.50%). The standard deviation for the CBL was 18.82 while that of RTM was 11.39. The standard error mean for CBL was 3.23 while that for RTM was 1.90. In order to determine whether there was a notable disparity in mean scores in post-test CAT between RTM and CBL, independent samples t-test was used. The results are as shown in Table 10.

Table 10: t-test Results for the Post-test CAT Mean Scores of Students Exposed to CBL and those Exposed to RTM

	F	Sig	t	df	Sig(2tailed)	Mean Difference	Std Error Difference
Equal Variances Assumed	8.11	0.01	-3.70	68	0.00	-13.65	3.70

Table 10 shows that the mean differences between RTM and CBL was -13.65 while the standard error difference was 3.70. The mean differences when equal variances were assumed between RTM and CBL were statistically significant, $t(68) = -3.70$, $p < 0.05$. Therefore, the null hypothesis HO1, which claimed that there was no statistically significant disparity in students' Chemistry achievement between those instructed using CBL and those instructed using RTM, was rejected. Therefore, the contrary hypothesis, which claims that there was a statistically significant disparity in students' performance in Chemistry comparing those taught using CBL and those taught using RTM, was supported. This is evident that CBL contributed to higher achievement in Chemistry as compared to RTM by helping learners to construct knowledge meaningfully. Utilizing case studies as a pedagogical tool in the instruction of Chemistry enhanced learning through case scenarios which were applicable to everyday situations that helped learners to easily connect classroom learning with the daily life experiences. Based on the outcome of this study CBL was observed to be more effective in enhancing student's Chemistry achievement compared to RTM.

A study conducted by Dilek and Burhanettin (2018) revealed a substantial disparity in learning levels between the experimental groups and other groups, with the experimental groups showing superior performance. Research has shown that the implementation of Case Based Learning methodologies has a beneficial effect on the development of students' socialization, communication skills, and cooperation. A substantial percentage of students indicated that Case Based learning amplifies their enthusiasm for the course and heightens their awareness of their profession as teachers. Thus, Case-based Learning can serve as a foundation for curriculum development, and the efficacy of the curriculum can be evaluated in relation to improving students' cognitive, social, and emotional skills. The outcomes of this study are consistent with those of Kelvin (2015), who noted that case studies, regardless of their origin, were significantly more efficient than other means of delivering knowledge, resulting in improved performance on examination problems related to chemical bonding, osmosis and diffusion, mitosis and meiosis, and DNA structure. The reported learning gains obtained from using case studies were significantly different from those obtained from class discussion and textbook readings. Nevertheless, there was no statistically noteworthy disparity in learning gains observed between class conversation and textbook readings ($p>0.05$). The use of case studies greatly enhanced the understanding of the practical applications of science in everyday life, as compared to class discussions and textbook readings. However, there was no significant difference in the learning gains between participating in class discussions and reading the textbook, with a p-value greater than 0.05. In this study students taught through CBL had better performance compared to those taught through RTM. Studies have showed that using case studies is associated with favourable learning approach change across time as compared to a non-CBL learning techniques (Kulak *et al.,* 2014). Similar findings by Sendur and Aysel (2015) observed that there was a substantial disparity between experimental groups taught using CBL than those taught through activities defined in Chemistry curriculum and that CBL was more effective in facilitating conceptual transformation and ensuring a greater level of conceptual comprehension among students. There was a notable disparity observed between the groups following the instruction, with the experimental group demonstrating superior performance. Moon-Sook *et al.* (2014) compared case based learning with regular teaching methods, it was discovered that the group that underwent case-based learning demonstrated significantly higher levels of proficiency in interpersonal communication, aptitude for resolving complex issues, and strong drive for acquiring knowledge compared to those who received standard instruction. Their findings indicate that case-based learning is an efficacious strategy for both learning and teaching.

Research has identified a statistically significant discrepancy in the average scores of the relational and extended abstract categories between the CBL and lecture-based learning groups. Learners who were taught using the CBL methodology had the highest scores compared to students taught with lecture-based learning methodology (Mehmet *et al*., 2014). The findings of the study by Mabel (2021) indicated that Case Based Learning was more efficacious in improving students learning outcomes in Chemistry. When compared to conventional teaching methods Case Based Learning has been associated with increased on students learning outcomes in areas such as reasoning, the ability to make objective judgements, problem solving skills, students' retention, higher order skills among others. Hien and Tina (2014) also found that post test scores were significantly higher for CBL because it allowed students to gain knowledge and skills on health literacy and concluded that CBL exercises were more effective in teaching students the defined learning objectives. Previous research has demonstrated that students who were exposed to a case-based learning environment in a gradual manner, with lectures being gradually replaced by case-based learning, achieved lower scores in the surface approach (superficial understanding) and higher scores in the strategic approach (organized studying and effort management) during the post-measure, compared to students in a fully case-based learning environment. Thus, students in the progressively introduced case-based environment exhibited less reliance on superficial learning strategies, shown improved organization and efficiency, and invested greater effort and concentration compared to students who were exposed solely to case-based learning. Implementing a CBL structure that allows students greater autonomy in selecting problem-solving methods and resources has the potential to improve students' approaches over time (Marlies *et al*., 2012).

According to Kelvin (2015), case studies are more effective than traditional methods of information delivery in increasing the acquisition of many basic concepts in a general Biology course. Utilizing case study teaching methods has the potential to enhance student motivation and engagement during classroom activities, ultimately leading to improved learning outcomes and performance on assignments. The study conducted by Biggs and Tang (2011) demonstrated that problem-based learning (PBL) can effectively stimulate students to collect and utilize information in order to solve issues, enhance the retention of important information, and improve communication skills. More over CBL facilitates accessing higher-older cognitive skills such as applications, analysis, synthesis and evaluating more that than lecturing (Perlin, 2011). From previous study, it has been claimed that using an integrated case-based curriculum could effectively enhance students' deep learning and facilitate the integration of various scenarios that they are expected to meet during autonomous practice. According to Mehmet *et al*. (2014), Case Based Learning is potentially more beneficial for students compared to lectures, and it is suggested that group learning activities should be seen as a method of imparting information. The results of the current study are corroborated by Francis and Mabel (2015), who discovered that inquiry-based techniques, such as Case Based Learning, frequently offer a superior framework and setting for more substantial learning to occur. The technique promotes the student's active engagement while the teacher takes on the role of a facilitator rather than a traditional instructor in a conventional Chemistry class. Case Based Learning has a notable impact on students' performance in Chemistry. The student's interest was noted to be stimulated. The kids exhibited a strong inclination to acquire additional knowledge and shown heightened attentiveness towards the teacher. A case-based lesson is highly engaging since it enables students to engage in critical thinking and express their ideas and opinions, regardless of their correctness.

Other findings have showed that, case-based lecture was more efficient than didactic lecture in understanding the topic, clearing the basic concepts and in retention of knowledge. In addition, there are several positive outcomes like improved learning skills, independent learning abilities, analytical skills and communication skills etc. this indicated that case-based method was an effective method in a large classroom setting than conventional didactic lecture to promote active learning among the students (Nazish *et al.*, 2015). Datta and Ray (2016) in their study found significant increase in mean score of post-tests than from pre-tests with post-test mean score of Case Based Learning group significantly higher than that of didactic lecture group, although the difference in preferred mean score of the group was not significant. A further comparison of mean score of late post-test and immediate post-test of Case Based Learning group in second phase showed no significant difference whereas the same for didactic lecture group showed significantly lower means core in the late post-test. Feedback of student and teachers revealed that they were more satisfied with CBL than didactic learning. The study concluded that CBL is more effective and highly acceptable teaching learning tool than didactic learning. It has also been found that Case Based Learning had a positive effect on the students' critical thinking. The results of comparing the average score of pre-test and post- test analysis for critical thinking in the control group was statistically significant (Fariborz *et al*., 2010). Kulak and Newton (2015) noted that while numerous studies support Case-Based Learning (CBL) as a successful active learning methodology with favorable educational results, the majority of research has only compared CBL to traditional lecture-based methods. It was discovered that CBL reduced the use of surface learning methods observed in non-CBL groups and enhanced performance at the knowledge level, as per Bloom's taxonomy. Verena and Genevieve (2014) emphasized the limited amount of research that compares the effectiveness of CBL to other active learning approaches or traditional lectures. They also pointed out the lack of sufficient information regarding CBL's overall effectiveness in teaching material. A comparable study revealed notable disparities in academic performance between students instructed in Chemistry by Computer-Based Learning (CBL) and those taught using conventional lectures. Additionally, there were variations in student attitudes towards Chemistry, with CBL students exhibiting a more favorable opinion. The study suggested that all Chemistry teachers in secondary schools should utilize the CBL instructional technique, as advocated by Chabo *et al*. (2021).

Multiple research have indicated that the utilization of case study-based learning enhances student involvement, indicating a robust positive relationship between CBL and all four aspects of engagement: behavioral, emotional, cognitive, and agentic. The findings were substantiated by statistical analysis, which demonstrated that CBL improves comprehension of class ideas, fosters skill development, and boosts motivation for learning. The impact of student participation on learning performance differs depending on the specific aspect, and only agentic engagement demonstrates a statistically significant correlation with student performance (Syed *et al*., 2019). The random effects models demonstrated a notable disparity in academic attainment between CBL and traditional learning approaches, with CBL exhibiting a positive impact on students' academic performance and analytical abilities. Therefore, CBL can be regarded as a very efficient method of active instruction (Tsekhmister, 2023).

Research has indicated a notable enhancement in students' acquisition of knowledge subsequent to engaging in CBL sessions. The post-test scores for all the CBL sessions shown a substantial increase compared to the pre-test results. Most students had a favourable reaction to CBL sessions. Most students reported that Case-Based Learning (CBL) was an exceptionally effective educational method that enhanced their learning, improved their critical and analytical thinking skills, and encouraged self-directed learning. They viewed CBL as an excellent tool for connecting the fundamental science knowledge and concepts taught in lectures with the clinical and laboratory findings in case scenarios to make accurate diagnoses. This approach helped students concentrate on crucial aspects of the topic, reinforce essential concepts, and thereby improve information retention and long-term memory. This effectiveness is likely because CBL promotes knowledge retention and long-term memory by involving students in group discussions to solve clinical problems, where they recall and apply lecture concepts alongside other resources. It enables students to quickly review key areas and concepts from lectures before exams (Mohan *et al*., 2019). It has been showed from other research that the CBL group compared to the LBL group, obtained noticeably better results on the course evaluation. Based on the survey results, it was found that 90.6% of students in the CBL group reported that CBL had a positive impact on their learning and clinical problem-solving skills. CBL additionally equipped them with enhanced comprehension and readiness for assessments. The CBL group exhibited significant improvement in learning motivation compared to the Lecture Based Learning group.

The results indicated that CBL was a superior instructional approach in comparison to conventional teaching approaches in a specific course. The adoption of CBL in teaching has been shown to enhance students' learning motivation, problem-solving ability, and mastery of knowledge (Xingming *et al*., 2019). The objective of this study was to compare the impacts of CBL, TBL, and RTM on the academic performance and self-perception of Chemistry among secondary school students. Therefore, instructors should embrace change by introducing CBL in the curriculum in the ever-changing society. In a study conducted by Logan *et al*. (2022), no significant difference in assessment scores was found between the Case Based and Lecture Based groups. However, the researchers did get valuable input through the attitude evaluation, which can be used to improve teaching procedures in comparable environments, particularly in relation to attitudes. It was discovered that students derived pleasure from receiving new information through a lecture led by an instructor prior to participating in Case-based teaching approaches. Students recognize the instructor's role in providing guidance with classroom materials and express a preference for being challenged to utilize their experience in practical scenarios such as case studies. Students proposed giving priority to the correlation between classroom learning and practical use can be achieved by delivering introductory lectures followed by case studies.

Nana *et al*. (2022) found that Case Based Learning had a favourable impact on student engagement and improved the process of combining and incorporating knowledge from various areas within the subject. Case-based learning sessions facilitated productive discourse and fostered profound acquisition of knowledge. In addition, tutors discovered that facilitating structured Case Based Learning sessions was more manageable. The analysis of exam results revealed a considerable rise in summative assessment scores for subjects that utilized Case Based Learning, as compared to previous years. Case Based Learning yielded enhanced educational outcomes, resulting in heightened engagement, self-assurance, discourse, and elevated examination scores. According to Epiphania (2022), Students who received case-based training demonstrated superior average scores in comparison to those who were taught using traditional lectures. Thus, the integration of case-based learning in chemistry classes enhances analytical ability, resolving problems and higher-level cognitive abilities, leading to significant improvements in student performance. Case-based instruction is highly recommended due to its favorable impact on the chemistry teaching process and the teaching of science. Kusumantoro *et al. (*2022) showed that improving students' comprehension during the e-learning process is crucial and requires development. Enhancing students' skill development to understand lecture material can not only be done through face-to-face activities in class, but can also be done using other supporting activities. Limitations in the in-person educational instruction and acquisition process could be improved by using learning media, namely the case-based interactive e-module. Most studies comparing the advantages of case-based learning to the traditional lecture method in terms of student achievement show good outcomes in support of case-based learning.

4.3 Effect of TBL on Students' Achievement in Chemistry.

The second aim of this study was to ascertain whether there was a difference in the academic performance of students in Chemistry based on their exposure to TBL or RTM. The hypothesis posited that there was no statistically significant disparity in students' Chemistry achievement between those instructed using TBL and those instructed using RTM. The data presented in

Table 11 provides the descriptive statistics for the RTM and TBL groups in terms of the mean scores on the CAT pre-test.

Table 11: Descriptive Statistics for the Pre-test CAT Mean Scores of Students in TBL and RTM

Groups	N	Mean	Std Deviation	Std Error Mean
RTM	39	16.00	7.34	1.18
TBL	37	15.54	5.90	0.98

The results in Table 11 indicates that TBL group had lower mean scores of 15.54% when compared to RTM (16.00%) in the pre-test CAT. The standard deviation for RTM was 7.34 while that of TBL was 65.90. The standard error mean for RTM was 1.18 while that for TBL was 0.98. To determine if there was a significant difference between the pre-test mean scores of RTMs and TBL in CAT, an independent samples t-test was employed. Table 12 presents the findings.

Table 12: t-test Results for the Pre-test CAT Mean Scores on CAT between TBL and RTM

	F	Sig	t	df	Sig (2-tailed)	Mean Difference	Std Error Difference
Equal Variances Assumed	0.77	0.38	0.30	74	0.77	0.46	1.55

Table 12 shows that the mean differences between TBL and RTM was 0.46 while the standard error difference was 1.55 when equal variances were assumed between RTM and TBL. However, the results indicate that the mean difference between RTM and TBL was statistically insignificant at $\alpha = 0.05$ significant level, $t(74) = 0.30$, $p > 0.05$. In order to find out the effect of TBL in Chemistry achievement the post-test mean scores in CAT were analysed after eight weeks of intervention. Data on Table 13 shows the descriptive statistics in CAT Post-test mean scores between TBL and RTM.

Table 13: Post –test CAT Mean Scores of Students Exposed to TBL and those Exposed to RTM.

Groups	N	Mean	Std Deviation	Std Error Mean
RTM	36	23.50	11.39	1.90
TBL	36	34.47	17.54	2.93

The results indicated that RTM group had a mean score of 23.50% while TBL group had a mean score of 34.47%. The standard deviation for RTM and TBL were 11.39 and 17.54 respectively. The standard error mean for RTM was 1.90 while that for TBL was 2.93. Thus, students achieved better in Chemistry in TBL group than RTM group. An independent samples t-test was employed to determine if there was a noteworthy disparity in mean scores in CAT between RTM and CBL. The results are displayed in Table 14.

Table 14: Table: t- test Results for the Post-test CAT Mean Scores of Students Exposed to TBL and those Exposed to RTM.

	F	Sig	t	df	Sig(2-tailed)	Mean Difference	Std Error Difference
Equal Variances Assumed	2.66	0.11	3.15	70	0.00	-10.97	3.49

Table 14 shows that the mean differences between RTM and TBL was -10.97 while the standard error difference was 3.49. The statistical significance of the mean differences between RTM and TBL when equal variances were assumed was established by $t (70) = 3.15$, $p < 0.05$. The hypothesis (HO2), which claimed that there was no statistically significant difference in the achievement of Chemistry students taught using TBL versus RTM, was rejected ($t (70) = 3.15$, $p < 0.05$). Therefore, the alternative hypothesis, which states that there was a statistically significant difference in students' achievement in Chemistry between those taught using TBL and those taught using RTM, was confirmed. TBL led to higher students' mean scores in Chemistry when compared with RTM. The results of this study are consistent with the study by Haj-Ali and Quran (2013) that compared effects of Team Based Learning to regular teaching methods and found that team-based learning increased scores and student's satisfaction.

Researchers recommended that Team Based Learning sessions should begin with individual readiness assessment tests. Subsequent to these assessments, a concise explanatory presentation may be provided if necessary. Most of the time is dedicated to completing application exercises. The problems necessitate student groups to analyze the substance of the preparing resources and select a particular option, supported by evidence, as stated by Colin *et al.* (2019).

