UNIVERSITY OF EDUCATION, WINNEBA

EVALUATING THE EFFECT OF TEAM GAME TOURNAMENT APPROACH ON SENIOR HIGH SCHOOL STUDENTS' ACADEMIC PERFORMANCE IN CHEMICAL BONDING

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DECLARATION

STUDENT'S DECLARATION

I, Antoinette Adzi, declare that this thesis, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my original work, and that it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE: ______________________________________

DATE: ____

SUPERVISOR'S DECLARATION

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

NAME: Stephen Twumasi Annan (PhD)

SIGNATURE: ______________________________________

DATE: ____

DEDICATION

I dedicate this work to my husband, Mr. Felix Kodzo Attawiah, and my mother , Vecentia Avevor

ACKKNOWLEDGEMENT

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ABSTRACT

This study examined the effect of the Team Game Tournament (TGT) approach on Senior High School students' academic performance and perceptions in learning chemical bonding. The study was conducted at Tsito Senior High Secondary Technical School and employed a quasi-experimental design with a quantitative research approach. Two intact classes were used: one as the Experimental Group taught using the TGT approach and the other as the Control Group taught using the conventional learning technique. The experimental group consisted of 32 students while the control group consisted of 35 students. The instructional intervention lasted four weeks and covered chemical bonding concepts, including ionic, covalent, and metallic bonding. Data were collected using a Chemistry Achievement Test administered as pretest and posttest, and a Students' Perception Questionnaire administered to the experimental group only. Data were analysed using descriptive statistics, independent and paired samples *t*-tests, and Cohen's *d* effect size. The results revealed a statistically significant difference in posttest academic performance between students taught using the TGT approach and those taught using the conventional method, with the Experimental Group achieving significantly higher mean scores ($p < .001$). A large effect size indicated a strong practical impact of the TGT approach. Gender analysis within the Experimental Group showed no statistically significant difference in performance between male and female students ($p > .05$). Findings from the perception questionnaire indicated that students generally held positive perceptions of the TGT approach in terms of engagement, collaboration, understanding, confidence, enjoyment, and fairness. The study concluded that the Team Game Tournament approach is an effective instructional strategy for improving students' academic performance in chemical bonding and fostering positive learning experiences. The findings support the integration of cooperative game-based learning strategies in Senior High School chemistry instruction.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter presents the research background, and clearly outlines the research problem. It further covers important headings including research objectives questions and significance of the study. Delimitations and limitations are further discussed in this section.

1.1 Background to the Study

Understanding the concept of chemical bonding is the basis for learning other chemistry concepts at the senior high school level, as it supports key concepts in atomic structure, molecules, and reactivity (Hunter *et al.,* 2022). In the Ghanaian Senior High School (SHS) curriculum, the topic of chemical bonding is an important component in the syllabus of the West African Examinations Council (WAEC) for General Science. However, despite the importance of chemical bonding concept, students often face difficulties in understanding it fully. This is due to the abstract nature of the concept. When teaching a concept like chemical bonding, conventional method may not be contribute to sufficient engagement of all learners (Joshua *et al.,* 2023).

In order to address these concerns, more innovative instructional strategies that promote active learning, peer interaction, and motivation have been explored. One major instructional approach that has gained attention is cooperative learning, which involves students working together in small groups to achieve shared academic goals. Among the various cooperative learning models, the Team Game Tournament (TGT) approach is a structured strategy that integrates heterogeneous grouping, periodic review sessions, individual accountability, academic games, and team recognition. The TGT model was developed and popularised by Slavin in the 1970s as part of the cooperative learning framework. It is grounded in the principles of positive interdependence, face-to-face promotive interaction, individual accountability, group processing, and the development of social skills (Juwita et al., 2017). For instance, when used in a university physical-education context in Taiwan, TGT improved students' learning motivation and motor skills relative to a conventional method.

In science and chemistry education, studies have shown promising results when game-based and competitive cooperative methods are applied. For example, a quasi-experimental study in Turkey revealed that teaching with TGT on an ―Reproduction and Growth in Living Things" unit significantly improved 8th-grade students' achievement and their affective attitudes compared to lecture-based teaching. In chemistry-specific research, an Indonesian study using a computer-game medium for chemical bonding found that students using the game achieved higher post-test scores and expressed more positive attitudes compared with a traditional method.

Despite these international findings, there is a paucity of published research investigating the use of the Team Game Tournament (TGT) approach in senior high school chemistry classrooms in Ghana, particularly in the topic of chemical bonding. Existing studies in Ghana suggest that chemistry instruction at the senior high school level remains largely teacher-centred (Nkrumah *et al.,* 2025). This instructional approach has been associated with persistent learning difficulties in abstract topics such as chemical bonding (Coffie *et al.,* 2025).

Students' performance in chemical bonding has generally been reported as modest, especially among female students and learners from less-resourced schools (Kokka, 2017). In addition, gender disparities in science achievement continue to be a concern within the Ghanaian educational context (Durak *et al.,* 2025). Furthermore, students' perceptions of cooperative, game-based instructional approaches such as TGT remain under-explored in Ghanaian senior high schools.

Therefore, this study examined the effect of the TGT approach on SHS students' academic performance in chemical bonding (ionic, covalent, metallic) at Tsito Senior High Technical School, Ghana. It also explored whether the effect differed by gender, and how students perceived the use of TGT in learning chemical bonding.

1.2 Statement of the Problem

Chemistry is a core science subject in the Senior High School (SHS) curriculum in Ghana and serves as a foundational requirement for careers in medicine, engineering, pharmacy, agriculture, and other science-related fields. Despite its importance, students' performance in chemistry at the SHS level has consistently been a matter of concern, as reflected in both internal assessments and external examination reports (Hinson, 2023). Several studies in Ghana have attributed students' low achievement in chemistry to factors such as teacher quality, classroom environment, limited teaching and learning resources, and the continued reliance on teacher-centred instructional approaches (Nkrumah *et al.,* 2025).

Within the chemistry curriculum, certain topics are consistently identified as particularly difficult. Chemical bonding is one such abstract concept that requires learners to understand invisible particle interactions, electron configurations, and theoretical models. Research has shown that students often struggle with bonding due to its abstract nature, limited practical illustrations, and insufficient learner engagement during instruction (Wong & Liem, 2022). These challenges frequently result in misconceptions, low test scores, and poor retention of knowledge.

In the case of Tsito Senior High Technical School, anecdotal reports from chemistry teachers indicate that students taught using conventional lecture-based methods often remain passive during the chemical bonding unit. This has been associated with low mean scores in post-tests, higher failure rates in periodic assessments, and noticeable gender disparities favouring male students. However, these observations have not been supported by rigorous empirical investigation.

Although cooperative learning strategies have been widely studied internationally, there is limited quasi-experimental research in Ghanaian SHS contexts examining the effectiveness of game-based cooperative models such as the Team Game Tournament (TGT) approach in teaching chemical bonding. Furthermore, empirical evidence on gender-based differences in the impact of such instructional strategies remains scarce. There is also limited documentation of students' perceptions of the TGT approach in Ghanaian chemistry classrooms.

Therefore, given the persistent low achievement in chemistry, particularly in the topic of chemical bonding, and the limited empirical evidence on the effectiveness of game-based cooperative learning strategies in Ghana, this study sought to examine the effect of the TGT approach on students' academic performance, explore gender differences in achievement, and assess students' perceptions of the approach at Tsito Senior High Technical School.

1.3 Purpose of the Study

The purpose of this study was to investigate the effect of the Team Game Tournament (TGT) approach on Senior High School students' academic performance in the topic of chemical bonding at Tsito Senior High Technical School in Ghana.

1.4 Research Objectives

The objectives of the study were to:

1. assess the academic performance of students taught the concept of chemical bonding using the Team Game Tournament (TGT) approach and those taught using the conventional learning technique.
2. examine the effect of the Team Game Tournament approach on the academic performance of male and female students in the concept of chemical bonding.
3. determine students' perceptions of the use of the Team Game Tournament approach in learning chemical bonding.

1.5 Research Questions

The study was guided by the following research questions:

1. What is the difference in academic performance between students taught the concept of chemical bonding using the Team Game Tournament (TGT) approach and those taught using the conventional learning technique?
2. What is the effect of the Team Game Tournament approach on the academic performance of male and female students in learning the concept of chemical bonding?
3. What are the perceptions of students regarding the use of the Team Game Tournament approach in learning chemical bonding?

1.6 Hypotheses

The following null hypotheses were tested at a 0.05 level of significance:

1. H_{01}: There is no statistically significant difference in the academic performance of students taught the concept of chemical bonding using the Team Game Tournament (TGT) approach and those taught using the conventional learning technique.
2. H_{02}: There is no statistically significant difference in the academic performance of male and female students taught the concept of chemical bonding using the Team Game Tournament (TGT) approach.

1.7 Significance of the Study

The findings of this study are significant in several ways. Firstly, they contribute to improving the teaching and learning of chemistry in Ghanaian Senior High Schools particularly at Tsito Senior high school by providing empirical evidence on the effectiveness of the Team Game Tournament (TGT) approach in enhancing students' academic performance in chemical bonding a topic known for its conceptual difficulty. By demonstrating how a cooperative, game-based method can improve understanding and retention, this study offers chemistry teachers an alternative pedagogical tool that encourages student engagement, collaboration, and motivation.

Secondly, the study provides valuable insights for curriculum developers and policymakers at the Ghana Education Service (GES) and the National Council for Curriculum and Assessment (NaCCA). The results can guide the integration of active, learner-centred approaches such as TGT into the chemistry curriculum to promote deeper conceptual understanding and reduce gender gaps in science achievement.

Thirdly, for students, the TGT approach creates an interactive and enjoyable learning environment that fosters teamwork and critical thinking skills. These experiences not only improve academic achievement but also build confidence and positive attitudes toward chemistry attributes necessary for pursuing science-related careers.