Richard and Lisa (2015) in their study on effectiveness of TBL found that the reaction to TBL was generally favourable. The overall satisfaction rating of the Team Based Learning class was greater for all questions in comparison to previous editions of the course. Several of the most crucial attributes shown a significant improvement at the 99% level. They saw that the majority of pupils perceived the RATs as a genuinely revolutionary deviation from the structured standard that they had encountered in previous educational environments. A report by some researchers has shown that student engagement and learning outcomes are significantly improved when students actively participate in team-based learning. The comprehensive analysis demonstrates that the utilization of team-based learning in theoretical teaching yields superior results compared to lecture-based learning in enhancing learning knowledge, attitude, and abilities in China. It is recommended to gradually include team-based learning into educational programs, as suggested by Minhian *et al*. (2018). Team-based learning produces results that are more substantial in comparison to the regular teaching methods. When a teacher employs Team based learning as a teaching approach, the students' academic performance improves enhancing their social and communication skills. Both high achievers and low achievers are proven to benefit from team-based strategies used in classrooms increasing their motivation and interest in the subject (Faiza &Musarrat, 2022). The findings by Minna and Thomas (2020) showed that TBL courses had significantly higher self-reported low-order and high-order cognitive outcomes compared to moderately structured active learning courses. Student ratings for three of the perceived learning outcomes were significantly higher for students in the TBL classes compared to active learning. These learning outcomes were: gaining factual knowledge, understanding concepts and learning to synthesize. All other measures were not found to be significantly different. Their results demonstrate that a specific teaching intervention by a given instructor can lead to reproducible course evaluation scores.

Researchers have additionally documented that TBL is a dynamic and organized learning procedure. The results exhibited statistical significance for the TBL group. The students' perspective was assessed using a 5-point Likert scale for both teaching techniques. The results showed a statistically significant higher score for TBL compared to the typical didactic lecture. Based on the students' performance and impression, the study determined that TBL is an effective teaching and learning method. Utilizing interactive and inventive small-group sessions can effectively address the limitations of conventional methods. In a typical traditional lecture, the facilitators or teachers serve as the main providers of knowledge. In order to engage students, the instructor should employ several instructional strategies along with the utilization of existing technologies (Rajeswarie *et al*., 2022). A separate study discovered that the academic performance of students who utilized team-based learning surpassed that of students who relied on lecture-based learning. This finding held true regardless of the students' gender and was particularly evident among senior students (Karim *et al*., 2021It has been concluded that TBL is an educational instructional technique that leverages the individual abilities of students by facilitating collaborative work towards a shared aim and objective. The main objective of TBL is the utilization of individual learners, emphasizing a high level of learning, effective communication, and consistency. TBL has been discovered that its implementation leads to better academic performance, increased student involvement, and higher levels of student contentment (Haidet *et al*., 2012). Students reported significant benefits from Team-Based Learning (TBL) according to a study by Sean *et al*. (2018). The majority of participants found TBL to be more effective than traditional lectures in promoting deeper understanding, applying knowledge, and retaining information. Notably, nearly all participants (almost 96%) felt TBL led to better knowledge retention compared to lectures. Moreover, TBL is better at promoting team work collaboration, communication and problem solving. Additionally, it is more efficient in fostering interpersonal responsibility, cultivating leadership abilities, and enhancing teaching proficiencies. Centrally to the present findings Salehe and Mohammadreza (2017) has demonstrated that there were no significant discrepancies in the performance among learners who were instructed using the TBL methodology in comparison to those who were taught using conventional teaching methods. Nevertheless, students who received instruction through the TBL approach exhibited a greater degree of satisfaction compared to those who were taught using conventional teaching methods. Students had elevated levels of fear, but, the reciprocal relationship and active collaboration among students throughout class had an impact on their willingness to embrace Team Based Learning.

A study conducted by Jafari (2014) revealed a significant discrepancy in the final scores between lecture-based learning and team-based learning. The study found TBL to be 81.3%

more satisfying than the lecture method. Their findings demonstrated greater efficacy and student contentment with team-based learning as opposed to traditional lectures in the instruction of neurology to undergraduate students. Implementing innovative teaching methods, including team-based learning, has the capacity to greatly improve educational results and student performance. Studies show Team-Based Learning (TBL) improves clinical reasoning in students. Unlike lectures, TBL fosters active learning – students build knowledge and then discuss cases with peers, sharpening their reasoning skills. A study found midwifery students using TBL had better reasoning compared to those in lectures, and this benefit lasted even two weeks later. Additionally, TBL students seemed more engaged. These findings suggest TBL is a valuable teaching method that can enhance reasoning and engagement compared to traditional approaches. Future research should explore the ideal TBL duration to maximize its effectiveness (Yunefit *et al*., 2021). In their study, Jeanne *et al.* (2014) investigated the impact of incorporating Team Based Learning into social studies lessons for 11th-grade students. The TBL components were incorporated by social studies teachers in the treatment groups for three educational units. An analysis was conducted to assess the overall influence of TBL on both proficiency in subject matter and the ability to understand written information. On the whole, students who took part in the classes using Team Based Learning achieved significantly better results in terms of their content understanding compared to students in the regular instruction sessions. Those in the treatment classes demonstrated superior learning and retention of knowledge compared to those in the regular instruction classes. Only the specific construct of topic knowledge showed noticeable impacts, while no distinctions were observed across groups using an established test that measures how well people understand different kinds of reading materials. Nevertheless, TBL did not seem to be an effective component in enhancing comprehension of written text. Hence, the incorporation of additional instructional elements should prioritize the attainment of information and improvement of reading comprehension in the field of social studies.

Research have shown that Team-based learning is an effective pedagogical approach for instructors seeking to augment student engagement, active learning, and classroom discourse. This teaching style has been examined in numerous curricular models in pharmacy education and various other disciplines. The Readiness Assurance Process enhances students' comprehension of instructors' requirements, ensures their preparedness for class discussions, and fosters their active engagement in the learning process as part of a team. Utilizing TBL enables students to employ fundamental information in practical situations. Funding is necessary for faculty development initiatives focused on efficiently utilizing TBL, preparing students for a new learning method and fostering strong teamwork to ensure its smooth adoption. Regular and effective assessment of team-based learning activities is necessary to track progress and ensure that desired goals are met. In order to evaluate the effectiveness of any modifications made to the curriculum, it is crucial to consider the perspectives of teachers, students, and the metrics used to evaluate the course. These factors should be considered while planning future implementation of TBL. Team-based learning enables educators to cultivate an engaged teaching methodology in the classroom by utilizing group activity. The TBL architecture involves students actively participating in the learning process by utilizing the Readiness Assurance Process, engaging in problem-solving through team discussions, and providing peer feedback to ensure responsibility and ownership (Heather *et al.*, 2015). It has been concluded that TBL is a preferable and recommended method for the students, and that while seminars achieved more presentation skills, however, TBL achieved more clinical skills. Regarding assessment methods, most of the participants believed it depends on the group work in TBL (Mohammed *et al*., 2020**)**.

A study conducted by Jonathan and Jacqueline (2018) also demonstrated a positive familiarity Team-based Learning. The majority of pupils expressed increased responsibility and contentment with Team-based Learning. The learners' choice for Team-based Learning may be attributed to the perceived significance of lectures that encouraged active learning, which constituted a crucial aspect of their educational experience, as evidenced by the 76% who exhibited this preference. The majority of students expressed a desire to make a significant impact in order to avoid disappointing their team. Participating in Team-based Learning activities significantly impacted students' individual experiences with teamwork, according to research. The study conducted by Faiza and Musarrat (2022) revealed that students taught through team-based learning had considerably better levels of motivation compared to students taught using conventional techniques, as indicated by the mean scores. Furthermore, the Pearson correlation analysis revealed a strong, positive, and statistically significant association between the two variables: scholarly achievement as well as inspiration. This suggests that students' academic achievement in the field of Chemistry is closely linked to their level of motivation. TBL exercises are often considered to be more demanding, beneficial, and fun compared to standard lectures, as they promote peer interaction, assist students in resolving issues with their peers, enhance confidence, and facilitate learning. In addition, classroom discussions alleviate student anxiety and enhance their self-awareness regarding the learning process. Team-based learning guarantees equal access to educational opportunities, converts competition into camaraderie, enhances collaboration and partnerships, and fosters critical thinking and creativity in a classroom environment.

4.4 Comparison of the Effects of CBL and TBL on Students' Achievement in Chemistry

A third objective of this research was to assess how CBL, TBL, and RTM teaching approaches impacted student performance in Chemistry. The corresponding hypothesis was that there was no statistically significant disparity in learners achievement in Chemistry between those who were instructed using CBL, TBL, and those who were instructed using RTM. Data in Table 15 shows the descriptive statistics obtained by students in the three groups in the Pre-test CAT.

Table 15: Pre-test CAT Mean Scores of Students in the Three Groups

Group	N	Mean	Std. Deviation	Std. Error
RTM	39	16.00	7.34	1.18
CBL	36	19.92	10.47	1.75
TBL	37	15.54	5.97	0.98
Total	112	17.07	8.31	0.79

The mean scores of the RTM were 16.00%, CBL (19.92%) and TBL (15.54%) in the Pre-test CAT. The standard deviation for RTM, CBL and TBL were 7.34, 10.47 and 5.97 respectively. The results indicate that the mean score in CAT for CBL was highest while that of TBL was the lowest. The standard error for RTM, CBL and TBL were 1.18, 1.75 and 0.98 respectively. Although the mean score for CBL was the highest than the RTM and TBL groups, the differences were not statistically significant between RTM and CBL, TBL and RTM. One-way ANOVA was used to analyse whether there was significant difference in pre-test mean scores of the students taught using TBL, CBL and those taught using RTM. The results are shown in Table 16.

Table 16 : Analysis of Variance (ANOVA) of the Pre-test CAT Mean Scores

Learning Type	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	422.78	2	211.39	3.21	0.04
Within Groups	7167.94	109	65.76		
Total	7590.71	111			

The results showed that the mean difference between the Pre-test CAT mean scores were statistically significant, F (2,109) = 3.21, p<0.05. This showed that the groups started experiments at different levels and consequently, additional analysis was required to identify the disparities among the group's initial level. Tukey HSD was used to establish whether there was a statistically significant difference in achievement in CAT pre-test means scores of students in the three groups. The results are shown in Table 17.

Table 17 : Tukey HSD Post Hoc Comparisons of Pre – test CAT Mean Scores for the Three Groups

Dependent Variable: learning Type Tukey HSD				
(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.
RTM	CBL	-3.92	1.87	0.10
	TBL	0.46	1.86	0.97
CBL	RTM	3.92	1.87	0.10
	TBL	4.38	1.90	0.06
TBL	RTM	-0.46	1.86	0.97
	CBL	-4.38	1.90	0.06

The results indicate that the mean differences were statistically insignificant between groups RTM and TBL, RTM and CBL and between groups CBL and TBL. An analysis of Covariance (ANCOVA) was also carried out using KCPE marks as the covariates. The results are shown in Table 18.

Table 18 : Analysis of Covariance (ANCOVA) of the Pre- test CAT Mean Scores using KCPE Marks as Covariates

Source	Sum of Square	df	Mean Score	F	Sig
Intercept	823.43	1	823.43	12.49	0.00
KCPE Marks	20.75	1	20.75	0.32	0.58
Groups	441.33	2	220.67	3.35	0.04
Error	7122.16	108	65.95		
Total	40375.00	112			
Corrected total	7563.49	111			

The results in Table 18 for the ANCOVA demonstrate the average difference were statistically insignificant. A test for the homogeneity of variances was done and the results obtained are shown in Table 19.

Table 19 : Test for Homogeneity of Variances on the Pre-test CAT Mean scores

	Levene's Statistic	df_1	df_2	Sig
Based on mean	4.72	2	109	0.01
Based on median	2.27	2	109	0.11
Based on median and with adjusted df	2.72	2	89.65	0.11
Based on trimmed mean	4.21	2	109	0.02

The results in Table 19 on the test for homogeneity of variance using Levene's test for equality of error variances revealed that the error variances of the dependent variables were equal across the three groups. The results also confirmed that the three groups started the experiment at the same entry level of achievement as evidenced in CAT mean scores. Any significant difference that was observed in the Post –test in CAT mean scores was attributed to the effects of interventions. The experimental groups were taught using CBL and TBL and then compared with those students taught through RTM. After the experiment was concluded, the analysis on the mean scores of the post-test CAT was done. Data in Table 20 shows descriptive statistics for CBL, TBL and RTM in post-test CAT.

Table 20 : Results for the Post-test CAT Mean Scores of Students Exposed to CBL, TBL and those Exposed to RTM

	N	Mean	Std deviation	Std error
RTM	36	23.50	11.39	1.90
CBL	34	37.15	18.82	3.23
TBL	36	34.47	17.55	2.93
Total	106	31.60	17.10	1.66

CBL had a mean score of 37.15% while TBL group attained a mean score of 34.47%. RTM had a mean score of 23.50%. The standard deviation for CBL, TBL and RTM were 18.82, 17.55 and 11.39 respectively. The standard error for CBL, TBL and RTM were 3.23, 2.93 and 1.90 respectively. One-way ANOVA was used to analyse the differences in post -test CAT mean scores in the three groups. The results are shown in Table 21.

Table 21 : Analysis of variances (ANOVA) of the Post – test CAT Mean Scores of Students in the Three Groups

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	3705.12	2	1852.56	7.01	0.00
Within Groups	2700.24	103	262.20		
Total	30711.36	105			

The results presented in Table 21 show the average disparities in CAT were statistically significant in the three groups, $F(2,103) = 7.01$, $p<0.05$. Table 22 shows the Test for Homogeneity of Variances on the Post-test CAT Mean scores.

Table 22 : Test for Homogeneity of Variances on the Post-test CAT Mean Scores

	Levene's Statistic	df_1	df_2	Sig
Based on mean	3.32	2	103	0.04
Based on median	3.26	2	103	0.04
Based on median and adjusted df	3.26	2	94.09	0.04
Based on trimmed mean	3.44	2	103	0.04

The analysis conducted using Levene's test for equality of error variances, as shown in Table 22, indicated that the error variances of the dependent variable were found to be equal across the three groups, with a significance level of $p<0.05$. Post-hoc multiple comparisons were employed to determine the average disparities in achievement in CAT mean scores among students who received instruction through CBL, TBL, and RTM. The findings are displayed in Table 23.

Table 23 : Tukey HSD Post Hoc Comparisons of Post – test CAT Mean Scores for the Three Groups

Group (i)	Group (j)	Mean Difference (i - j)	Std. Error	p-value
RTM	CBL	-13.65*	3.87	0.00
	TBL	-10.97*	3.82	0.01
CBL	RTM	13.65*	3.87	0.00
	TBL	2.68	3.87	0.77
TBL	RTM	10.97*	3.82	0.01
	CBL	-2.68	3.87	0.77

*The mean difference is significant at α= 0.05 level.

The results indicated that there were statistically significant mean differences in post-test CAT scores between the two instructional methods, RTM and TBL, with a p-value of less than 0.05. The post-test CAT scores showed statistically significant mean differences between RTM and CBL, with a p-value of less than 0.05. Nevertheless, the average disparities in post-test computerized adaptive testing (CAT) scores between computer-based learning (CBL) and technology-based learning (TBL) were not statistically significant, with a p-value greater than 0.05. The study employed Analysis of Covariance (ANCOVA) with KCPE marks as the covariates. The findings are presented in Table 24.

Table 24 : Post -test CAT Analysis of Covariance (ANCOVA) Carried out using KCPE marks as Covariates

Source	Sum of Square	df	Mean Score	F	Sig
Intercept	3738.69	1	3738.69	14.30	0.00
KCPE Marks	328.21	1	328.21	1.26	0.27
Groups	3430.76	2	1715.38	6.56	0.00
Error	26678.03	102	261.55		
Total	136584.00	106			
Corrected total	30711.56	105			

The ANCOVA analysis revealed that there were statistically significant mean differences, with a p-value of less than 0.05. The hypothesis HO3, which claimed that there was no statistically significant difference in students' achievement in Chemistry between those taught using CBL, TBL, and RTM, was disproven. The alternative hypothesis, which posited a statistically significant disparity in students' Chemistry achievement between those instructed with CBL and those instructed with TBL, was confirmed.

This study found that TBL improved student's mean scores and that the mean differences were statistically significant when compared with RTM. The results of this study are consistent with that of Lucas *et al*. *(*2017) that found a significant increase in the students' engagement from pre-test to post-test when students were taught using TBL and a significant increase in student perceived learning. In TBL classes, the teacher guides the students by explaining the reasons behind the learning tasks and providing a framework for them. The teacher also encourages critical thinking and collaboration among the students through individual readiness assurance tests (IRAT) and working together with their peers. Based on a systematic review conducted by Fatmi *et al*. (2013), the majority of studies have shown that Team-Based Learning (TBL) has a considerable positive impact on students' knowledge level. However, some researchers have discovered that when compared to other teaching approaches, TBL does not offer any clear advantages. A comparable study revealed that students expressed greater happiness and perceived a deeper comprehension of the subject matter while engaged in CBL as opposed to TBL. However, in terms of total student performance, TBL outperformed CBL. The students demonstrated superior performance in TBL compared to CBL, but both strategies required extensive resource utilization. While TBL necessitated a smaller number of rooms and facilitators compared to CBL, it demanded a greater amount of preparation time for both students and teachers. CBL and TBL are both ways of guided inquiry, but TBL is a more organized approach to learning that includes several chances for formative evaluation (Colin *et al*., 2019). According to Maia *et al*. (2023), the Case Based Learning group outperformed the other teaching technique groups in terms of academic performance, as indicated by exam results and curiosity. There were no significant differences in other academic performance or perceived outcomes between Case Based Learning and other teaching techniques, based on the combined effect. The usage of CBL demonstrated higher academic achievement, particularly when compared to didactic lectures and tutorial-based instruction. Additionally, it fostered greater interest and motivation among students compared to other teaching techniques.