Furthermore, the study adds to the growing body of empirical research on cooperative learning and game-based instruction in science education, particularly within the Ghanaian context where such studies remain limited. Findings from this research can serve as a reference for future researchers interested in exploring innovative instructional strategies for improving performance in science subjects.

Finally, school administrators and teacher educators can also benefit from the insights provided. Administrators may use the results to support teacher training and professional development initiatives that emphasise interactive and student-centred teaching methods. Teacher education institutions can also incorporate the findings into their instructional design courses to prepare pre-service teachers for more engaging and effective classroom practices.

1.8 Delimitations

This study was delimited to second-year Senior High School (SHS 2) students of Tsito Senior High Technical School in the Volta Region of Ghana. The focus was specifically on the topic of chemical bonding, which included subtopics such as ionic, covalent, and metallic bonding as outlined in the Ghana Education Service (GES) chemistry syllabus. The study covered only two intact classes: 2 General Arts 2 (serving as the experimental group) and 2 Business 2 (serving as the control group).

The research was further delimited to the use of the Team Game Tournament (TGT) approach for the experimental group and the conventional lecture method for the control group. The study examined students' academic performance through pretest and posttest scores, and their perceptions through a structured questionnaire.

Additionally, the study adopted a quantitative, quasi-experimental design with a pretest-posttest control group format. It did not include other teaching methods such as jigsaw, group investigation, or student teams–achievement divisions (STAD). Likewise, the study focused only on one Senior High School and therefore did not seek to generalize findings to all Ghanaian SHSs, although the results may have implications for similar contexts.

1.9 Limitations of the Study

Although the study provided valuable insights into the effect of the Team Game Tournament (TGT) approach on students' academic performance in chemical bonding, certain limitations were acknowledged. Firstly, the study was conducted in one Senior High School Tsito Senior High Technical School in the Volta Region of Ghana. As such, the findings may not be entirely generalisable to other schools with different student populations, teacher competencies, or resource levels.

Secondly, the duration of the intervention was limited to a short instructional period. A longer implementation might have provided a more robust measure of the long-term impact of the TGT approach on learning retention and conceptual understanding.

Additionally, the study relied on achievement tests and perception questionnaires as the main data collection instruments. These tools, though valid and reliable, may not capture all the dimensions of learning such as students' motivation, communication skills, or deeper conceptual shifts that qualitative methods might reveal.

Finally, the study did not consider other contextual factors such as teacher effects, classroom climate, or students' prior attitudes toward chemistry, which could have influenced learning outcomes. Future studies may incorporate mixed-method approaches or longitudinal designs to provide a more comprehensive understanding of the impact of cooperative game-based learning strategies on chemistry education in Ghana.

1.10 Organization of the Study

This thesis is organized into five main chapters. Chapter One presents the introduction to the study. It outlines the background to the study, statement of the problem, purpose of the study, research objectives, research questions, hypotheses, significance of the study, delimitations, limitations, and organization of the study. Chapter Two provides a review of related literature. It covers theoretical and empirical studies relevant to cooperative learning and the Team Game Tournament (TGT) approach, with particular emphasis on its application in science and chemistry education. The chapter also discusses conceptual frameworks, key constructs such as academic performance and perception, and the theoretical basis underpinning the study. Chapter Three describes the research methodology adopted for the study. It includes the research design, population, sample and sampling procedures, research instruments, data collection procedures, and methods of data analysis. Chapter Four presents the results and discussion of findings. It includes analyses of pretest and posttest scores, gender-based comparisons, effect sizes, and students' perceptions of the TGT approach. The discussion interprets these findings in relation to existing literature and theoretical perspectives. Chapter Five contains the summary, conclusions, and recommendations of the study. It highlights the key findings, draws conclusions based on the results, and makes recommendations for classroom practice, curriculum development, and future research.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter presents a review of related literature that is most relevant to the study. Theoretical and conceptual framework is clearly outline and justified in this section as well as important empirical studies that support the effectiveness of team game tournament instructional approach

2.1 Concept of Chemical Bonding in Senior High School Chemistry

Chemical bonding occupies a central place in senior high school (SHS) chemistry curricula because it explains how atoms combine to form molecules, compounds, and crystal lattices structures which underpin much of the physical and chemical behaviour of substances.

The teaching of chemical bonding concept serves as the baseline for understanding atomic structure, periodic trends and more advanced chemical reactivity and stoichiometry concepts.

From a pedagogical perspective, the concept of chemical bonding is described in literature as particularly abstract and therefore challenging at the SHS level. According to National Science Teaching Association (NSTA), even when students can define bonding types, many still persist in misconceptions for example, thinking that a chemical bond is a physical ―stick” between atoms rather than an energy effect or force of attraction. These misconceptions underscore the need for instructional strategies that emphasise conceptual understanding rather than rote rule-memorisation. Hunter *et al.* (2022) also reported that conventional teaching of bonding tends to encourage students to learn ―rules” such as octet rule, electron transfer rather than invest in understanding underlying reasons.