Ray *et al*. (2014) observed that despite the long-standing application of TBL, additional research is necessary to ascertain the influence of this on teaching effectiveness and its acknowledgement by both teachers and students. This research is essential to obtain more definitive data for validation and support. TBL teaching can be effective for large classes with shortage of teachers. The results of this study align with another study that demonstrated a significant improvement in individual students' scores on terminal tests after TBL teaching interventions. These findings further confirm that TBL has been shown to be a highly successful approach for improving students' acquisition of knowledge (Rul *et al*., 2017). Tan *et al*. (2011) showed that preparation outside the class encouraged the students to study regularly and make necessary preparations before to attending class and creates an optimal environment for independent and active learning. TBL may be a useful adjunct teaching method particularly for academically weaker learners. A similar study by Maria *et al*. (2015) showed that TBL improved student learning and was well-received by the students. They suggested the use of TBL model in science topics. In their study, Karen *et al*. (2018) proposed that the implementation of a TBL (Team-Based Learning) approach can significantly improve students' academic, professional, and interpersonal skills. According to Annette *et al*. (2019) both students and teachers saw that the usage of TRAT and small groups not only fostered collaboration and teamwork, but also provided each individual student with an equal chance to contribute to their teams and enhance practical efficiency in the learning and teaching process. Both students and facilitators concurred that the utilization of problem-solving in TBL offered a chance to enhance students' comprehension by promoting self-reflection and providing a method to recognize areas of insufficient information and expand upon existing knowledge. Dixon and Wellsteed (2019) provided evidence that implementing a structured team-based learning method for quality improvement has a significant impact on the performance of teams in clinical settings. This impact was assessed using a validated tool for measuring team performance. The teams shown a heightened emphasis on the patients' needs and an elevated commitment to quality. The team climate demonstrated a high level of support for creativity and innovation, as team members consistently provided practical assistance to one another in order to foster the development of new ideas or approaches to work. Furthermore, there was an enhanced level of contentment regarding the acknowledgment that team members received from their colleagues for their valuable input to the team, as well as the manner in which conflicts were effectively addressed and resolved. Team members expressed a heightened sense of connection to both the team and their fellow team members. According to their study, the teams expressed a significant increase in motivation to engage in collaborative work with other teams, which was seen as the most notable area of improvement. In their study, Maria *et al*. (2019) proposed that combining the flipped classroom method the use of team-based learning led to favourable student results, improved learning, and enhanced understanding. The students provided excellent feedback regarding the use of in-class Team Based Learning activities in Physics and Engineering teaching. This has resulted in an improvement in the students' participation rate in the Team Based Learning workshops.

In order to analyze the correlations between the proposed dimensions, future researchers need take into account individual attributes and specific circumstances. This is important because students exhibit different responses to learning activities. Developing students' ability to analyze information, solve problems, and participate actively in their learning in higher education is essential for fostering students' cognitive processes and assessing their abilities (Syed *et al*., 2019). Students derive satisfaction from various aspects of Team-based Learning, including collaborating with a team and resolving practical exercises. It is clear that TBL (Team-Based Learning) has the potential to be an equally successful substitute for the traditional lecture style in teacher preparation courses, as shown by Brannan *et al*. (2022). Team Based Learning can be introduced with relatively small changes to the course structure and offer an effective means to increase student engagement. The Team Based Learning pedagogy helps to move students beyond information gathering as a primary takeaway from class to apply content to the real world. Until science instructors are able to convert lectureheavy content courses into more active learning environments, students will continue to struggle with collaboration, which is imperative in preparing students to become more scientifically literate and competitive in the world (Virginia *et al*., 2020). The findings of the study carried out by Hellen (2017) indicated that the constructivist group outperformed the Lecture group significantly. These findings indicate that the constructivist model is more effective than the Lecture technique for instructing Biology at the secondary school level. The reason for this discrepancy might be attributed to the constructivist paradigm, which allows pupils to actively participate in constructing their own knowledge. Koles *et al*. (2010) suggest that academic success can be attributed to a mix of heightened drive to study, influence from peers, and the effectiveness of group discussions. Regarding the test scores obtained one week following the teaching intervention, the TBL group had a much superior level of performance in comparison to the lecture-based learning group, which is consistent with the results of this study (Rul *et al*., 2017). Research indicates that while TBL is not widely employed in STEM disciplines, it has been effective in improving student learning outcomes in various other academic areas (Maria *et al*., 2015). Team Based Learning offers students the chance to acquire essential skills and use them in preparation for future employment. Their findings highlight the potential advantages of using a TBL approach as a student-centred teaching method that introduces students to novel concepts, fosters connections, enhances organizational abilities, and promotes self-awareness of strengths and weaknesses. Furthermore, TBL offers students the opportunity to acquire the necessary skills and knowledge for transdisciplinary practice, hence enhancing their learning experience (Karen *et al*., 2018). Dixon and Wellsteed (2019 noted that on repeated measurement using Team based learning the teams perceived a reduction in the level of challenge to the teams. Nevertheless, it remained uncertain whether the discoveries could be generalized to other teams or contexts, or if alternative methods yielded comparable outcomes. Therefore, further investigation is required to explore the correlation between team development and the long-term performance of teams in the context of learning.

In a separate survey, numerous students expressed their inclination towards CBL as opposed to TBL for various reasons. First, in the context of Case Based Learning, participants had a greater number of occasions for engaging in conversation and were able to comprehensively address learning objectives compared to Team Based Learning. Secondly, the utilization of a small group structure in CBL resulted in a less stressful atmosphere that was more favourable for active engagement. Conversely, participants said that TBL fostered a more disruptive environment, impeding their ability to focus. The individuals who favoured the TBL found it beneficial for maintaining personal responsibility in their learning and ensuring they remained knowledgeable about all the materials. Another potential reason for the preference for CBL might be attributed to the existence of previous weekly sessions and a reduced amount of overall preparation time compared to TBL. Nevertheless, the students demonstrated superior performance on examinations in the TBL course compared to the CBL course, despite a substantial disparity in knowledge item scores. Furthermore, the extensive student preparation that is typical in CBL and TBL enables the majority of in-class time to be dedicated to the application of materials, rather than the repetition of factual information. This approach assists students in achieving a higher degree of learning, as outlined in Blooms' taxonomy. The marginally superior academic learners' performance in the TBL course compared to those in the CBL course can be attributed to their performance on the knowledge-based assessments within the TBL course. The results contradict with the present findings whereby the performance of students in Chemistry was higher in CBL class than in TBL group (Colin *et al*., 2019). Richard and Lisa (2015) argue that TBL, can be a highly effective pedagogical approach for teaching science, particularly in an environment that maximizes the potential for collaborative exploration, discussion, and presentation. Partitioning the class into enduring teams facilitates the administration and assessment of student involvement. Typically, conducting TBL in a specialized collaborative classroom with strong technology support leads to a more favourable outcome.

4.5 Effect of CBL on Students' Self-concept in Chemistry

The fourth objective of this study was to find out if there was a disparity in students' Chemistry self-concept between those who were subjected to CBL and those exposed to RTM. The hypothesis states that there is no statistically significant disparity in students' Chemistry self-concept between those who were taught using CBL and those who were taught through RTM. The results in Table 25 shows the descriptive statistics for the pre-test mean scores in SSCQ between RTM and CBL groups.

Table 25 : Descriptive Statistics for the Pre-test SSCQ Mean Scores of Students in CBL and RTM

Groups	N	Mean	Std Deviation	Std Error Mean
RTM	39	66.46	9.27	1.49
CBL	36	64.08	8.48	1.41

The results indicate that RTM had a higher pre-test mean score (66.46%) as compared to CBL (64.08%). The standard deviation for the RTM was 9.27 while that of CBL was 8.48. The standard error mean for RTM was 1.49 while that for CBL was 1.41. An independent samples t-test was employed to determine if there was a notable difference between the mean scores of RTMs and CBL in the SSCQ pre-test. The outcomes are presented in Table 26.

Table 26 : t-test Results for the Pre-test SSCQ Mean Scores of Students in CBL and RTM

	F	Sig	t	df	Sig(2tailed)	Mean Difference	Std Error Difference
Equal Variances Assumed	0.44	0.51	1.16	73	0.25	2.38	2.06

Table 26 shows that the mean differences between RTM and CBL was 2.38 while the standard error difference was 2.06. The mean differences when equal variances were assumed between RTM and CBL not was statistically significant, t (73) = 1.16, $p > 0.05$. The results in Table 27 shows the descriptive statistics for the post-test mean scores in SSCQ between RTM and TBL groups.

Table 27 : Post – test SSCQ Mean Scores of Students Exposed to RTM and those Exposed to CBL

Groups	N	Mean	Std Deviation	Std Error Mean
RTM	36	64.58	9.26	1.54
CBL	34	72.94	13.88	2.38

The results indicated that RTM group had a mean score of 64.58% while CBL group had a mean score of 72.94%. The standard deviation for RTM and CBL were 9.26 and 13.88 respectively. The standard error mean for RTM was 1.54 while that for CBL was 2.38. Independent samples t-test was used to determine whether there was a significant difference in mean scores in SSCQ between RTM and CBL. The results are shown in Table 28.

Table 28 : t-test Results for the Post -test SSCQ Mean Scores of Students Exposed to RTM and those Exposed to CBL

	F	Sig	t	df	Sig(2tailed)	Mean Difference	Std Error Difference
Equal Variances Assumed	7.70	0.01	-3.0	68	0.00	-8.36	2.81

Table 28 shows that the mean differences between RTM and CBL was -8.36 while the standard error difference was 2.81. The mean difference when equal variances were assumed between RTM and CBL was statistically significant, $t(68) = -3.00$, $p < 0.05$. The $H_0 4$ stating that there is no statistically significant difference in students' Chemistry self-concept between those taught using CBL and those taught through RTM was rejected. Therefore, the alternative hypothesis stating that there is a statistically significant difference in the mean scores of students' Chemistry self-concept between those taught via CBL and those taught through RTM was confirmed. The results of this study are consistent with the findings of Amruta *et al*. (2018) which also concluded that CBL creates self-interest reading in the students' discussion during lesson and thus helps in understanding the concepts and that was a better method for obtaining the knowledge. Similar research by Gabel and Connie (2000) found that students' interest was stimulated when CBL was used. Students feel better in the interaction and their active involvement can be seen. Interactive teaching styles incorporate a multitude of goals beneath a single roof whereas students often lose interest during lecture- style teaching. Interactive teaching styles promote an atmosphere of attention and participation making it interesting, exciting and creating fun. Oluwatosin and Bamidele (2014) determined that possessing a positive self-concept is a crucial psychological element for attaining success in the field of science. As a result, it is recommended that professors and school counsellors actively involve students in cultivating a favourable self-concept in relation to their chosen subject.

Richard and Lisa (2015) discovered that although structuring the class into permanent teams was a difficult and uncertain undertaking for the instructor, it was generally well-received by the majority of students. The learners' achievement rate was comparable between the previous active-learning classes and the TBL versions, with grades generally being higher. Nevertheless, a thorough examination of the final exam questions indicates that TBL does not seem to notably enhance understanding of specific ideas, especially in a conventional auditorium-style classroom. The conventional TBL approach significantly reduces the use of lectures and instead promotes collaborative work among students during class time. This allows students to delve into many areas of the subject matter in a more comprehensive manner than what is often achievable in a traditional classroom setting. A study by Suvarna and Singh (2014) found that post test scores and gains in learning in CBL sessions were significantly higher than that of lecture. Students responded that CBL had improved their learning skills, independent learning abilities, analytical and communication skills indicating that CBL is an effective method in a large classroom setting than lecture.

Oluwatosin and Bamidele (2014) noted that science teachers should consistently assess the initial behavior of learners and enhance their self-assurance through suitable teaching and learning methods that would yield the desired outcomes. Students with a positive self-concept on their Chemistry abilities are likely to be driven to achieve success, even when faced with challenges. A study by Marsh and Martin (2011) suggests that improving students' self-concept in their academic abilities can lead to better academic performance and other positive educational results. Their research showed that self-concept is not only an important result, but also has a crucial influence on another desirable educational outcome. Ebeh (2000) argued that a robust self-concept in a specific subject promotes contentment in the learning process of that subject, together with social approval and accomplishment. On the other hand, a deficient self-perception in a certain subject can result in unsuccessful outcomes in that field. The academic self-concept is a significant construct for educators to consider when trying to comprehend an individual student's degree of accomplishment (Mohamed & Sarwat, 1998). The promotion of self-concept and motivation is highly esteemed as a favorable result of secondary education. Parents, educators, and researchers are constantly seeking effective strategies to enhance students' academic motivation and, consequently, their performance. Enhanced academic self-perception and drive can result in higher academic performance, while better performance can in turn lead to enhanced academic self-perception and motivation (Jasmine *et al*., 2006). Hellen (2017) conducted a study which found that students who were instructed utilizing the constructivist technique had considerably higher levels of self-concept in comparison to those who received standard lecture-based training. This may be attributed to pupils independently solving issues, which in turn fosters their comprehension of the subject matter. The acquisition of knowledge is an ongoing and continuous process throughout one's life. The individuals' created body of knowledge is coherent and aids in their interpretation and prediction of events in their experience realms.

4.6 Effect of TBL on Students' Self-concept in Chemistry

The fifth objective of this study was to compare the Chemistry self-concept between students exposed to TBL with those exposed to RTM. The corresponding hypothesis stated that there is no statistically significant difference in students' Chemistry self-concept between those taught using TBL and those taught through RTM. The data presented in Table 29 displays the descriptive statistics for the pre-test mean scores in SSCQ between RTM and TBL groups.

Table 29 : Descriptive Statistics for the Pre-test SSCQ Mean Scores of Students in RTM and TBL

Groups	N	Mean	Std Deviation	Std Error Mean
RTM	39	66.46	9.27	1.49
TBL	37	68.84	10.89	1.79

The results indicate that RTM had a lower pre-test mean score (66.46%) as compared to TBL (68.84%). The standard deviation for the RTM was 9.27 while that of TBL was 10.89. The standard error mean for RTM was 1.49 while that for TBL was 1.79. Independent sample t-test was used to determine whether there was a significant difference in mean scores in SSCQ between TBL and RTM. The results are shown in Table 30.

Table 30 : t-test Results for the Pre-test SSCQ Mean Scores of Students in TBL and RTM

	F	Sig	t	df	Sig(2tailed)	Mean Difference	Std Error Difference
Equal Variances Assumed	0.93	0.34	-1.03	74	0.31	-2.38	2.32

Table 30 shows that the mean differences between RTM and TBL was -2.38 while the standard error difference was 2.32. The mean differences when equal variances were assumed between RTM and TBL was statistically insignificant, t (74) =-1.03, $p > 0.05$. Data in Table 31 shows results obtained in the post-test SSCQ mean scores.

Table 31 : Post– test SSCQ Mean Scores of Students Exposed to RTM and those Exposed to TBL

Groups	N	Mean	Std Deviation	Std Error Mean
RTM	36	64.58	9.26	1.54
TBL	36	74.64	12.26	2.04

The results indicate that RTM had a mean score of 64.58% which represents a decline while TBL had a mean score of 74.64%. The standard deviation of RTM was 9.26 while that of TBL was 12.26. The standard error mean for RTM was 1.54 while that of TBL was 2.04. Independent sample t-test was used to determine whether there was a significant difference in post-test mean scores in SSCQ between TBL and RTM. The results are shown in Table 32.

Table 32 : t-test Results for the Post- test SSCQ Mean Scores of Students Exposed to RTM and those Exposed to TBL

	F	Sig	t	df	Sig(2tailed)	Mean Difference	Std Error Difference
Equal Variances Assumed	4.40	0.04	-3.93	70	0.00	-10.06	2.56

Table 32 shows that the mean differences between RTM and TBL was -10.06 while the standard error difference was 2.56. The mean difference when equal variances were assumed between RTM and TBL was statistically significant, t (70) =-3.93, $p < 0.05$. The null hypothesis stating that there is no statistically significant difference in students' Chemistry self-concept between those taught using TBL and those taught through RTM was therefore rejected. The alternative hypothesis stating that there is statistically significant difference in students'

Chemistry self-concept between those taught using TBL and those taught through RTM was accepted.

4.7 Comparison of the Effects of CBL, TBL and RTM on Students' Chemistry Self-Concept

The sixth objective of this study was to compare the difference in students' Chemistry self-concept among those exposed to CBL, TBL with those exposed to RTM. The corresponding hypothesis was there is no statistically significant difference in students' Chemistry self-concept among those taught using CBL, TBL and those taught through RTM. The results in Table 33 show the descriptive statistics for the pre-test mean scores in SSCQ for CBL, TBL and RTM groups.

Table 33 : Pre- test SSCQ Mean Scores for Students in CBL, TBL and RTM.

Group	N	Mean	Std. Deviation	Std. Error
RTM	39	66.46	9.27	1.49
CBL	36	66.08	8.48	1.41
TBL	37	68.84	10.88	1.79
Total	112	66.48	9.71	0.92

TBL had highest mean scores (68.84%) while CBL had the lowest mean scores (66.08%). The standard deviation was 10.88, 9.27 and 8.48 for TBL, RTM and CBL respectively. The standard error mean for RTM, CBL and TBL were 1.49, 1.41 and 1.79 respectively. Tukey HSD was used to establish the differences in mean scores in SSCQ for the three groups. The results are shown in Table 34.

Table 34 : Tukey HSD Post Hoc Comparisons of Pre – test SSCQ Mean Scores for the three Groups

Dependent Variable: learning Type Tukey HSD				
(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.
RTM	CBL	2.38	2.22	0.53
	TBL	-2.38	2.20	0.53
CBL	RTM	-2.38	2.22	0.53
	TBL	-4.76	2.25	0.09
TBL	RTM	2.38	2.20	0.53
	CBL	4.76	2.25	0.09

The results indicate that the mean differences were not statistically significant between groups RTM and TBL, RTM and CBL and between groups CBL and TBL when equal variances were assumed. An analysis of variance (ANOVA) was also carried out and the results are shown in Table 35.

Table 35 : Analysis of variance (ANOVA) of the Pre-test SSCQ Mean Scores

Learning Type	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	412.50	2	206.25	2.24	0.11
Within Groups	10047.47	109	92.18		
Total	10459.96	111			

The results of this experiment indicate that mean differences in SSCQ was statistically insignificant in the three groups, $p>0.05$. The results also indicate that the three groups started the experiment at same levels of self-concept as revealed by SSCQ mean scores. Any significant difference that was observed in the Post-test in SSCQ mean scores could be attributed to the effect of interventions. Data on Table 36 shows the post-test mean scores in SSCQ obtained by the three groups.

Table 36 : Post- test SSCQ Mean Scores of Students in the Three Groups

	N	Mean	Std Deviation	Std Error
RTM	36	64.58	9.26	1.54
CBL	34	72.94	13.88	2.38
TBL	36	74.64	12.56	2.04
Total	106	70.68	12.61	1.23

The mean scores indicate that the experimental groups CBL and TBL attained higher mean scores than RTM. The mean score of the RTM was 64.58% while that of TBL and CBL were 74.64% and 72.94 respectively. The standard deviation of CBL, RTM and TBL were 13.88, 9.26 and 12.56. The standard error for RTM, CBL and TBL 1.54, 2.38 and 1.23 respectively. Based on this result, students taught using CBL and TBL achieved better in SSCQ as compared to those taught using RTM. This indicates that the use of CBL and TBL enhanced self-concept of leaners in Chemistry. A test for homogeneity of variances in post-test mean scores was carried out. The results are shown in Table 37.

Table 37 : Test for Homogeneity of Variances in Post- test SSCQ

	Levene's statistic	df_1	df_2	Sig
Based on mean	4.10	2	103	0.02
Based on median	3.70	2	103	0.03
Based on median and trimmed df	3.70	2	96.24	0.03
Based on trimmed mean	4.04	2	103	0.02

The results in Table 37 on the test for homogeneity of variance using Levene's test for equality of error variances revealed that the error variances of the dependent variable were equal across the three groups, $p<0.05$. Analysis of Variance (ANOVA) was used to analyse the differences in mean scores in the three groups. The results are shown in Table 38.

Table 38 : Analysis of Variance (ANOVA) of the Post-test SSCQ Mean Scores

Group	Sum of Squares	df	Mean square	F	Sig.
Between Groups	2076.16	2	1038.08	7.32	0.00
Within Groups	14612.94	103	141.87		
Total	16689.09	105			

The results show that the mean difference among the three groups in post -test mean scores in SSCQ were statistically significant, F (2, 103) = 7.32, P<0.05. This effect could be attributed to intervention in teaching Chemistry since TBL and CBL groups had a higher mean score in SSCQ than RTM. Post hoc multiple comparison of post- test on SSCQ mean scores of students who were taught using CBL, TBL with those taught using RTM was carried out to determine where the mean differences were statistically significant. The results are shown in Table 39.

Table 39 : Post Hoc Tukey Multiple Comparisons of Post -test SSCQ Mean Scores for the three Groups

Group (i)	Group (j)	Mean Difference (I-J)	Std. Error	Sig p-value
RTM	CBL	-8.36*	2.86	0.01
	TBL	-10.06*	2.81	0.00
CBL	RTM	8.36*	2.85	0.01
	TBL	-1.07	2.85	0.82
TBL	RTM	10.06*	2.81	0.00
	CBL	1.70	2.85	0.82

The results show that the mean differences in post-test SSCQ for groups RTM and CBL, RTM and TBL groups were statistically significant P<0.05. Thus, the null hypothesis, which posits that there is no statistically significant disparity in students' Chemistry self-concept among those instructed via CBL, TBL, and those who learned through RTM, was rejected. The alternative hypothesis, which states that there is a statistically significant difference in learners' Chemistry self-concept among those who learned using CBL, TBL, and those taught by RTM, was found to be true. The study's findings indicate that learners who received instruction via TBL and CBL obtained higher mean scores in academic self-concept than those taught using RTM. Zeb *et al*. (2022) enhances students' critical thinking abilities. The data demonstrated a significant disparity in critical thinking scores between the pre-test and post-test. The mean score on the post-test critical thinking assessment was higher than the score on the pre-test, and this difference is statistically significant. The learners' critical thinking skills significantly improved after participating in Team Based Learning. Critical thinking involves a combination of six key abilities: curiosity, analysis, open-mindedness, confidence, systematic thinking, and a desire for truth. The traits of curiosity, analytical thinking, confidence, systematic approach, and pursuit of truth have shown a strong statistical impact. In their study, Jeanne *et al*. (2014) compared the performance of students who were taught using modified Team-based Learning methods to a control group who received standard lecture-based instruction. They assessed the students' performance on content-area assessments and national certification tests. Students who were taught using TBL methods achieved significantly superior results than the historical control group in both outcomes. Furthermore, there was a decrease in the proportion of students who did not pass the exams and an improvement in the overall course results.

Similar studies suggest that the students viewed the teacher as a more independent support through the phase of Team based learning. This is significant since in conventional lecture-oriented courses, students exhibit lower levels of engagement and are more inclined to assume the position of passive recipients of knowledge (Lucas *et al*., 2017). An optimal grading system for a Team Based Learning course is one that offers rewards for both collaborative and individual efforts (Masood & Kajal, 2021). Team Based Learning offers students the chance to identify deficiencies in their own knowledge. These deficiencies are revealed during team meetings and reporting, which can serve as a powerful incentive for ongoing learning. The instructor must oversee the process of group formation to ensure the group's success and cohesiveness. To effectively monitor Team-Based Learning (TBL), it is imperative that students remain in the same group during the whole term. Students are required to be responsible to both their teacher and their group. Insufficient preparation hinders individual learning, group development, and group cohesiveness (Michaelsen and Michael, 2008). Fang *et al*. (2018) found that students tend to compare their own academic performance with that of their classmates or schoolmates. This comparison often results in students feeling more negatively about their own abilities in high-achieving environments compared to low-achieving environments. Bryan and Wang (2014) found that knowledge acquisition entails the application of knowledge rather than only achieving high scores on exams. Students can improve their academic performance by gaining a thorough awareness of their own learning capabilities. In a study conducted by Siski (2011), it was discovered that students in a Task-Based Learning (TBL) approach were generally more content, more involved, and achieved higher exam scores compared to students in traditional lecture-based courses. TBL and CBL enhanced students to learn Chemistry better than RTM although the effects of CBL on achievement was more superior. Chepkorir *et al*. (2014) also recommended from their study that science teachers should encourage development of positive self-concept of ability among students.

A study by Priscilla *et al*. (2019) indicated that self-concept of their academic abilities had a favourable and significant impact on their performance in mathematics. Their study proposed that the implementation of excellent guidance and counseling, together with mentoring programs, in schools could enhance learners' academic self-concept. Masood and Kajal (2021) asserted that Team Based Learning has yielded favorable outcomes in both functional and interpersonal dimensions of personality. A strong correlation exists between perceptual factors and the perceived utility of TBL. TBL facilitates the exchange of ideas through peer learning and peer conversations. Consequently, learners are more inclined to express themselves because open debates contribute to a boost in confidence. Team Based Learning is an activity that helps future managers to consider an issue from multiple perspectives, be open to the opinions of others, and gain confidence by overcoming their hesitations. It can be concluded that open and frequent discussions within teams reduce glossophobia.

Ommundsen *et al*. (2005) suggest that theoretical assumptions indicate an individual's beliefs about their sense of mastery and learning ability affect how they approach learning situations. Student learning strategies can impact academic and school accomplishments, leading to an enhanced academic self-concept and a belief in gradual improvement of abilities. It is crucial to enhance students' academic self-perception and cultivate a mindset that believes abilities may be improved over time, rather than being fixed. The mean values of the results indicate that learners exhibit higher scores in academic self-concept and exhibit a strong belief in their learning capabilities. The research conducted by Álvaro *et al*. (2022) examined the progression of students' intellectual self-concept over a duration of four years, encompassing the transition from primary to secondary school. The study examined many factors, including personal, school, and environmental variables that influenced this progression. The findings indicated a noticeable decline in academic self-perception from primary to secondary education. Furthermore, an individual's self-concept is significantly impacted by their background circumstances and are likely to have influenced them since the start of their education. Furthermore, the act of repeating a school year has detrimental consequences on one's intellectual self-concept. Therefore, it is essential to investigate the reasons behind student retention in Spain, outside from medical, cognitive, or motor issues. The study revealed that repeating school years leads to a decline in academic self-concept. Therefore, it refutes the hypothesis of the big-fish little-pond effect, proposes that students who repeat a grade can improve their academic self-perception by comparing themselves to peers who have inferior academic achievements. Thus, their findings raised doubts on the efficacy of grade retention, specifically regarding the way it shapes students' perceptions of their academic competence.

Both psychologists and educators share a strong interest in understanding academic achievement. The question of what shapes academic achievement has been the subject of many investigations, looking at both beneficial and detrimental factors. The sense of self is considered to be a factor that mediates the relationship between resilience and academic performance. The results suggested that pupils with high levels of resilience are more adept at handling challenging situations and have a deep appreciation for the effort and dedication necessary during study periods. The study provides evidence that optimistic ideas and behaviours contribute to improved academic performance. The study investigated the relationship between resilience, emotional intelligence, and self-concept and their impact on academic performance in students at universities. The study found no significant association between resilience and exceling in school, and also between emotional intelligence and school accomplishment (Inmaculada *et al*., 2022). The research carried out by María and Pegalajar (2017) aimed to analyze the perceived self-concept of primary school kids with compensatory education requirements. Students' judgments of peer interactions, physical appearance, physical ability, and academic self-concept in mathematics showed positive improvements. The most unfavourable results were linked to the evaluations given by these students on their educational requirements in language, overall academic self-perception, and parent-child relationships. The students assessed themselves favourably and their interpersonal connections with their peers, although not as uniformly favourable in comparison to their familial relationships. In the academic realm, whereas general academic self-concept assessments were not particularly positive, distinctions were observed based on whether the subject was mathematics or language. According to their analysis, in an educational setting that aims to make up for disadvantages, it is recommended to implement a mindfulness program that focuses on enhancing students' understanding of family relationships and language skills, ultimately leading to improved academic achievement. The persistent issue of school failure and inadequate academic performance has consistently resulted in the emergence of difficulties with social maladjustment, lack of desire, and low self-concept.

Bruce *et al*. (2011) conducted a study to examine student perceptions towards a team-based learning method known as the readiness assurance process. Their focus was on the impact of academic achievement and perceived growth in professional abilities on student satisfaction, both at the beginning and as time progresses. It was discovered that students had a generally favorable attitude towards the learning technique and acknowledged its advantages in terms of fostering collaborative abilities. An analysis of student responses to a survey conducted after each of four quizzes throughout the semester revealed that student satisfaction with the teaching method is only slightly influenced by the immediate feedback they receive on their quiz performance. However, it is significantly influenced by their perception of how the method has improved their professional skills. There was a significant and consistent increase in satisfaction with the approach after each use. Their research indicates that student views are influenced by a variety of significant objectives, rather than solely academic achievement. Chun-Yen and Pei-Ling (2017) suggested that interaction skills have a substantial impact on the formation of academic self-concepts in gifted students who attain high academic scores. The widespread use of cooperative learning is crucial in science education, as teamwork and cooperation have become essential components. This technique facilitates the development of students' interpersonal skills and fosters their willingness to engage in collaborative experiences within the realm of science. This has the potential to enhance the cultivation of a favorable academic self-perception among learners.

Christensen *et al*. (2019) argue that teamwork is a crucial skill for employability, nevertheless learners tend to hold unfavorable views towards working in groups. However, by adopting an alternative method like team-based learning, students are grouped into long-lasting strategic teams and engage in various team-based tasks. Students demonstrated improvements in certain attitudes, namely among those with a strong inclination towards quantitative subjects. Following their participation in Team Based Learning, learners experienced a significant improvement in their ability to work together, specifically in relation to cultural diversity. Students reported a considerable improvement in their capacity to fulfill the responsibilities of being a task leader, socio-emotional leader, and information supplier. They also expressed a stronger preference for taking on these leadership responsibilities.

CHAPTER FIVE

SUMMARY, CONCLUSSIONS AND RECOMMENDATIONS

5.1 Introduction

This section provides the summary, conclusions, and recommendations of the study. The research examined the impact of Case-Based Learning, Team-Based Learning, and Regular Teaching Methods on secondary school students' achievement and self-concept in Chemistry in Maara Sub County, Tharaka Nithi County, Kenya. A total of 112 students participated in the pre-test, while 106 Form Two Chemistry students took the post-test. These students were drawn from three co-educational secondary schools purposefully sampled from Maara Sub County. This study had six objectives and six hypotheses. The independent variables were Case Based Learning, Team Based Learning and Regular Teaching Methods. The dependent variables were the academic self -concept and achievement in Chemistry. Data were collected using Students Self-concept and Chemistry Achievement Test scores. Data analysis was done using descriptive and inferential statistics by use of Statistical Package for Social Sciences Version 25.

5.2 Summary of Findings

i. This study revealed that the Case Based Learning strategy enhanced students' achievement in Chemistry better than Regular Teaching Methods.

ii. When Team Based Learning was compared with the Regular Teaching Method group on successful performance for students in Chemistry subject, the outcomes showed that the Team Based Learning was better in improving achievement of students in chemistry than the Regular Teaching Method.

iii. Comparing the achievement of students in Chemistry across the Case Based Learning, Team Based Learning, and Regular Teaching Methods groups revealed that the Case Based Learning group was more effective in enhancing students' chemistry achievement. This demonstrates that the Case Based Learning Strategy outperformed other methods in fostering chemistry achievement among learners.

iv. It was found that students taught through Case Based Learning had a greater academic self-concept than those instructed using Regular Teaching Methods when comparing the two groups in Chemistry.

v. When Team Based Learning strategy and Regular Teaching Methods were compared based on academic self-concept the analysis showed that students taught through the Team Based Learning Strategy performed better than those taught chemistry using Regular Teaching Methods.

vi. Further comparison was also made to determine the self-concept of students in chemistry among those taught though Case Based Learning, Team Based Learning and the Regular Teaching Methods. The outcome of this study showed that students taught chemistry using the Team Based Learning strategy had the highest self-concept than those taught using the Case Based Learning Strategy and Regular Teaching Methods. The experimental groups enhanced students' self-concept in chemistry although the Team Based Learning was superior in enhancing chemistry self-concept of students.

5.3 Conclusions

The study yielded the following conclusions:

i. Teaching students by the use of Case Based Learning can contribute to higher achievement in Chemistry as compared to Regular Teaching Methods.

ii. Teaching students through Team Based Learning can lead to had better achievement in Chemistry than the Regular Teaching Methods.

iii. The use of Case Based Learning in teaching Chemistry is superior in enhancing achievement of students than Team Based Learning and Regular Teaching Methods.

iv. Teaching students by using Case Based Learning would lead to better Chemistry self-concept than Regular Teaching Methods.

v. The use of Team Based Learning in chemistry would lead to enhanced self-concept of students than the Regular Teaching Methods.

vi. Team Based Learning is superior in improving student's perceived self-concept in Chemistry than Case Based Learning and Regular Teaching Methods.

5.4 Recommendations

The researcher presents the following recommendations based on the outcomes of this study:

i. Chemistry educators should incorporate the use of CBL strategy since this strategy leads to improved achievement in Chemistry among students in secondary schools.
ii. TBL Strategy should be adopted by chemistry teachers since it is e efficient in improving students' performance in learning through collaboration and team work.
iii. The use of CBL in teaching Chemistry should be applied in teaching chemistry due to its superior efficacy compared to Team Based Learning and the Regular Teaching Methods.
iv. CBL appears to be significantly effective method than traditional teaching for boosting students' confidence in chemistry. Therefore, chemistry teachers should consider adopting this approach.
v. Chemistry educators should incorporate the utilization of the TBL approach in their classroom instruction, as this technique has been found to result in a significant enhancement of students' chemistry self-concept compared to the use of traditional teaching methods.
vi. Teachers may apply the TBL since it is more appropriate in enhancing student's chemistry self-concept than the use of CBL and the Regular Teaching Methods.
vii. Chemistry trainers in the Universities and Colleges should train future Chemistry teachers on the use of Team Based Learning and Case Based Leaning in Chemistry teaching since both strategies enhanced better higher achievement among students than the Regular Teaching Methods.
viii. The effectiveness of CBL and TBL may also be tested in other counties for generalizations.

5.5 Suggestions for Further Research

The subsequent recommendations were derived from this study:

i. The impacts of Team Based Learning and Case Based Learning in relation to other variables, for example, gender, attitudes or motivation of students to learn Chemistry should be investigated.

ii. The factors that make CBL to be more superior in teaching Chemistry than Team Based Learning and Regular Teaching Methods should be researched and determined.

iii. A research investigation should also be undertaken to assess the effects of CBL and TBL in comparison to alternative instructional methods such as individualized learning, differentiated learning on students' achievement.

iv. The efficacy of CBL, TBL and Regular Teaching Methods may also be investigated in other subjects such as Biology, Physics, mathematics or English.

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APPENDICES

Appendix A: Chemistry Achievement Test

INSTRUCTIONS:

Do not indicate your name anywhere in this paper. You are required to answer all questions in the spaces provided.

The CAT consists of ten questions with total of 30 marks.

Admission number…………………

KCPE MARKS……...

1. What is the meaning of the following terms? (4mks)

Salt.…………………………………………………………………………………………

…………………………………………………………………………………………

Efflorescent…………………………………………………………………………………

……………………………………………………………………………………

Hygroscopy…………………………………………………………………………………

………………………………………………………………………………………

Deliquescence………………………………………………………………………………

…………………………………………………………………………………….

2. Classify the following salts into types. (4mks)

$NaHCO_3$……………………………………………………………………………

Na_2CO_3……………………………………………………………………………

$Mg(OH)Cl$…………………………………………………………………………

$Na_2CO_3.NaHCO_3.2H_2O$………………………………………………………..............

3. Complete the following statements as regards to types of salts (3mks)

All …………………………………… are soluble in water

All carbonates are insoluble in water except……………………...and ammonium carbonates.