Van-Dulmen *et al* (2023) affirms that comprehension of chemical bonding needs proficiency in different foundational concepts such as atomic structure periodic trends and the ability to interpret models. These prerequisite conceptual understandings often form part of the barrier to mastering bonding. In Ghana, for instance, students have been observed to struggle with connecting such prerequisites to bonding, resulting in low performance in bonding units of the syllabus.

Furthermore, the types of chemical bonding each have distinctive features, which are often used as teaching anchors in SHS chemistry.

Ionic bonding occurs between metal and non-metal atoms and involves the transfer of electrons, leading to the formation of cations and anions, and also the creation of crystalline lattices held by electrostatic forces (Gagné & Hawthorne (2018). Covalent bonding involves sharing of electrons between non-metal atoms, leading to molecules or network structures; issues such as bond polarity, bond length and bond energy are sometimes introduced at SHS level. Metallic bonding is characterised by a ―sea” of delocalised valence electrons around metal cations, which accounts for properties like electrical conductivity and malleability in metals (Gagné & Hawthorne (2018). These different bonding types are important not only for classification but because they underlie physical properties of materials (e.g., melting point, electrical conductivity, solubility) and chemical behaviour (reactivity, stability). Thus, the topic of chemical bonding, when taught well, links both the microscopic and macroscopic levels a connection that is often highlighted as beneficial for deep learning in SHS chemistry (Gagné & Hawthorne (2018).

2.2 Students' Difficulties in Learning Chemical Bonding

Learning the concept of chemical bonding has long been recognized as one of the most challenging areas in secondary-level chemistry education. Students at the senior high school (SHS) level frequently demonstrate misconceptions, fragmented understanding, and rote memorization of rules rather than conceptual comprehension (Fadillah & Salirawati, 2018). Research across multiple educational systems indicates that chemical bonding difficulties arise from both the abstract nature of the concept and the pedagogical methods commonly used in teaching it (Lahlali *et al.,* 2023).

2.2.1 Cognitive and Conceptual Challenges

One of the reasons why students struggle with chemical bonding is that it needs the integration of multiple representational levels of chemistry macroscopic, submicroscopic, and symbolic (Rau, 2015). Students often fail to connect these levels. For example, they may correctly describe that sodium and chlorine react to form sodium chloride, but cannot visualize how the transfer of electrons between atoms leads to the ionic lattice structure or interpret this process symbolically. According to Joki and Aksela (2018), students tend to interpret bonding as a tangible connection between atoms rather than an electrostatic or energetic phenomenon, indicating limited understanding of the underlying physics of attraction and repulsion forces.

Students also find it difficult to differentiate among the three main types of bonds ionic, covalent, and metallic often confusing their formation and properties. Tsaparlis *et al.* (2022) found that many learners believe covalent bonds occur through complete electron transfer instead of sharing, while ionic bonds are sometimes thought to involve ―partial sharing." These alternative conceptions reflect an oversimplification of bonding models typically introduced at early stages of chemistry learning.

2.2.2 Instructional and Representational Factors

Instructional methods strongly influence the persistence of misconceptions. Traditional lecture-based teaching, dominated by teacher explanations and textbook memorization, rarely provides opportunities for students to construct their own mental models of bonding phenomena (Joshua *et al.*, 2023). Classroom observations indicate that many chemistry teachers depend on teacher-centred delivery with minimal visual or interactive materials (Al-Balushi *et al.,* 2020). Such approaches may encourage memorization of bonding rules rather than meaningful understanding.

The use of static representations such as 2-D drawings in textbooks can also reinforce misconceptions. Research by Fadillah and Salirawati (2018) highlighted that student struggle to interpret Lewis structures or lattice diagrams because they fail to visualize the dynamic nature of atomic interactions and electron behaviour. When students cannot transition between symbolic diagrams and submicroscopic reasoning, their conceptual understanding of bonding remains superficial.

2.2.3 Language and Prior Knowledge Barriers

Language has also been identified as a barrier in chemistry learning. Technical vocabulary such as bond, sharing, attraction, or energy level may carry different meanings in everyday usage, leading to confusion (Martin & Graulich, 2024). Additionally, many Ghanaian students enter SHS with limited prior knowledge of atomic structure and periodicity, both of which are prerequisite concepts for understanding bonding (Aboagye *et al.,* 2019). The lack of foundational understanding limits their ability to predict bonding behaviour or relate bonding to the properties of substances.

2.2.4 Assessment-Driven Learning and Misconceptions

Another factor contributing to students' difficulties is assessment orientation. Studies show that when chemistry instruction focuses primarily on examination preparation, students aim to memorize definitions and procedures rather than develop conceptual reasoning (Cooper & Stowe, 2018). The WAEC chemistry examinations, while comprehensive, often emphasize recall questions on bond types or characteristics rather than problem-solving or application-based tasks, reinforcing rote learning behaviours among students (Nweze & Obu, 2022).