All chlorides are soluble in water except………………………………and……………

4. Describe how crystals of $ZnCl_2$ can be prepared using the following reagents:

Zinc powder, dilute hydrochloric acid. (3mks)

…………………………………………………………………………………………

………………………………………………………………………………………

…………………………………………………………………………………………

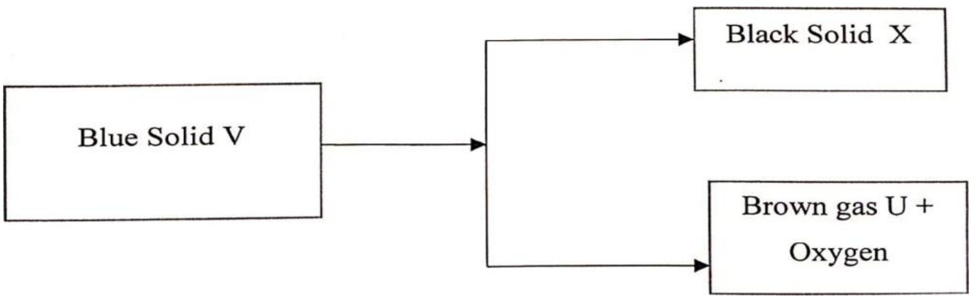
………………………………………………………………………………………

…………………………………………………………………………………………

5. Examine the representation provided below and respond to the subsequent questions: -

Black solid V

Solid X



Brown gas U + Oxygen

(a) Name (3mks)

Solid X………………………………………………………………………………………

Solid V……………………………………………………………………………………………

Brown gas U ……………………………………………………………………………….

6. When crystals of hydrated sodium carbonate (Na_2CO_3. $10H_2O$) were exposed to the atmosphere overnight a white powder was formed.

Write the formula of the white powder (1mk)

…………………………………………………………………………………………

Name the process which led to the formation of the white powder (1mk)

…………………………………………………………………………………………

7. The following experiment was carried out by a Form Two Chemistry student in Avogadro secondary school. Use the information to answer the following questions. Procedure:

Put about $25cm^3$ of dilute sulphuric acid in a glass beaker and warm. Add copper (II) Oxide gradually while continuously stirring until none can dissolve. Filter the mixture and move the resulting liquid to an evaporating dish. Apply heat to the filtrate utilizing a water bath until the formation of crystals commences. Name the method of salt preparation described in the procedure above. (lmk)

…………………………………………………………………………………………

What was the reason for adding an excess amount of copper (II) oxide? (lmk)

…………………………………………………………………………………………

Compose a chemically balanced equation to represent the reaction. (lmk)

…………………………………………………………………………………………

Name another salt from the list given below that can be prepared using the same method: NaCl, $CuCO_3$, $ZnSO_4$, $PbSO_4$ (1mk)

…………………………………………………………………………………………

8. Insoluble salts are mainly prepared by double decomposition. Write balanced ionic equations for the following reactions. (3mks)

$CuCl_2$ (aq) + Na_2CO_3 (aq) $\longrightarrow$ NaCl (aq) + $CuCO_3$ (s)

…………………………………………………………………………………………

$AgNO_3$ (aq) + $CaCl_2$ (aq) $\longrightarrow$ AgCl(s) + $Ca(NO_3)_2$(aq)

……………………………………………………………………………………………

$Pb(NO_3)_2$ (aq) + K_2SO_4(aq) $\longrightarrow$ $PbSO_4$(s) + $2KNO_3$(aq)

………………………………………………………………………………………

9. List three uses of calcium salts (3mks)

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

10. Crystals are obtained from a saturated solution. What is a saturated solution? (1mk)

…………………………………………………………………………………………

Appendix B: Chemistry Achievement Test Marking Scheme

INSTRUCTIONS:

Do not write your name anywhere in this paper. Answer all questions in the spaces provided.

The CAT consists of ten questions with total of 30 marks.

GENDER (tick appropriately

1. Male
2. Female

Name of the school…………………………………………………………………………

KCPE MARKS……………...

1. What is the meaning of the following terms? ***(4mks)***

Salt. A substance formed when hydrogen ion of an acid is wholly or partially displaced directly or indirectly by a metal or ammonium radical

Efflorescent.

- Process in which a salts loses water of crystallization when exposed to air

Hygroscopy.

- Process in which salts absorbs water from air and do not dissolve in it to form a solution

Deliquescence.

- Process in which salts absorbs water from air and dissolve in it to form a solution

2. Classify the following salts into types. ***(4mks)***

$NaHCO_3$… Acid salt

Na_2CO_3…. Normal salt

$Mg(OH)Cl$…Basic salt…

$Na_2CO_3.NaHCO_3.2H_2O$…Double salt…

3. Complete the following statements as regards to types of salts *(3mks)*

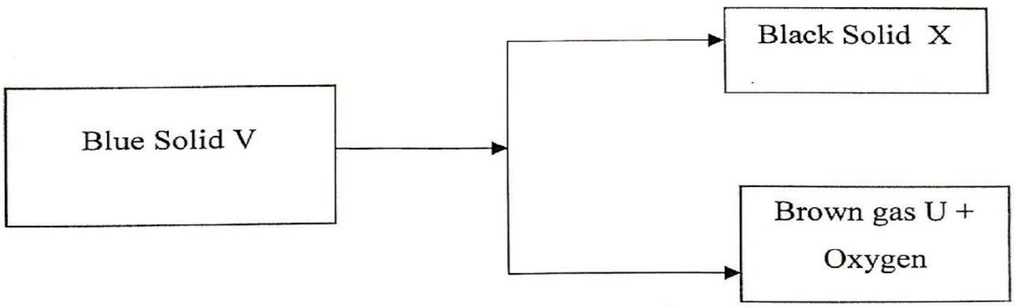
   a) All …nitrate salts… are soluble in water
   b) All carbonates are insoluble in water except…Potassium…and ammonium carbonates.
   c) All chlorides are soluble in water except…Lead(II) chloride… And …Silver chloride

4. Describe how crystals of $ZnCl_2$ can be prepared using the following reagents:

Zinc powder, dilute hydrochloric acid. *(3mks)*

- Add excess zinc powder into dil HCl
- Filter excess zinc to obtain filtrate
- Heat filtrate to saturation
- Cool for crystals to form
- Decant mother liquor to obtain crystals

5. Study the scheme below and answer the questions that follow: -



(a) Name *(3mks)*

Solid X. Copper(II) oxide

Solid V. Copper (II) nitrate

Brown Gas U Nitrogen(IV) oxide

6. a) When crystals of hydrated sodium carbonate ($Na_2CO_3 . 10H_2O$) were exposed to the atmosphere overnight a white powder was formed. Write the formula of the white powder *(1mk)*

$Na_2CO_3 \cdot H_2O$

b)Name the process which led to the formation of the white powder *(1mk)*

Efflorescence

7. a) The following experiment was carried out by a Form Two Chemistry student in Avogadro secondary school. Use the information to answer the following questions. Procedure:

Put about 25cm^3 of dilute sulphuric acid in a glass beaker and warm. Add copper (II) Oxide a little at a time as you stir until none can dissolve. Filter the mixture and transfer the filtrate to evaporating dish. Heat the filtrate using a water bath until crystals start to form. Name the method of salt preparation described in the procedure above. *(1mk)*

Insoluble base + acid reaction.

b) Why was copper (II) oxide added in excess? *(1mk)*

To ensure all acid reacted

c) Write a balanced chemical equation for the reaction (1mk)

$CuO_{(s)} + H_2SO_{4(aq)} \rightarrow CuSO_{4(aq)} + H_2O_{(l)}$

d) Give another salt from the list given below that can be prepared using the same method:
NaCl, $CuCO_3$, $ZnSO_4$, $PbSO_4$ (1mk)

$ZnSO_4$

8. Insoluble salts are mainly prepared by double decomposition. Write balanced ionic equations for the following reactions. (3mks)

$CuCl_2$ (aq) + Na_2CO_3 (aq) $\longrightarrow$ 2 NaCl (aq) + $CuCO_3$ (s)

$Cu^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)} \rightarrow$

2 $AgNO_3$ (aq) + $CaCl_2$ (aq) $\longrightarrow$ 2AgCl(s) + $Ca(NO_3)_2$(aq)

$Ag^+_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)}$

$Pb(NO_3)_2$ (aq) + K_2SO_4(aq) $\longrightarrow$ $PbSO_4$(s) + 2KNO_3(aq)

$Pb^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow PbSO_{4(s)}$

9. List three uses of calcium salts (3mks)

- $CaCl_2$ is used as a drying agent
- $CaSO_4$ is used to make plaster of paris
- $Ca(NO_3)_2 \cdot NH_4NO_3$ is used as a nitrogenous fertilizer

10. Crystals are obtained from a saturated solution. What is a saturated solution? (1mk)

A solution that can not dissolve any more solute at a given temperature.

Appendix C: Teaching Manual

1.1 Introduction

The breakdown of the Form Two Chemistry syllabus covering the topic "Salts" is as follows, divided into weeks. The teaching manual contains the topics for every week alongside the instructional objectives. Please refer to the schemes of work for specific details.

1.2 Objectives.

Upon completion of this topic, the learner will possess the ability to:

- Define salt.
- State and describe the types of salts. Identify soluble and insoluble salts.
- Explain the terms saturated solution, crystallization, neutralization and precipitation.
- Choose and employ suitable techniques for the production of soluble and insoluble compounds.
- Explain through experimental observations the effects of heat on different salts. Compose ionic equations for the preparation of insoluble salts.
- Describe and explain, based on experimental observations, the effect of heat on different salts.
- State uses of some salts.

Week 1:

Introduction and implementation of a pre-test for all three groups.

Definition of salt.

Types of salts.

Week 2:

The water solubility of salts.

The water solubility of bases.

Week 3:

Procedure for synthesizing copper (II) sulfate crystals from a solution that is already saturated with the compound.

Crystallization.

Saturated solution

Preparation of soluble salts

Acid + metal reaction e.g. $ZnSO_4$, $Mg\ (NO_3)_2$

Week 4:

Preparation of salts by neutralization e.g. $CuSO_4$, $Pb(NO_3)_2$, $CaCl_2$, NaCl

Week 5:

Preparation of salts by reaction between acid and carbonate.

e.g. $Pb(NO_3)_2$, $Mg(NO_3)_2$, $Zn(NO_3)_2$, $CaCl_2$, $NaNO_3$

Preparation of salts by direct combination of elements e.g FeS, NaCl, $FeCl_3$.

Week 6:

Preparation of salts by double decomposition.

e.g. $PbSO_4$, $CaSO_4$, $BaSO_4$, Pbl_2, $CuCO_3$.

Ionic equations.

Week 7:

Behavior of salts when exposed to the atmosphere.

Action of heat on salts e.g. carbonates.

Action of heat on nitrates, sulphates

Week 8:

Uses of some salts.

Revision.

Administration of post-test CAT and SSC Q.

Appendix D: Teacher's Guide on Team Based Learning

1.1 Introduction

This training will be founded upon the Team Based Learning (TBL) process according to Fink (2004) model and Michaelson and Michael (2008).

1.2 Team Based Learning

TBL are practices are approach that combines efforts to provide a strong instructional impact. Michaelson and Michael (2008) outline four essential principles of team-based learning. Initially, it is imperative to construct and proficiently oversee groups, structuring them in a manner that empowers them to successfully accomplish the designated responsibilities. Furthermore, it is imperative that students are held responsible for their actions, which entails taking personal responsibility for preparing for collaborative tasks, allocating sufficient time and exerting diligent effort towards group assignments, and engaging in constructive interactions. Furthermore, team assignments should facilitate both the acquisition of knowledge and the growth of the team. Assignments that necessitate group decision-making and subsequent reporting in a concise format typically foster substantial levels of group engagement. Additionally, it is crucial for students to be provided with regular and prompt feedback. In order for teams to function optimally and progress, it is crucial that they receive consistent and punctual feedback regarding their collective performance. Feedback obtained from Readiness Assurance Tests (RATs) enhances learning by providing students and groups with information regarding the efficacy of their existing learning practices. High scores indicate successful learning practices, while low scores signal the need for improvement. RATs also facilitate team development by motivating group members to work together to protect their public image and address any failures in utilizing the group's collective knowledge (Watson, Michaelson, & Sharp, 1991).

1.3 How to Implement Team Based Learning

To effectively implement Team-Based Learning (TBL), Fink (2004) suggests beginning with a comprehensive restructuring of the course, organizing it into 5 to 7 units focused on major subject topics. Within each of these topical units, the instructor establishes a sequence consisting of three phases as shown in Figure 1

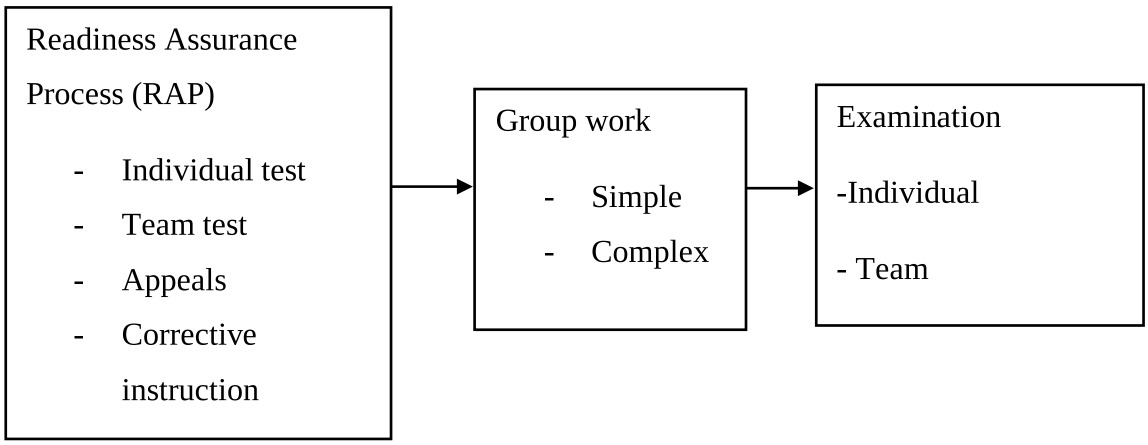


Figure 5: *The sequence of learning activities in Team Based Learning (Fink, 2004).*

<u>Preparation Phase</u>

Reading assignments will be given to students for a particular sub topic outside the class. Students thereafter participate in a process called RAP to ensure their preparedness for the subsequent phase of the sequence, during which they acquire the skills to apply or utilize the content. Within the RAP program, students commence by independently completing a test on the assigned texts. It is preferable for this test to be very brief, allowing for in-class grading. Students submit their individual answer sheets and subsequently participate in a collective examination. Finally, both examinations have been evaluated.

Appeals Process

Students submit appeals in reference to the materials they have learnt to support their answers. The teacher has the authority to determine whether to approve or reject the appeal for credit. Teacher offers corrective instructions to enhance correct understanding of concepts.

Application Phase

Students utilize the information to respond to questions, resolve issues, generate explanations, and formulate predictions based on the subject matter at hand. Application exercises are provided in small groups, where participants are presented with more challenging questions and issues. Teacher offers feedback on the quality of their Reponses. The following reading assignments were useful in this study.

A salt is a compound that results from the partial or complete replacement of hydrogen ions in an acid with a positively charged ion. There are four distinct categories of salts: acid salts, basic salts, and double salts. Normal salts are compounds that lack any replaceable hydrogen atoms. Examples of typical salts include sodium chloride, potassium sulfate, sodium carbonate, and calcium nitrate. These salts have a neutral pH when dissolved in water. Acid salts are compounds that possess a hydrogen atom that can be replaced. Some examples of acid salts include sodium hydrogen carbonate, potassium hydrogen sulphate, and sodium dihydrogen phosphate. They exhibit acidic characteristics as a result of the existence of replaceable hydrogen. Basic salts consist of hydroxide ions. The basic qualities of basic salts are attributed to the presence of hydroxyl ions. Examples of basic alternatives include magnesium chloride, lead (II) carbonate, zinc chloride, and copper (II) carbonate. Double salts are compounds that include two distinct anions and cations. The compounds mentioned are hydrated potassium aluminum sulfate (KAl(SO4)2.12H2O), hydrated ammonium iron (II) sulfate, and trona (Na2CO3.NaHCO3.2H2O).

Readiness Assurance Test 1

1. What is salt

……………………………………………………………………………………………..

2. Complete the following table

Type of salt	Name of salt	Formulae of salt

		NaCl
Basic		Mg (OH)Cl
	$NaHCO_3$	
Normal		
		$Na_2CO_3.NaHCO_3.2H_2O$

Reading Assignment Two

Solubility of Salts in Water

Demonstration Expt: 4.1 KLB pg. 82 Chemistry Bk 2

Summary of Tests on Solubility of Salts in Water

1. All potassium, sodium and ammonium salts are soluble in water.
2. All nitrates are soluble in water
3. All sulphates are soluble in water except lead (II) chloride and silver chloride. Lead (II) chloride is insoluble in cold water but soluble in hot water.
4. All carbonates are insoluble in water except those of potassium, sodium and ammonium carbonate.

Solubility of Bases in Water

Some salts are products of chemical reactions between acids and bases. Knowledge about the solubility of bases is useful in the formation of certain salts.

Demonstration: Expt 4.4. KLB Chemistry BK2 pg 84

The majority of bases are not soluble in water, while just a small number are soluble. These bars are referred to as alkalis. The primary alkalis include sodium hydroxide, calcium hydroxide, and ammonium hydroxide. Calcium hydroxide exhibits significantly lower solubility in water compared to sodium hydroxide and ammonia. Lime water is commonly referred to as a solution of calcium hydroxide in water. The compounds sodium oxide, calcium oxide, and magnesium oxide react with water to produce their respective hydroxides.

$Na_2O(s) + H_2O(l) \rightarrow$

$2NaOH(aq)$ $CaO(s) + H_2O(l) \rightarrow$

$Ca(OH)_2(aq)$

$MgO(s) + H_2O(l) \rightarrow Mg(OH)_2(aq)$

Most other metal oxides and hydroxides are insoluble in water.

Readiness Assurance Test two

1. Name two soluble bases
2. Name two metal hydroxides
3. A red litmus paper is put into a soluble of am alkali: state the effect on the red litmus paper _______________
4. Complete the following statements about salts
5. All______________ are soluble in water
6. All chlorides are soluble in water except _______________ and _______________
7. All carbonates are insoluble in water except _______________, _______________ and ammonium carbonates

Reading Assignment Three

To prepare copper (II) sulphate crystals, begin by making a saturated solution of copper (II) sulphate. Measure approximately 20 cm^3 of water into a beaker and add a spatula full of copper (II) sulphate crystals. Stir the mixture and continue adding crystals until no more will dissolve, leaving some undissolved at the bottom. Portion of the solution is traansfered into an evaporating dish and then position it over a water bath for heating. Subject the solution to evaporation until it reaches a state near crystallization. To check, immerse a clean glass rod into the mixture, permit it to cool, and examine for the presence of crystals. Once crystals form on the rod, let the solution cool slowly to grow larger crystals, covering the dish with perforated paper to promote this. Separate the crystals by passing them through a filter and then remove any remaining moisture by using filter papers after a duration of 12 hours.

When copper (II) sulfate is added to water, it forms a blue solution. Adding more salt until no more dissolves creates a saturated solution, where excess solute remains undissolved. Upon cooling, this solution forms solid crystals in a process called crystallization. Slow cooling aids in forming larger crystals. Some salts, like copper (II) sulfate, include fixed quantities of water in their crystalline structure, known as water of crystallization, making them hydrated salts. Heating hydrated copper (II) sulfate removes this water, turning it into anhydrous copper (II) sulfate. Examples of hydrated salts include sodium carbonate decahydrate ($Na_2CO_3 \cdot 10H_2O$) and iron (II) sulfate heptahydrate ($FeSO_4 \cdot 7H_2O$).

Readiness Assurance Test Three

1. What is a saturated solution?
2. What is water crystallization
3. Describe how crystals of cooper (II) sulphate can be made in the laboratory.

Reading Assignment Four Preparation of Salts by Direct Combination of Elements

Preparation of Iron (II) Sulphide Procedure

Put a spatula of iron fillings in a crucible. Add a spatula of Sulphur, mix them. Heat the mixture strongly. Allow the products to cool.

Discussion

When a mixture of iron filings and Sulphur is strongly heated in glows red even when the source of heat is removed. This shows that the reaction between iron and Sulphur produces heat. The colour of iron is grey and that of Sulphur is yellow while the colour of the product is black. The black solid formed is iron (II) sulphide.

$Fe_{(s)} + S_{(g)} \longrightarrow FeS_{(s)}$

Other salts that can be prepared by this method are sodium chloride and iron (III) chloride

Preparation of insoluble salts Procedure

Add 10cm3 of Lead (II) Nitrate to a beaker. Place the identical beaker and introduce an excessive amount of magnesium sulphate solution. Stir the solution using a glass rod. Allow the solid to separate and subsequently pour the liquid. Thoroughly cleanse the solid by using water that is free from impurities. To isolate and remove moisture from the solid, position it between filter sheets.

Upon mixing Lead (II) Nitrate and magnesium sulphate solution, a precipitate of white solid is generated, the ions present in the reactants are Lead ions, and nitrate ions from Lead (II) Nitrate; magnesium ions and sulphate ions from magnesium sulphate. When the two salts solution react, lead sulphate and magnesium nitrate salts are formed. The metal ions of the salts simply exchange their anions. Lead sulphate is formed as a white solid (precipitate). This type of reaction is called double decomposition.

$MgSO_4$ (aq) + Pb $(NO_3)_2$aq $\longrightarrow$ $PbSO_4$(s) + Mg $(NO_3)_2$aq

The ions in the salt solutions that react to form Lead Sulphate are lead ions and sulphate ions. These ions are in aqueous state in the beginning of the reaction and the end up in solid state at the end of the reaction. The ions undergo a change in their physical; state as shown by the equation below.

Pb^{2+}_{aq} + $SO^{2-}_{4(aq)}$ $\longrightarrow$ $PbSO_{4(s)}$

The equation obtained by writing only those ions that undergo change during a chemical reaction is called an ionic equation. Mg^{2+} and $NO^{-}3$ ions are in aqueous state in the beginning and at the end of the reaction, they remain unchanged throughout the reaction. The ions that remain unchanged during a chemical reaction are called spectator ions and they are omitted when writing u=ionic equations. Reactions in which solids are formed from aqueous solutions are called precipitation reactions. The solids are formed are referred to as precipitates. Precipitation reactions are suitable for preparing insoluble salts. Other examples of precipitation reactions are:

i. Ba $(NO_3)_2$(aq) + $ZnSO_4$ (aq) $\longrightarrow$ $BaSO_4$(s) + $Zn(NO_3)_2$(q)

Ba^{2+}(aq) + SO^{2-}_4 (aq) $\longrightarrow$ $BaSO_4$(s)

ii. $Pb(NO_3)_2$(aq) +2Kl(aq) $\longrightarrow$ Pbl_2(s) + $2KNO_3$(aq)

Pb^{2+}(aq) +$2l^{-}$(aq) $\longrightarrow$ PbI_2(s)

iii AgNO$_3$(aq) +NaCl(aq) $\longrightarrow$ AgCl(s) + NO_3^{-}(aq)

Ag^{+}(aq) +Cl^{-}(aq) $\longrightarrow$ AgCl(s)

NB: In precipitation reactions, the two reactants must be soluble salts and one of the productions must be soluble salt.

Readiness Assurance test Five

Which pair of salts can be reacted to form the following salts? Write ionic equations for each reaction (10Marks)

i. $CaSO_4$

ii. $ZnCO_3$

iii. $BaCO_3$

iv. $PbSO_4$

v. $CuCO_3$

Reading Assignment Six

<u>What happens to salt, when they are exposed to the atmosphere?</u>

1. Deliquescent salts

These are salts which absorb water from the atmosphere to form solutions. This process is called deliquescent

The salts include: -

- Anhydrous $CaCl_2$
- Anhydrous $FeCl_3$
- $AlCl_3$
- $Cu(NO_3)_2$
- $Ca\ (NO_3)_2$, $ZnCl_2$ etc.

Other substances that are deliquescent are: KOH, NaOH

2. Hygroscopic salts

They absorb water from atmosphere but do not dissolve to form a solution. The process is called hygroscopy.

The salts include:

- Anhydrous $CuSO_4$
- Anhydrous $CoCl_2$
- Common table salt

3. Efflorescent salts

They lose some water of crystallization when exposed to atmosphere. The process is called efflorescence. Examples are:

- Hydrated Na_2CO_3. $10H_2O$
- $FeSO_4.7H_2O$
- $Na_2SO_4.10H_2O$

QUESTIONS

1. State the meaning of:

   a) Efflorescence

   b) Hygroscopic

   c) Deliquescent

Readiness Assurance Process Six

Uses of Salts

1. Fertilizers e.g ammonium nitrate
2. Food additives
3. P.O.P in hospitals e.g. $CaSO_4.2H_2O$
4. Road surfacing to keep the road moist due to its deliquescent nature. e.g. $CaCl_2$

5. $CaCl_2$ is used in extraction of sodium metal by electrolysis
6. KNO_3 is used for making fireworks and gun powder
7. Na_2CO_3 is used to soften hard water, making glass and detergents
8. $CaCl_2$ is applied in defrosting snow during winter by lowering its freezing point.

Action of Heat in Salts

Expt: What Happens when Carbonates are heated?

Procedure:

Place a spatula full of sodium carbonate into a test tube. Gradually increase the temperature of the sample and then raise it significantly until no additional alteration is observed. Assess the gas emitted by positioning a glass rod that has been immersed in calcium hydroxide solution at the opening of the test tube.

Record observations

Repeat the experiment using the carbonates of K, Ca, Zn, Pb, Cu, NH_4^+ and Hydrogen carbonates of Na and K.

Discussion

Pure carbonates of Na, K are not affected by heat because they are very stable. if they are hydrated the salts only lose their crystallization. The water vapor condenses on the cooler sides of the test tube on colorless liquid.

$$Na_2CO_3.10H_2O(s) \xrightarrow{heat} Na_2CO_3(s) + 10H_2O(g)$$

The other metal carbonate decomposes on heating to give off a colorless gas and a corresponding metal oxide.

The gas produced form a white precipitate when bubbled into calcium hydroxide to confirm that it is CO_2

$$\longrightarrow$$

$CaCO_3(s)$ heat $CaO(s) + CO_2(g)$

$ZnCO_{3(s)}$ heat $ZnO_{(s)} + CO_{2(g)}$

$CuCO_3(s) \xrightarrow{heat} CuO(s) + CO_2(g)$

Ammonium carbonate decomposes to form ammonia gas, CO2 and water. NH3 (g) is tested using moist red litmus paper which changes to blue.

$(NH_4)_2 CO_{3(s)} \xrightarrow{heat} 2NH_{3(g)} + CO_2(g) + H_2O_{(l)}$

Hydrogen carbonate of metal high in the reactivity series, decompose on heating to produce the corresponding metal carbonates, CO_2 and water.

$2NaHCO_3(s) \longrightarrow Na_2CO_3(s) + H_2O(l) + CO_2(g)$

$2KHCO_3(s) \longrightarrow K_2CO_3(s) + H_2O(l) + CO_2(g)$

The hydrogen carbonates of calcium and magnesium exist only in solution whereas hydrogen carbonates of aluminum and iron do not exist.

Action of Heat on Nitrates

Expt: What is the Effect of Heat on Nitrates?

Procedure

Heat about half a spatula of potassium nitrate in a boiling tube. Observe the colour of the gases evolved and test using moist litmus paper. Insert a glowing splint into the test tube. Do not test the gases of hydrated salts until all the water of crystallization has been removed.

Document your observations.

Repeat the experiment again using sodium, calcium, zinc, lead, and copper nitrates.

Potassium nitrate and sodium nitrate decompose to form oxygen and a white residue which is potassium nitrate and sodium nitrate respectively.

$2KNO3(s) \longrightarrow 2KNO_2(s) + O_2(g)$

$2NaNO3(s) \longrightarrow 2NaNO_2 + O_2(g)$

Calcium zinc, lead, and copper nitrates undergo decomposition upon ingestion, resulting in the formation of the respective metal oxide, nitrogen (IV) oxide, and oxygen gas.

$2Ca\ (NO_3)2(s) \xrightarrow{heat} 2CaO(s) + 4NO_2(g) + O_2(g)$

$2Zn\ (NO_3)_{2(s)} \xrightarrow{heat} 2ZnO_{(s)} + 4NO_{2(g)} + O_{2(g)}$

$2Pb\ (NO_3)_{2(s)} \xrightarrow{heat} 2CaO_{(s)} + 4\ NO_{2(g)} + O_{2(g)}$

$2Cu\ (NO_3)_{2(s)} \xrightarrow{heat} 2CuO_{(s)} + 4NO_{2(g)} + O_{2(g)}$

The nitrates of silver and mercury decompose to give nitrogen (IV) oxide, oxygen and the corresponding metal.

$2AgNO_3\ (s) \longrightarrow 2AgO(s) + 2NO_2(g) + O_2(g)$

$2HgNO_3\ (s) \xrightarrow{heat} 2Hg(s) + 2NO_2(g) + O_2(g)$

Ammonium nitrate decompose to give steam and nitrogen (I) oxide

$NH_4NO_3(s) \xrightarrow{heat} N_2O(g) + H_2O(g)$

The decomposition of metal nitrates upon heating becomes more pronounced as we move down the reactivity spectrum of metals.

All nitrates decompose on heating

Expt: What is the Effect of Heat on Sulphates?

Position the spatula onto the hydrated Iron (II) sulphate contained in a test tube, gradually apply heat to the test tube first and then increase the intensity. Examine any gas produced by placing it in contact with damp litmus paper. Conduct the experiment again using the hydrated sodium, magnesium, zinc, and copper.

Record your observations

The sulphate of K, Na, Ca, and Mg are stable and are not affected by heat. However, if hydrated they lose water of crystallization on heating which condense high up in the test tube.

$Na_2SO_4.10H_2O(s) \xrightarrow{heat} Na_2SO_4(s) + 10H_2O\ (l)$

Zinc sulphate and copper (II) sulphate decompose on strong heating to form the metal oxide water and sulphur (IV) oxide gas which is colorless. The gas changes moist blue litmus paper red.

$ZnSO_4.7H_2O(s) \xrightarrow{heat} ZnO(s) + SO_3(g) + 7H_2O(l)$

$CuSO_4.5H_2O(s) \xrightarrow{heat} CuO(s) + SO_3(g) + 5H_2O(l)$

Upon heating, Iron II sulphate crystals undergo decomposition, resulting in the formation of iron II oxide, Sulphur IV oxide, Sulphur VI oxide, and water.

$2FeSO_4.7H_2O(s) \xrightarrow{heat} Fe_2O_3(s) + SO_2(g) + SO_3(g) + 14H_2O(l)$

Appendix E: Students' Self- Concept Questionnaire (SSCQ)

Admission number ……………

KCPE mark………

INSTRUCTIONS:

Please ensure that your answers show how you feel about yourself. Read each statement below and choose your answer that indicates your opinion in the boxes. There are five possible responses: agree, disagree, undecided, strongly agree, and strongly disagree. Put a tick √ on your best answer for example:

S/N	STATEMENT	Strongly disagree SD	Disagree D	Undecided U	Agree A	Strongly Agree SA
	Scale	1	2	3	4	5
1	I like to watch football			√		

S/N	STATEMENT	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
1	I possess the ability to comprehend Chemistry classes with ease.					
2	I possess the capability to assist fellow students in their Chemistry tasks.					
3	I frequently engage in my Chemistry assignments with extensive thinking.					
4	If I exert diligent effort in the field of Chemistry, I believe I can attain admission to a university or college.					
5	I focus on the Chemistry teachers during Chemistry class					

6	I am smarter in Chemistry than most of my classmates					
7	I diligently prepare for my Chemistry examinations					
8	My teachers perceive me to be knowledgeable in Chemistry					
9	I am typically focused on my Chemistry tasks					
10	I frequently retain the knowledge I have acquired in Chemistry.					
11	I am good in Chemistry					
12	I always do well in Chemistry tests					
13	I am able to do better than my friends in Chemistry tests					
14	I am willing to put more effort in Chemistry					
15	I like Chemistry					
16	I get good marks in Chemistry					
17	I learn things quickly in Chemistry					
18	Work in Chemistry is easy for me					
19	Most of my friends are good in Chemistry					
20	I like my Chemistry teachers					

Source: Joyce, B.Y.T., & Shirley, M. Y. (2007).

Appendix F: Teacher's Guide on Case Based Learning (CBL)

1.1 Introduction

A case study typically consists of a captivating or contentious narrative, often with a predicament that necessitates a fundamental grasp of scientific ideas (Herreid, 1994). Yalcinkaya, Yezdan &, Ozgur (2012) study has determined that case-based learning is a good approach for enhancing students' motivation in the field of Chemistry. Case based learning produces greater achievement in the understanding of Gas Laws than traditional Instruction (Sendur, 2012). According to Sendur (2012) the structure of CBL can vary from lecture method to small group format. In the small group format students receive the case and they investigate the case using sources such as books and the internet. In the following sessions students share their findings to the group and the teacher who might give additional information related to the problem (Sendur, 2012).

1.2 Teaching using Cases.

Case studies usually generate animated class discussion especially if students feel that cases will serve as a basis of wide-ranging exploration. A good classroom atmosphere will help generate and sustain students' participation. Instructors can emphasize that the analysis will be a group project and that no one will be criticized for raising naive questions or uncertainties. Using case to teach can help students take much more responsibility (Daniel, 1994). Cases are educational resources that encompass a diverse range of factual information and data, including psychological, sociological, scientific, anthropological, historical, observational, and technical content. According to Yalcinkaya et al. (2012), cases can range in length from a few paragraphs to several pages. However, it is recommended that longer cases be provided and studied prior to the class in order to avoid students getting confused and overwhelmed by the information. Learners have the ability to generate their own instances in some situations. Nevertheless, meaningful contributions can also be derived from situations reported in newspapers, papers, periodicals, individual experiences, or the experiences of others (Tomey, 2003). According to Sendur (2012), it is recommended that cases be concise, narrative-driven, address contemporary issues that are pertinent to students, and include relevant questions at the conclusion. After each case, students are provided with study questions that allow them to assess the outcome, concepts, and subjects of the case.. According to Sikula (1996), CBL involves the following phases; -

Phase 1: Analyzing a case

It involves; forming student groups, delivering case connected to daily life to student groups to read together, students recognizing prominent themes and present challenges and facilitating group discussions.

Phase II: Researching the questions.

The key topics are assigned to the groups in order to efficiently tackle the difficulty presented in the case. Learners groups research their main topic from various sources, exchange their knowledge and perspectives, and engage in discussions to consolidate their learning. The formation of new collaborative groups is based on the expertise of prior groups. These groups engage in problem-solving discussions to find solutions and obtain answers to their questions. Following their class discussions, participants engage in collaborative study sessions to arrive at a definitive answer for the problem, either in the classroom or Laboratory.

Phase III: Evaluation of the Results

Assessing the students' acquired knowledge is crucial. The teacher exercises control over the group's collaborative efforts and seeks their input on problem-solving strategies. The leaders of the groups present the outcomes they have achieved. The results are displayed on the board and the teacher determines the best appropriate solution to the problem based on their instructions. To effectively address the challenges, it is necessary to conduct an experimental process in the laboratory. Students are then required to document their experimental findings in a report.