Research suggests that meaningful understanding of chemical bonding requires interactive, visual, and student-centred pedagogies that encourage reasoning and conceptual change (Chowdhury *et al.,* 2018; Partanen, 2020). Techniques such as cooperative learning, multiple representations, and model-based inquiry have proven effective in addressing misconceptions and promoting deeper understanding (Soulios & Psillos, 2016). Therefore, exploring an approach such as Teams-Games-Tournaments (TGT) within this context may help alleviate these challenges by providing opportunities for peer interaction, feedback, and conceptual discussion.

2.3 Overview of Cooperative Learning in Science Education

Cooperative learning has emerged as one of the most effective instructional strategies for promoting student engagement, conceptual understanding, and academic achievement in science education. Rooted in constructivist learning theory, cooperative learning emphasizes active participation, social interaction, and shared responsibility among students as they work collaboratively toward common learning goals (Saleem *et al.,* 2021; Johnson & Johnson, 2015). In contrast to traditional teacher-centered instruction, cooperative learning creates a learner-centered environment where students construct knowledge through discussion, explanation, and peer support (Chowdhury, 2021).

2.3.1 Nature and Principles of Cooperative Learning

Cooperative learning involves students working together in small, structured groups to achieve both individual and group academic goals. According to Johnson and Johnson (2015), five essential elements characterize effective cooperative learning: positive interdependence**,** individual accountability**,** face-to-face promotive interaction**,** social skills**,** and group processing**.** Positive interdependence ensures that students perceive their success as linked with the success of their peers, while individual accountability ensures that each learner contributes meaningfully to the group task.

Cooperative learning also enhances higher-order thinking skills through peer dialogue and negotiation of meaning. By explaining concepts to peers and defending their reasoning, students deepen their understanding and correct misconceptions (Alam, 2023). This aligns with Vygotsky's concept of the Zone of Proximal Development (ZPD)**,** which posits that learners can achieve higher levels of understanding through interaction with more capable peers or through guided collaboration (Alam, 2023).

2.3.2 Application of Cooperative Learning in Science Education

In science classrooms, cooperative learning has been shown to facilitate improved comprehension of complex and abstract concepts by promoting active engagement and collaborative problem-solving (Chowdhury, 2021). Topics such as chemical bonding, molecular structure, and energy transformations, which require reasoning at both macroscopic and microscopic levels, benefit significantly from peer-assisted explanation and discussion. Cooperative learning also encourages scientific discourse and inquiry-based learning, essential elements in developing scientific literacy (Alam, 2023).

Empirical studies in Ghana and other countries have reported that cooperative learning enhances students' academic performance in science subjects. Kabutu *et al.* (2015) found that Nigerian students taught with cooperative learning strategies performed significantly better in chemistry than those taught through lecture-based methods. Similarly, Abubakari and Nabie (2024) reported that cooperative learning improved Ghanaian students' retention and motivation in physics and chemistry classrooms. These findings suggest that interactive strategies allow learners to connect new information to prior knowledge through dialogue and experimentation.

2.3.3 Benefits of Cooperative Learning

The benefits of cooperative learning extend beyond academic achievement. Research has shown that it promotes social and communication skills**,** teamwork**,** and positive attitudes toward learning (Simesso *et al.,* 2024; Senyefia *et al.,* 2021). Cooperative learning reduces classroom anxiety and fosters inclusivity by enabling students of different abilities to contribute meaningfully to shared tasks. It also supports gender equity, as collaborative learning settings tend to reduce competitive dominance and increase participation among female students (Appiah-Twumasi *et al*., 2020).

Furthermore, the cooperative learning model supports the development of metacognitive skills, such as self-regulation and reflective thinking. Students engage in planning, monitoring, and evaluating their own learning processes, which contributes to long-term knowledge retention (Senyefia *et al.,* 2021).

2.3.4 Transition to Game-Based Cooperative Strategies

While cooperative learning is effective on its own, researchers have explored ways to make it more engaging and motivating for learners. One such innovation is the Team Game Tournament (TGT) approach, developed by Nofriansyah *et al.* 2024), which integrates competition and gamification elements into cooperative learning structures. The TGT approach maintains the core principles of cooperation while introducing games and tournaments to enhance motivation, active participation, and excitement in learning.

2.4 The Team Game Tournament (TGT) Approach: Concept and Structure

The Team Game Tournament (TGT) approach is a cooperative learning strategy developed by Juwita *et al.* (2017) as part of the broader Student Team Learning models designed at Johns Hopkins University. TGT integrates principles of teamwork, competition, and game-based learning to foster student engagement, motivation, and achievement. It is particularly effective in subjects like science, where conceptual understanding and active participation are critical (Novritasari *et al.,* 2022; Mudiyanto, 2017).

2.4.1 Concept of the TGT Approach

TGT is based on the premise that students learn best when they work collaboratively toward shared goals while engaging in friendly academic competition. The approach combines cooperation within teams and competition between teams, allowing learners to interact, explain, and defend their understanding of concepts in a fun and structured manner (Muttaqien *et al.,* 2021). In this model, students are organized into heterogeneous teams, typically consisting of four to five members of varied academic abilities, gender, and backgrounds (Pongkendek *et al.,* 2019).