Appendix G: Teaching with Cases

CASE 1

The following cases was designed for use to teach students the uses of salts.

Catherine and John were chatting one of the hot afternoons after Chemistry lesson while they had their lunch which their mum had packed for them. Hey, John. What did mum pack for our lunch?

She said excitedly. It's popcorns, chips, milk and……

Catherine: I prefer chips. They are my favorite; you know?

John: Alright. But of course, remember we have to share equally.

Catherine: Yes, brother. No problem. Let us sit and have our lunch.

John: Well, I cannot see a packet of salt. It seems mum forgot.

Catherine: Have you tasted to confirm whether it is salty?

John: Nope. Anyway, we may not require it, who knows?

Catherine: Mmmhh... The chips and popcorns are salted. How is the flavor, John?

John: You know; Catherine many people add a lot of table salt even when it is already enough. I read in the Journal of nutrition that our bodies require a maximum of 6g of salt per day. Any amount above this is dangerous to our health and can elevate blood pressure.

Catherine: What did our Chemistry teacher say is the chemical name for table salt? Sodium Chloride, am I right, John?

John: Yes, but it also contains Iodine and Magnesium chloride.

(Then a gunshot is heard in the nearby market and the two were shocked)

Catherine: I fear gunshots. I wonder what makes the gunshot so loud. What did our Chemistry teacher tell us about the chemical that make gun powder?

John: Come on, Catherine. I think it is a nitrate, right?

John: A gun powder contains potassium nitrate. This is why it explodes very loud. (Another gunshot is heard. Out of fear Catherine jumps to escape but unfortunately falls and breaks her left arm)

Catherine: (crying loud). Wooh. Help, help... It's broken. Please take me to hospital, Brother.

John: Sure. We need to go to hospital before it's too late. May be a plaster of Paris would do.

Catherine: (in pain). Yeah, you are right brother. Now, can you remind me what makes up the plaster of Paris?

John: Good question Catherine. Plaster of Paris is chemically called hydrated Calcium Sulphate.

It is mixed with water and applied on broken arms to enable healing.

Questions:

I. What is the chemical name for table salt?

2. State one use of table salt

3. Explain how $CaSO_4.5H_2O$ is used as a plaster of Paris.

4. Which salt is used to make fireworks?

Case 2

The second case was used to teach students the uses of bases and acids.

One bright morning Mrs. Terry entered her classroom and said. "Good morning. Isn't this a beautiful day?" Getting a minimal response from her students, she went on. "Today we shall do a simple experiment and I hope you will enjoy and find it instructive. Mary who had heard from another Terry's Chemistry class said. "I hope this isn't going to be another of your brain teasers, Mrs. Terry".

"No this is actually a simple experiment that happens to most of us unknowingly. I do not think that you shall have any trouble with it, and should be interesting for you".

It's the interesting part that usually worries us," said Kenneth who seldom spoke in class.

"Well, I assure you that it is going to be easy. Has anyone been sick of heartburn? I have been from the school clinic where I found some anti-acid tablets. We shall do two things. First, is to test the pH of the Actal tablets, and then react the tablets with dilute hydrochloric acids". "But how shall we do that Mrs. Terry?" asked John one of her students. "Alright, as you can see here, we have Actal tablets, mortar and pestle, distilled water, universal indicator solution, universal indicator paper and some dilute hydrochloric acid. First, we need to crash the Actal tablets, using mortar and pestle, then add some little water, stir to dissolve." "That sounds like the experiment we had done while in form one" isn't it?" Asked, Catherine, one of her students.

"Off course yes, knowledge keeps on repeating itself, as you know, there is no knowledge that exists in isolation. He continued." Next, we will place a small amount of actal solution into a test tube and then two drops of universal indicator solution is added. Finally, the color of the solution is matched with that of the pH chart to determine the pH of actal solution." All the students nodded in agreement. Jane asked. "What about the second experiment, teacher Terry?"

Yeah Jane, "We shall add the Actal tablet into dilute hydrochloric acid, and as you can see there is no more Actal tablet remaining alter reaction. We call this reaction neutralization".

"What is neutralization? Asked, James.

The teacher explained," Neutralization is a chemical process in which an acid and a base combine to produce just salt and water. This is what happens when one takes actal powder or actal solution when suffering from heartburn, to neutralize the excess hydrochloric acid produced in our digestive systems." The students clapped for Mrs. Terry. "Is it the same thing that happens when we apply fertilizers to the soils"'? Asked, Catherine, curiously. "Yes, fertilizers are also products of neutralization reactions. Could your identity some of the fertilizers that are used by farmers? That is why Chemistry is everywhere in life my students".

QUESTIONS:

1. What is neutralization?

2. Identify the basis substance present in Actal powders or tablets.

3. Formulate a chemical equation representing the reaction between Actal powders and a solution of hydrochloric acid that has been diluted.

4. Name two of the fertilizers used by farmers and write their chemical formula.

5. Explain how neutralization is used to prevent tooth decay?

A summary of cases used to teach students the topic of salts is shown in Table 3

Summary of Cases used to teach Chemistry

Case	Topic	Objectives
Popcorns	Definition of salt	define salt
	Types of salts	uses of salt
Behavior of salts	Properties of salts	explain terms: Deliquescent, Hygroscopy, efflorescence
Indigestion	properties of bases/acids	write equations of reactions
Analogy of Dancers	double decompositions	write ionic equations
Alkali industry	uses of bases/ salts	state properties/uses of bases

Case 3

Behavior of salts

James and Janet were visiting their grandfather, a retired high school Chemistry teacher who lived in a nearly adult community apartment. Janet a form two student wanted to talk about something they had seen on National TV. "Grandpa, have you been watching the National Agricultural channel recently? We saw a program on it called “SAL T”. James said excitedly, "it is a documentary about the behaviour of salts." Oh yes, I saw that program'. Said, Janet's grandpa. "I wonder how Chemistry’s determine the behaviour of salts in nature". Said James! "Well most plants, do well in soils rich in nutrients, as a matter of fact most foods we eat and materials we utilize are made of salts.

What's that? Asked, Jane. Salts are ionic substances which are formed when hydrogen ions or ammonium ion are replaced by a positive ion. The common salt we use to add flavour to foods is called sodium chloride also referred to as Table salt probably because we use it when food is placed in tables. Of course, common salt contains Magnesium chloride as one of its ingredients. By the way have you wondered why salts exposed to atmosphere become damp or wet after sometime?

Janet: True to what you have said grandpa. I have seen this happen in our school's dining tables many times. So, what happens to the salt, grandpa?

Grandpa: You are right Janet. Some salts attract moisture to become wet. We call this hygroscopic. Hygroscopy is the process by which a substance attracts water from atmosphere but do not form a solution.

James: Mmmmh. Hydroscopic, is it?

Grandpa: Yes, my grandson. Hydroscopic is the substance that absorbs water but do not form a solution. There are other substances that behave this way although they are not salts. Yet other substances behave differently, James.

James: So, there are other processes, grandpa?

Grandpa: Good question James. We have deliquescence and efflorescence. Deliquescence is the process by which a substance absorbs moisture from the atmosphere to form a solution. Salts such as copper (II) nitrate, Sodium nitrate, Calcium chloride and Magnesium chloride among others are deliquescent. On the other hand, efflorescent salts lose their water of crystallization when exposed to the atmosphere and so they undergo efflorescence.
Hydrated salts of sodium carbonate, Iron (II) Sulphate are efflorescent in nature.

<u>QUESTIONS: -</u>

1. What is a salt

(ii) State the meaning of these terms: -

(a) Deliquescent

(b) Efflorescent

(c) Hygroscopy

2. Name the following processes: -

(a) Concentrated Sulphuric (VI) acid absorbs moisture from atmosphere.

(b) White crystals of copper (II) Sulphate changes to blue when left outside for some time.

(c) Crystals of Sodium Carbonate dehydrate weight less when left over night.

3. State two applications of behaviors characterized by salts in real life situations.

4. What is crystallization?

Case 4

Analogy of Dancers

Double Decomposition reactions

Two couples are dancing. The two girls look over and state that they wish to switch partners. And so, they do

For a double decomposition reaction to occur, one of the products must be insoluble and form a solid. This solid called a precipitate is denser than the surrounding solution and falls to the bottom of the test tube. If both products are soluble then there is no reaction. When writing double decomposition reactions, both reactants must be dissolved in water (aqueous). This frees up the ions and allows them to exchange just the same way the dancing couples exchange their partners. If either of the reactants is not soluble, the reaction will not occur in the same manner if the dancing couples are unwilling to exchange dancing partners.

<u>QUESTIONS:</u>

Refer to solubility table and answer the following questions.

I. Predict and write equations for these reactions where they occur.

a. $Na_2CO_3(aq) + BaCl_2(aq)$

b. $K_2CO_3(aq) + MgSO_4(aq)$

c. $(NH4)_2CO_3(aq) + CuC1_2(aq)$

d. $NaCl(aq) + AgNO_3(aq)$

e. $Ba(NO_3)_2(aq) + Na_2SO_4(aq)$

f. $MgCl_2(aq)+Pb(NO_3)_2(aq)$

<u>CASE 5</u>

Alkali Industry

Tom and Julian were visiting a soap and salt/production firm located on the bank of a sea in one of the-industrial cities during the school holiday. Engineer Dan the firm production Manager welcomed them.

This is one of the biggest firm's we have in our County," Dan said. The firm occupies approximately three acres of land. Dan continued.

Tom: Sir, what are your main products

Dan: Well, my son, I will take you through various sections of the firm. This factory makes a variety of products. You see (pointing to the display on one of the verandahs)

Julian: I like the display.

Dan: This industry manufactures soap, paper, rayon, cement and fertilizers.

Tom: I would like to know how soap is prepared Sir. Could you explain please?

Dan: Well, the first thing is the gathering of the raw materials: I hope that your Chemistry teacher taught you the alkalis, you remember?

Julian: Yes Sir, I remember my Chemistry teacher explain to us some soluble bases such as magnesium oxide, calcium oxide and.

Tom: You mean the alkalis are very important in industries?

Dan: Thank you. Life is full of Chemistry, Tom. Most substances we use in our day to day lives are products of Chemistry. For example, the soaps we use are basically made of sodium hydroxide or potassium hydroxide.

Tom: But I remember our Chemistry teacher reacting sodium and potassium with water and both were very violent. How is this possible, Sir?

Dan: Sodium is first extracted through electrolysis. One of the products is Sodium hydroxide. Sodium hydroxide is then used to make soap. Did your Chemistry teacher tell you that soaps are bases?

Julian: Oh, yes Sir.

Dan: Concentrated Sodium hydroxide is and with oils or fats and boiled to make soap. The other use of Sodium hydroxide is in the manufacture of paper and rayon (garment).

Tom: Do calcium oxide have use in industries, you mentioned fertilizers, didn't you?

Dan: Oh, Yes Tom, in deed, Fertilizers and Cement are very important compounds. To enrich soils or in order to raise pH of soil lime is. This creates favorable soils for various plants and consequently the yield is affected. More so, cement which contains calcium oxide and clay is very important in construction industries. Fertilizers are indeed salts; this is the reason why we have a combination of three industries in our firm.

Tom: Thank you sir, I think now we can get into the sections of industries to learn more.

Dan: Welcome.

Julian: But sir, how are salts made here?

Dan: Well, have you asked yourself why sea water is salty?

Tom: I think it contains sodium chloride, right?

Dan: In the sea, sodium chloride ions and chloride ions from dissolved rock material like silica and carbonated originate from underwater volcanoes and vents. As sea waste is evaporated, the ionic concentration increases where the ions precipitate out as sodium chloride.

Julian: So, how are salts used in this industry?

Dan: The industrial uses of salts are many. It has long been used to preserve food, absorb water to desiccate the materials production of plastics and detergents. Remarkably, half of the salt produced is now used in roads to clear snow in temperate lands. Some of the stories of

sodium chloride use and misuse are many. Salt remain, the only mineral you are likely to find on the kitchen shelves as in an industrial process. Too much salt may wreck a meal but we all find that life is much better thanks to this compound.

QUESTIONS:

1. Name three bases that are soluble in water.
2. State the uses of the following bases: -

i. Sodium hydroxide-

ii. Calcium oxide

iii. Name any two uses of sodium carbonate

Appendix H: Some Data out puts from Statistical Package for Social Sciences Vesrion 25

```
DATASET ACTIVATE DataSet3.
ONEWAY learningtype BY group
  /STATISTICS DESCRIPTIVES HOMOGENEITY
  /MISSING ANALYSIS
  /POSTHOC=TUKEY ALPHA(0.05).
```

[DataSet3] C:\Users\stella\Documents\anova phd.sav

Descriptives(pretest CAT scores)

learningtype

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
cbl	36	19.92	10.470	1.745	16.37	23.46	6	46
tbl	37	15.54	5.970	.982	13.55	17.53	8	30
rtm	39	16.00	7.341	1.176	13.62	18.38	3	40
Total	112	17.11	8.270	.781	15.56	18.66	3	46

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Learningtype	Based on Mean	4.719	2	109	.011
	Based on Median	2.272	2	109	.108
	Based on Median and with adjusted df	2.272	2	89.652	.109
	Based on trimmed mean	4.211	2	109	.017

ANOVA(pretest cat)

learningtype

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	422.775	2	211.388	3.214	.044
Within Groups	7167.939	109	65.761		
Total	7590.714	111			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: learningtype

Tukey HSD

					95% Confidence Interval	
(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Cbl	Tbl	4.376	1.898	.059	-.13	8.89
	Rtm	3.917	1.874	.097	-.54	8.37
Tbl	Cbl	-4.376	1.898	.059	-8.89	.13
	Rtm	-.459	1.861	.967	-4.88	3.96
Rtm	Cbl	-3.917	1.874	.097	-8.37	.54
	Tbl	.459	1.861	.967	-3.96	4.88

Homogeneous Subsets

Learningtype

Tukey HSD[a,b]

		Subset for alpha = 0.05
Group	N	1
Tbl	37	15.54
Rtm	39	16.00
Cbl	36	19.92
Sig.		.056

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 37.292.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

GET

Post CAT analysis (Oneway)

Descriptives

learningtype

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
rtm	36	23.50	11.385	1.898	19.65	27.35	7	57
cbl	34	37.15	18.823	3.228	30.58	43.71	10	87
tbl	36	34.47	17.547	2.925	28.54	40.41	3	83
Total	106	31.60	17.102	1.661	28.31	34.90	3	87

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Learningtype	Based on Mean	3.318	2	103	.040
	Based on Median	3.257	2	103	.042
	Based on Median and with adjusted df	3.257	2	94.089	.043
	Based on trimmed mean	3.435	2	103	.036

ANOVA

learningtype

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3705.122	2	1852.561	7.066	.001
Within Groups	27006.237	103	262.196		
Total	30711.358	105			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: learningtype

Tukey HSD

(I) groups	(J) groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Rtm	Cbl	-13.647*	3.872	.002	-22.86	-4.44
	Tbl	-10.972*	3.817	.014	-20.05	-1.90
Cbl	Rtm	13.647*	3.872	.002	4.44	22.86
	Tbl	2.675	3.872	.769	-6.53	11.88
Tbl	Rtm	10.972*	3.817	.014	1.90	20.05
	Cbl	-2.675	3.872	.769	-11.88	6.53

*. The mean difference is significant at the 0.05 level.