Each team works together to master instructional material, after which they participate in tournaments structured game sessions where representatives from different teams compete by answering questions or solving problems related to the topic studied. Points earned by individual students contribute to their team's total score, promoting accountability and mutual support.

2.4.2 Structure and Stages of the TGT Model

The TGT approach is implemented through five main stages as outlined by Slavin and Madden (2021):

1. Class Presentation – The teacher introduces the new content through lectures, demonstrations, or multimedia presentations. This phase ensures all students have access to the same foundational knowledge before team activities begin.
2. Team Study – Students work in their assigned teams to discuss the material, explain difficult concepts, and prepare for the tournament. Team members tutor one another, using learning materials such as worksheets, flashcards, or concept maps.
3. Games – This stage involves quiz-based games designed to reinforce understanding. Questions are structured to require critical thinking rather than rote recall. The game format encourages active engagement and excitement while maintaining focus on academic content.
4. Tournaments – Students compete in weekly or unit-based tournaments where they are matched with others of similar prior performance levels. The emphasis is on equitable participation rather than dominance by high achievers.

5. Team Recognition – Teams receive certificates or rewards based on their accumulated points. Recognition motivates students to contribute effectively during study sessions and tournaments.

This structured format creates a dynamic learning environment that combines individual accountability with collective success.

2.4.3 Pedagogical Benefits of TGT

Empirical evidence supports TGT's positive impact on students' academic performance, motivation, and attitudes toward learning. Nadrah (2023) found that Nigerian secondary school students taught physics through TGT achieved significantly higher test scores than those taught via traditional lecture methods. Similarly, Salam *et al*. (2015) reported improved conceptual understanding and retention in chemistry among students exposed to TGT.

The approach has also been shown to promote equity and inclusivity, as it allows both high and low achievers to contribute meaningfully to team success (Salam *et al*., 2015). The collaborative nature of TGT fosters peer tutoring and knowledge sharing, which enhance comprehension of abstract scientific concepts such as chemical bonding (Nadrah (2023). Moreover, the competitive element sustains attention and reduces classroom boredom, which are common issues in teacher-dominated instructional contexts (Pongkendek *et al.,* 2019). In chemistry education, particularly in topics like ionic, covalent, and metallic bonding, TGT can bridge the gap between abstract theoretical concepts and student understanding through interactive engagement. When implemented effectively, it transforms passive learning into an active, participatory process, enabling students to discuss bonding models, share analogies, and visualize structures collaboratively. Studies conducted in secondary schools have reported that game-based cooperative approaches significantly improve retention and problem-solving abilities in chemistry topics that traditionally pose learning difficulties (Idika & Oluwaseyi, 2024; Crucho *et al.,* 2025).

2.5 Theoretical Foundations Underpinning the Study

Every educational research study is anchored in theoretical frameworks that guide its assumptions, methodological choices, and interpretation of findings. The present study on the effect of the Team Game Tournament (TGT) approach on students' academic performance and perception in chemical bonding is grounded in three key theories: Social Interdependence Theory**,** Constructivist Learning Theory**,** and Motivation Theory (Self-Determination Theory). These frameworks collectively explain how cooperation, interaction, and intrinsic motivation contribute to learning effectiveness.

2.5.1 Social Interdependence Theory

The TGT model is primarily rooted in Social Interdependence Theory, developed by Johnson *et al.* (1994) and further elaborated by Johnson and Johnson (2015)**.** The theory posits that the way social interdependence is structured determines how individuals interact within a group, which in turn affects outcomes such as achievement and motivation. Social interdependence exists when the accomplishment of each individual's goals is affected by the actions of others.

According to Johnson and Johnson (2015), there are three types of interdependence: positive**,** negative, and none. Positive interdependence where individuals perceive that they can attain their goals only if others do is the cornerstone of cooperative learning and the TGT approach. In TGT, learners work collaboratively within teams to master content, knowing that their success in tournaments depends on the group's collective effort. This fosters a sense of shared responsibility, peer support, and mutual accountability (Nadrah, 2023).

Social Interdependence Theory explains how cooperative learning environments like TGT encourage students to engage in promotive interaction helping, sharing, and supporting each other's learning. This social structure enhances academic performance and interpersonal relationships, particularly in culturally diverse classrooms such as those in Ghana, where collectivist orientations naturally align with cooperative methods (Fenanlampir, 2021).

2.5.2 Constructivist Learning Theory

The Constructivist Learning Theory, championed by Piaget Vygotsky**,** asserts that learners actively construct their own understanding and knowledge through experiences and interactions with their environment. Learning is therefore viewed as an active, not passive, process. In science education, constructivism emphasizes that understanding is built through exploration, discussion, and reflection, rather than mere reception of information (Zajda, 2021).

The TGT approach aligns with this theory by positioning students as active participants in knowledge construction. During team discussions and tournaments, learners articulate ideas, question peers, and negotiate meanings. Such collaborative engagements facilitate conceptual change helping students replace misconceptions with scientifically accurate concepts, especially in abstract topics like chemical bonding (Shah, 2019).

Vygotsky's concept of the Zone of Proximal Development (ZPD) is particularly relevant to TGT. The ZPD describes the distance between what a learner can do independently and what they can achieve with guidance from peers or teachers. Within TGT teams, more capable peers assist others in understanding complex concepts, thereby expanding the group's collective knowledge (Nofriansyah *et al.,* 2024). The interactive and dialogic nature of TGT thus supports scaffolding and promotes deeper comprehension.

2.6 Empirical Studies on the Effect of TGT on Students' Academic Performance

Empirical research on the Team Game Tournament (TGT) approach has produced a consistent pattern of positive outcomes for student academic performance, especially relative to traditional lecture-based instruction. In a study of secondary school students in Nigeria, experimental groups taught the genetics concept using TGT outperformed control groups by a statistically significant margin, though gender differences were not significant (Ado *et al.,* 2024). Similarly, in Indonesia, a quasi-experimental study implemented TGT in a modern Islamic boarding school (30 students experimental vs 30 control) and found that the experimental class achieved a mean post-test score of 82.00 compared with 78.00 in the control, with a t-value exceeding the critical threshold ($t_{he} = 3.06 > t_t = 2.00$) indicating significant difference (Juniarti *et al.,* 2025). These findings point to the robust effect of TGT in improving learning outcomes, and underscore its potential for adaptation in difficult topics in science such as chemical bonding.

Beyond simple score increases, many studies highlight the mechanism through which TGT exerts its effect. Marinda *et al.* (2025) developed a science board game based on TGT and used it with fourth-grade elementary students on a force unit in Indonesia. Their results showed that the media was valid, practical and effective, with increases in cognitive outcomes rated medium to high; they obtained an n-gain of 0.62 for the

TGT board game group vs 0.45 for the control. This suggests that TGT not only improves performance but also enhances cognitive processing through game-based peer interactions and competitive tournaments. Moreover, the research underscored that when the TGT format is embedded in game media, learners participate more actively and engage in peer explanation, which is especially relevant for abstract science topics.

While most studies report improved outcomes, there is variation in the reported magnitude of effects and the domains in which TGT has been applied. A study investigating TGT for vocabulary mastery in German language found $t_o = 3.27 > 1.999$, illustrating significant difference in favour of TGT, albeit outside the science domain. This broader applicability across subjects reinforces the general efficacy of TGT, though it underscores the importance of context-specific implementation when shifting to science and chemistry.

Implementation fidelity emerges as a critical factor in maximizing TGT's effects. Studies that report detailed team assignments clear tournament rules, and frequent game cycles tend to yield stronger achievement gains. One review of the TGT model emphasises that team formation, regular tournaments, and equal scoring opportunity are key design features of the method. Without such careful design, the benefits of TGT may be dampened. This insight is vital for your Ghanaian SHS chemistry research, as ensuring proper TGT implementation will strengthen the validity and replicability of your findings (Nofriansyah *et al.,* 2024). Although several TGT studies found no significant difference between male and female performance (Juwita *et al.,* 2017; Salam *et al.,* 2015) very few disaggregate effect sizes by gender in science/chemistry topics.

2.7 Gender and Academic Performance in Science Education

Research on gender and academic performance in science education has long been central to understanding differential achievement patterns and informing equitable instructional strategies. Historically, gender disparities in science have been attributed to sociocultural, psychological, and instructional factors that shape students' attitudes, motivation, and performance

In many African countries, boys have traditionally been perceived as outperforming girls in science subjects, largely due to societal stereotypes, unequal participation opportunities, and gendered expectations (Khanyane *et al.,* 2016). However, recent reforms in science education and the adoption of interactive pedagogies are beginning to alter these trends. For instance, studies indicate that female students tend to perform as well as, or even better than, their male counterparts when instructional environments emphasize collaboration, dialogue, and active participation (Steegh *et al.,* 2019). These findings highlight the role of teaching strategies in mediating gender differences, suggesting that performance disparities are not innate but contextually influenced by the learning environment.

A number of empirical studies in Africa and other regions have confirmed that gender differences in science achievement often diminish when cooperative learning strategies are applied. For example, Okoli and Okigbo (2021) found that both male and female secondary school students in Nigeria improved significantly in chemistry when taught using cooperative learning, with no statistically significant gender difference in post-test scores. Also, Aliyu (2024) reported that cooperative-based instruction eliminated gender performance gaps in physics among Senior High School students. These findings suggest that cooperative learning models like TGT provide equitable participation opportunities that reduce performance disparities.

In contrast, studies relying on traditional lecture methods often report male advantage in achievement and science self-efficacy (Espinosa *et al*., 2019; Nissen & Shemwell, 2016). This is typically linked to the teacher-centered nature of conventional instruction, which favors verbal assertiveness and confidence traits socially encouraged in boys. Female students, however, tend to thrive in supportive, collaborative learning contexts that emphasize discussion and peer support. The TGT model, through its combination of teamwork, games, and competitive tournaments, provides a balanced structure where both genders can contribute meaningfully, potentially neutralizing pre-existing biases (Nofriansyah *et al.,* 2024).