Homogeneous Subsets

Learningtype

Tukey HSD[a,b]

Groups	N	Subset for alpha = 0.05: 1	2
Rtm	36	23.50	
Tbl	36		34.47
Cbl	34		37.15
Sig.		1.000	.767

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 35.308.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Univariate Analysis of Variance

[DataSet5] C:\Users\stella\Documents\kcpe marks phd.sav

Between-Subjects Factors

		Value Label	N
Groups	1	Rtm	36
	2	Cbl	34
	3	Tbl	36

Tests of Between-Subjects Effects

Dependent Variable: catmark

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4033.334[a]	3	1344.445	5.140	.002
Intercept	3738.687	1	3738.687	14.294	.000
Kcpemarks	328.212	1	328.212	1.255	.265
Groups	3430.763	2	1715.381	6.559	.002
Error	26678.025	102	261.549		
Total	136584.000	106			
Corrected Total	30711.358	105			

a. R Squared = .131 (Adjusted R Squared = .106)

Post CAT Data

Learningtype	Groups
17	Rtm
17	Rtm
37	Rtm
10	Rtm
43	Rtm
47	Rtm
20	Rtm
30	Rtm
27	Rtm

40	Rtm
57	Rtm
15	Rtm
23	Rtm
13	Rtm
20	Rtm
20	Rtm
32	Rtm
27	Rtm
17	Rtm
33	Rtm
7	Rtm
23	Rtm
20	Rtm
13	Rtm
20	Rtm
33	Rtm
27	Rtm
7	Rtm
10	Rtm
20	Rtm
17	Rtm
23	Rtm
32	Rtm
20	Rtm
16	Rtm
13	Rtm
40	Cbl
17	Cbl
53	Cbl
23	Cbl
20	Cbl
17	Cbl
27	Cbl
13	Cbl
40	Cbl

50	Cbl
13	Cbl
27	Cbl
53	Cbl
87	Cbl
80	Cbl
43	Cbl
12	Cbl
10	Cbl
57	Cbl
23	Cbl
43	Cbl
33	Cbl
22	Cbl
39	Cbl
42	Cbl
44	Cbl
60	Cbl
52	Cbl
22	Cbl
27	Cbl
32	Cbl
60	Cbl
40	Cbl
42	Cbl
63	Tbl
63	Tbl
27	Tbl
47	Tbl
20	Tbl
6	Tbl
57	Tbl
42	Tbl
40	Tbl
13	Tbl
24	Tbl

27	Tbl
83	Tbl
33	Tbl
22	Tbl
23	Tbl
20	Tbl
39	Tbl
27	Tbl
32	Tbl
27	Tbl
33	Tbl
3	Tbl
20	Tbl
30	Tbl
42	Tbl
36	Tbl
24	Tbl
80	Tbl
33	Tbl
40	Tbl
33	Tbl
22	Tbl
40	Tbl
32	Tbl
38	Tbl

Pre test CAT Data

learning type	groups
17	Rtm
17	Rtm
37	Rtm

10	Rtm
43	Rtm
47	Rtm
20	Rtm
30	Rtm
27	Rtm
40	Rtm
57	Rtm
15	Rtm
23	Rtm
13	Rtm
20	Rtm
20	Rtm
32	Rtm
27	Rtm
17	Rtm
33	Rtm
7	Rtm
23	Rtm
20	Rtm
13	Rtm
20	Rtm
33	Rtm
27	Rtm
7	Rtm
10	Rtm
20	Rtm
17	Rtm
23	Rtm
32	Rtm
20	Rtm
16	Rtm
13	Rtm
40	Cbl
17	Cbl
53	Cbl

23	Cbl
20	Cbl
17	Cbl
27	Cbl
13	Cbl
40	Cbl
50	Cbl
13	Cbl
27	Cbl
53	Cbl
87	Cbl
80	Cbl
43	Cbl
12	Cbl
10	Cbl
57	Cbl
23	Cbl
43	Cbl
33	Cbl
22	Cbl
39	Cbl
42	Cbl
44	Cbl
60	Cbl
52	Cbl
22	Cbl
27	Cbl
32	Cbl
60	Cbl
40	Cbl
42	Cbl
63	Tbl
63	Tbl
27	Tbl
47	Tbl
20	Tbl

6	Tbl
57	Tbl
42	Tbl
40	Tbl
13	Tbl
24	Tbl
27	Tbl
83	Tbl
33	Tbl
22	Tbl
23	Tbl
20	Tbl
39	Tbl
27	Tbl
32	Tbl
27	Tbl
33	Tbl
3	Tbl
20	Tbl
30	Tbl
42	Tbl
36	Tbl
24	Tbl
80	Tbl
33	Tbl
40	Tbl
33	Tbl
22	Tbl
40	Tbl
32	Tbl
38	tbl

Post CAT Data

learning type	groups

17	rtm
17	rtm
37	rtm
10	rtm
43	rtm
47	rtm
20	rtm
30	rtm
27	rtm
40	rtm
57	rtm
15	rtm
23	rtm
13	rtm
20	rtm
20	rtm
32	rtm
27	rtm
17	rtm
33	rtm
7	rtm
23	rtm
20	rtm
13	rtm
20	rtm
33	rtm
27	rtm
7	rtm
10	rtm
20	rtm
17	rtm
23	rtm
32	rtm
20	rtm
16	rtm
13	rtm

40	cbl
17	cbl
53	cbl
23	cbl
20	cbl
17	cbl
27	cbl
13	cbl
40	cbl
50	cbl
13	cbl
27	cbl
53	cbl
87	cbl
80	cbl
43	cbl
12	cbl
10	cbl
57	cbl
23	cbl
43	cbl
33	cbl
22	cbl
39	cbl
42	cbl
44	cbl
60	cbl
52	cbl
22	cbl
27	cbl
32	cbl
60	cbl
40	cbl
42	cbl
63	tbl
63	tbl

27	tbl
47	tbl
20	tbl
6	tbl
57	tbl
42	tbl
40	tbl
13	tbl
24	tbl
27	tbl
83	tbl
33	tbl
22	tbl
23	tbl
20	tbl
39	tbl
27	tbl
32	tbl
27	tbl
33	tbl
3	tbl
20	tbl
30	tbl
42	tbl
36	tbl
24	tbl
80	tbl
33	tbl
40	tbl
33	tbl
22	tbl
40	tbl
32	tbl
38	tbl

ANCOVA POST TEST CAT with KCPE MARKS (covariates)

275	17	rtm
215	17	rtm
321	37	rtm
278	10	rtm
307	43	rtm
256	47	rtm
236	20	rtm
246	30	rtm
232	27	rtm
273	40	rtm
308	57	rtm
226	15	rtm
264	23	rtm
296	13	rtm
243	20	rtm
238	20	rtm
189	32	rtm
283	27	rtm
265	17	rtm
234	33	rtm
276	7	rtm
264	23	rtm
235	20	rtm

333	13	rtm
325	20	rtm
290	33	rtm
298	27	rtm
252	7	rtm
260	10	rtm
275	20	rtm
202	17	rtm
216	23	rtm
286	32	rtm
256	20	rtm
182	16	rtm
253	13	rtm
230	40	cbl
316	17	cbl
286	53	cbl
282	23	cbl
242	20	cbl
289	17	cbl
323	27	cbl
284	13	cbl
225	40	cbl
199	50	cbl
316	13	cbl

301	27	cbl
254	53	cbl
242	87	cbl
251	80	cbl
261	43	cbl
278	12	cbl
297	10	cbl
256	57	cbl
250	23	cbl
265	43	cbl
267	33	cbl
254	22	cbl
236	39	cbl
258	42	cbl
223	44	cbl
276	60	cbl
268	52	cbl
224	22	cbl
234	27	cbl
203	32	cbl
296	60	cbl
261	40	cbl
243	42	cbl
179	63	tbl

186	63	tbl
210	27	tbl
254	47	tbl
251	20	tbl
215	6	tbl
214	57	tbl
240	42	tbl
203	40	tbl
285	13	tbl
215	24	tbl
298	27	tbl
238	83	tbl
218	33	tbl
196	22	tbl
260	23	tbl
227	20	tbl
184	39	tbl
314	27	tbl
200	32	tbl
225	27	tbl
251	33	tbl
236	3	tbl
208	20	tbl
226	30	tbl

307	42	tbl
230	36	tbl
203	24	tbl
238	80	tbl
205	33	tbl
213	40	tbl
275	33	tbl
258	22	tbl
208	40	tbl
212	32	tbl
228	38	tbl

Post test SSCQ (raw data)

sscq posttestrtm	sscq posttesttbl	sscq posttestcbl
65	93	93
65	57	57
50	80	80
67	65	65
66	76	76
70	58	50
67	79	79
70	59	49
59	65	63
76	56	51
77	59	59
79	78	75
90	56	48

	66	71	63
	56	69	62
	62	59	67
	66	67	90
	68	90	60
	62	68	76
	63	76	64
	52	64	87
	53	87	69
	78	71	73
	61	73	71
	60	71	76
	59	76	94
	50	94	85
	54	85	87
	75	87	100
	66	100	88
	68	85	83
	66	89	83
	50	92	78
	54	83	79
	60	72	
	75	77	

Descriptive(post-test sscq)

learning type

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
rtm	36	64.58	9.259	1.543	61.45	67.72	50	90
tbl	36	74.64	12.257	2.043	70.49	78.79	56	100

cbl	34	72.94	13.876	2.380	68.10	77.78	48	100
Total	106	70.68	12.607	1.225	68.25	73.11	48	100

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Learningtype	Based on Mean	4.103	2	103	.019
	Based on Median	3.704	2	103	.028
	Based on Median and with adjusted df	3.704	2	96.241	.028
	Based on trimmed mean	4.042	2	103	.020

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
learning type	Based on Mean	4.103	2	103	.019
	Based on Median	3.704	2	103	.028
	Based on Median and with adjusted df	3.704	2	96.241	.028
	Based on trimmed mean	4.042	2	103	.020

ANOVA

learning type

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2076.156	2	1038.078	7.317	.001
Within Groups	14612.938	103	141.873		
Total	16689.094	105			

Post Hoc Tests (post-test SSCQ)

Multiple Comparisons

Dependent Variable: learning type

Tukey HSD

(I) group	(J) group	Std. Error	Sig.	95% Confidence Interval

		Mean Difference (I-J)			Lower Bound	Upper Bound
rtm	tbl	-10.056*	2.807	.002	-16.73	-3.38
	cbl	-8.358*	2.848	.011	-15.13	-1.58
tbl	rtm	10.056*	2.807	.002	3.38	16.73
	cbl	1.698	2.848	.823	-5.08	8.47
cbl	rtm	8.358*	2.848	.011	1.58	15.13
	tbl	-1.698	2.848	.823	-8.47	5.08

*. The mean difference is significant at the 0.05 level.

Homogeneous Subsets

Learning type

Tukey HSD[a,b]

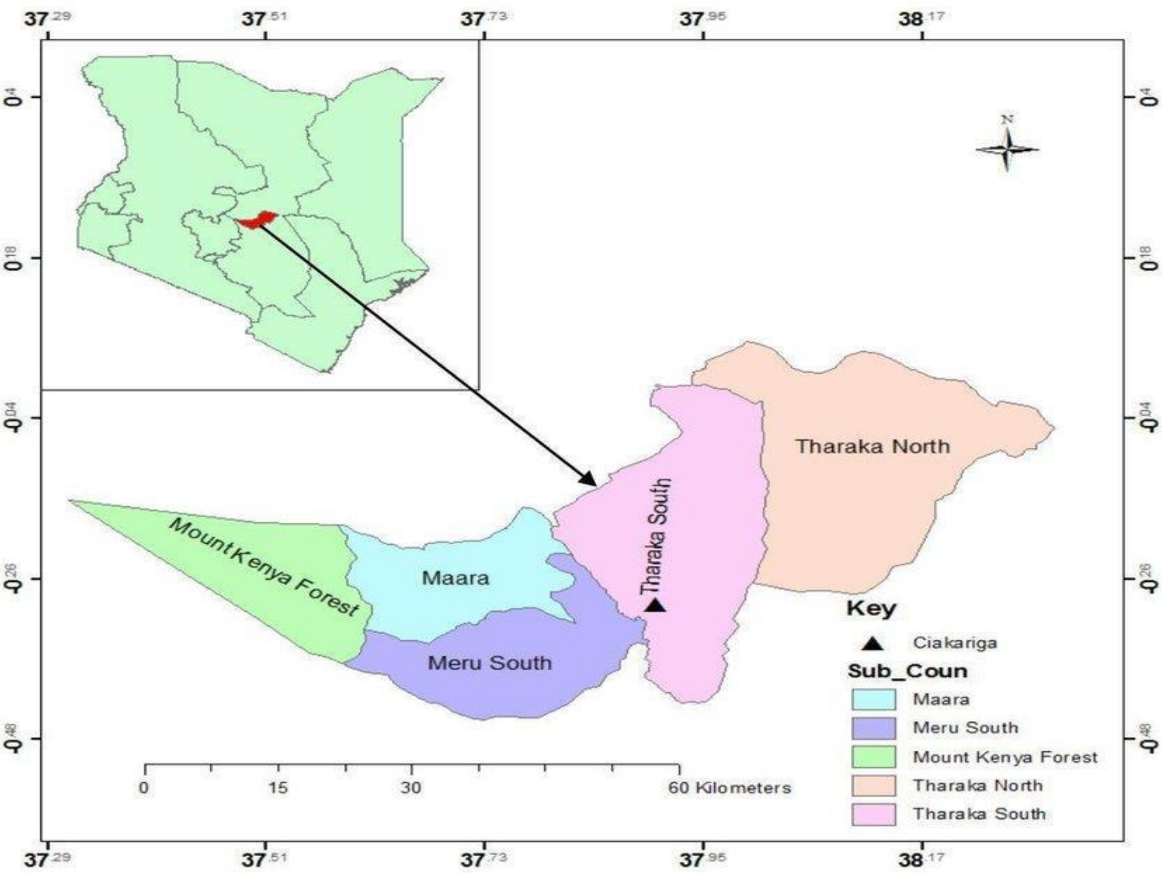
		Subset for alpha = 0.05	
group	N	1	2
rtm	36	64.58	
cbl	34		72.94
tbl	36		74.64
Sig.		1.000	.821

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 35.308.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Appendix I: Map of Tharaka Nithi County



Appendix J: Research Authorization from Nacosti

(19)

NACOSTI

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

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2241349,3310571,2219420
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Email: dg@nacosti.go.ke
Website : www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/18/17111/24656**

Date: **18th August, 2018**

Arimba Mugiira Antony
Egerton University
P.O. Box 536-20115
NJORO

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Effects of case based learning, team based learning and regular teaching methods on secondary school students achievement and self concept in chemistry in Maara Sub County,"*** I am pleased to inform you that you have been authorized to undertake research in **Tharaka Nithi County** for the period ending **17th August, 2019.**

You are advised to report to **the County Commissioner and the County Director of Education, Tharaka Nithi County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

BONIFACE WANYAMA
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Tharaka Nithi County.

The County Director of Education
Tharaka Nithi County.

National Commission for Science, Technology and Innovation is ISO9001 2008 Certified

Appendix K: Publications

Journal of Education and Practices
http://journals.essrak.org/index.php/education

Journal of Education and Practices
Vol 4 Issue No.1. February, 2024. PP 01-10. ISSN 2617-5444

A COMPARISON OF CASE BASED LEARNING, TEAM BASED LEARNING AND REGULAR TEACHING METHODS INFLUENCES ON STUDENTS' PERFORMANCE IN CHEMISTRY IN MAARA SUB COUNTY, KENYA

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Department of Curriculum Instruction and Educational Management, Egerton University, Kenya
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Abstract

Most concepts in Chemistry are difficult which leads to poor performance of students. The purpose of the study was to compare Case Based Learning (CBL), Team Based Learning (TBL) and Regular Teaching Methods (RTM) influences on students' performance in Chemistry. The study used a 3 x 2 x 2 quasi-experimental factorial design. The target population was eighteen thousand six hundred and eleven (18,611) students in Maara Sub County. Three schools were selected purposively. A sample of one hundred and six (106) Chemistry students were selected for the study. Simple random sampling method was used to assign groups to experimental and control. The experimental groups were exposed to Case Based Learning and Team Based Learning. The control group was instructed through Regular Teaching Methods. The instrument used was the Chemistry Achievement Test (CAT). The validity of the instrument was ascertained by experts from Egerton University. Reliability coefficient of the CAT was 0.79. Analysis of Data was done using means, standard deviations, standard error differences, t-test, ANOVA and ANCOVA at $\alpha = 0.05$. Students taught using CBL obtained higher mean scores in chemistry than those that were taught through TBL and RTMs. The study concluded that CBL should be used to teach students to improve performance in chemistry. Curriculum developers, policy makers and teachers may use CBL and TBL in chemistry learning.

Keywords: *Case Based Learning, Team Based Learning, Regular Teaching Methods*

Introduction

The current practice of applying the Regular Teaching Methods could be responsible for the ineffectiveness of instruction in schools (Ihendinihn, 2013). Therefore, teachers need innovative strategies in order to increase the academic attainment of learners in Chemistry. Chabo, Babagana, Shuaib, Aliyu and Mohamed (2021) recommended from their study that Chemistry teachers should employ the Case Based Learning to permit learners in the creation of individual knowledge and engagement in learning.

According to Izueg, Arinze, Abigail, Nwanze, Pins and Emerhiona (2018) various methods of instructions are normally anchored on some theories of learning. It is upon the teachers to choose desirable teaching approaches that can best suit the topic, nature of learners and objectives. In view of this, Chemistry should best be taught using constructivist approaches. Research by Uwalaka and Offorma (2015) showed a significant difference in the mean attainment scores of students trained using constructivist process than those instructed with the regular teaching methods. A constructivist teaching method offer the learners a chance to

Journal of Education and Practices
Vol 3 Issue No.2. July, 2022. PP 114-121. ISSN 2617-5444

EFFECT OF CASE BASED LEARNING AND REGULAR TEACHING METHODS ON SECONDARY SCHOOLS STUDENTS' ACHIEVEMENT IN CHEMISTRY IN MAARA, THARAKA NITHI COUNTY

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Abstract

Most concepts in Chemistry are abstract. Case Based Learning may help improve achievement in Chemistry. The purpose of this study was to find out the effect of Case Based Learning (CBL) and Regular Teaching Methods (RTM) on secondary school students' achievement in Chemistry in Maara Sub- County where performance is below average percentage mean scores. The study used a two by two pre-test post- test quasi-experimental factorial design. Purposive sampling was used to select 70 students from a population of 18,611students in three co-educational secondary schools. Simple random sampling method was used to assign groups to experimental and control groups. Pre-test was administered to two groups. The instrument was validated by science education experts from Egerton University Faculty of Education and Community Studies and examiners in the Kenya National Examinations Council. Pilot testing was done in Meru South Sub-County. The reliability of the instrument was 0.79. After eight weeks, a post-test was administered and data analyzed using descriptive and inferential statistics at $\alpha = 0.05$. The study found that the mean differences in post-test were statistically significant between those exposed to CBL and RTM, $p<0.05$ the experimental group performed better than RTM group. Based on this study, chemistry instructors may use CBL in teaching chemistry.

Key words: *Regular Teaching Methods, Case Based Learning, Chemistry Achievement Test*

Introduction

Chemistry is an important subject in many scientific fields of human endeavors and therefore, it should be given serious attention in secondary school education (Agboola & Oloyede, 2007). Despite the important potentials embedded in learning chemistry, its importance to mankind and the efforts of researchers to improve the quality of its teaching and learning especially at the secondary a school level, the performance of students in the subject in recent times is not impressive (Oluwatesin & Bamidele; (2014). According to Joje (2019) leading economies in Asia namely: Hong Kong, Japan, Singapore, South Korea and Taiwan have their chemistry achievement significantly higher than the world's mean achievement. Malaysia and Thailand had average and below average achievements in chemistry respectively which are attributed to the nature of teaching- learning process. Statistics from Nigeria showed that performance of candidates in senior secondary from (2001-2014) attested to students' poor achievement in chemistry to the use of ineffective teaching methods by chemistry teachers (Fatokum, Egya & Uzoechi, 2016). Marissa and Elizabeth (2014) revealed that students in South Africa performed poorly chemistry when various concepts