Beyond achievement, gender differences have also been reported in attitudes toward science learning. Studies such as that of Sari (2025) in Ghana show that while male students often report higher interest in science, female students express greater appreciation for cooperative and interactive forms of learning. When TGT is used, these attitudinal differences are further minimized, as female students display increased confidence and motivation during peer discussions and tournament phases. Similar results were observed in India, where Kadum and Karpudewan (2025) found that female students demonstrated improved self-concept and participation in chemistry lessons conducted using the TGT method compared to traditional instruction.

The literature thus suggests that gender differences in academic performance are more reflective of pedagogical and environmental influences than cognitive ability. By fostering peer interdependence, accountability, and motivation through friendly competition, the TGT approach creates conditions under which both male and female students can excel equally. This aligns with the principles of social interdependence theory, which posits that when students perceive their success as linked to that of their peers, mutual encouragement and support override competitive hierarchies based on gender (Butera & Buchs, 2019). Studies in schools across Ghana reveal that when teachers adopt participatory and cooperative learning models, performance gaps between male and female students narrow considerably (Asomah & Agyei, 2025; Gyimah & Ayinselya, 2022).

2.8 Students' Perception of the Team Game Tournament (TGT) Approach

Students' perception of any instructional strategy plays a critical role in determining its effectiveness and sustainability in classroom practice. In the case of the Team Game Tournament (TGT) approach, perception is often linked to how students view the learning process its enjoyment, competitiveness, fairness, collaboration, and overall influence on understanding difficult concepts. Studies across diverse contexts have reported that students generally perceive TGT as an engaging, interactive, and motivating learning approach compared to conventional instruction (Lumbantobing *et al*., 2025; Riyanti *et al*., 2024; Syaifuddin *et al.,* 2020).

According to Safitri and Fathurrahman (2024), TGT provides students with opportunities for cooperative interaction while introducing a fun and competitive element that enhances their motivation to learn. Unlike traditional lecture-based methods where students are passive recipients of information, TGT places them at the center of the learning process. During team discussions, students exchange ideas, clarify misconceptions, and prepare collaboratively for tournaments. This structure creates a learning environment where students feel ownership of their learning, leading to more positive perceptions toward science subjects (Salame *et al*., 2015).

Merdekawati *et al.* (2021) explored students' motivation and perceptions toward learning acid base concepts in chemistry using TGT. The findings showed that students in the TGT group exhibited higher levels of enthusiasm, participation, and self-efficacy compared to those in the control group. The students reported that they enjoyed the sense of competition and teamwork, which made the lessons more interactive and reduced classroom anxiety. Similar sentiments were echoed by Byusa *et al.* (2022), who developed a board-game-based TGT strategy for science topics in Indonesia. Their study revealed that students perceived the learning process as more enjoyable, less monotonous, and more effective in facilitating understanding of complex topics. Studies examining students' attitudes toward cooperative learning in science have also found strong positive responses. Rabgay (2018) reported that students in SHS chemistry classes expressed a preference for methods that involved teamwork and peer discussion, citing increased understanding, reduced boredom, and greater confidence in tackling complex problems.

A recurring perception among students exposed to TGT is that the tournament phase instills a healthy sense of competition, which drives active study and participation. Nofriansyah *et al*. (2024) observed that students appreciated the fair scoring system in TGT, as it rewarded effort and collaboration rather than individual dominance. This sense of equity fosters inclusion, especially among less confident learners who may otherwise remain disengaged in traditional settings. Additionally, the recognition and reward system associated with TGT such as certificates or verbal praise contributes to positive reinforcement and sustained motivation (Purnalyta *et al*., 2024).

Interestingly, some studies also reveal minor reservations among students. A few learners, particularly those with introverted dispositions, report feeling anxious during tournaments or competitive sessions (Suryanto *et al*., 2024). However, these apprehensions typically diminish as students become accustomed to the structure and realize that competition occurs in a supportive environment. Teachers who carefully structure the teams and tournaments ensuring inclusivity and fairness can minimize such anxiety and maintain the positive atmosphere that underpins TGT's effectiveness.

Another aspect of perception concerns the usefulness and relevance of TGT in understanding complex topics like chemical bonding. Chemical bonding concepts ionic, covalent, and metallic bonds are abstract, requiring visualization and reasoning at both macroscopic and submicroscopic levels. Studies by Latifa and Wulandari (2024) emphasized that interactive pedagogies help students relate these abstract ideas to real-world applications. In such contexts, students perceive TGT not merely as a game, but as a cognitive bridge connecting theoretical chemistry to meaningful learning experiences.

Overall, students' perceptions of TGT have been overwhelmingly positive across contexts. They consistently report increased enjoyment, improved comprehension, enhanced collaboration, and stronger motivation to learn science. The approach's social and competitive dimensions promote deeper engagement and foster a classroom culture of mutual support.

2.9 Conceptual Framework

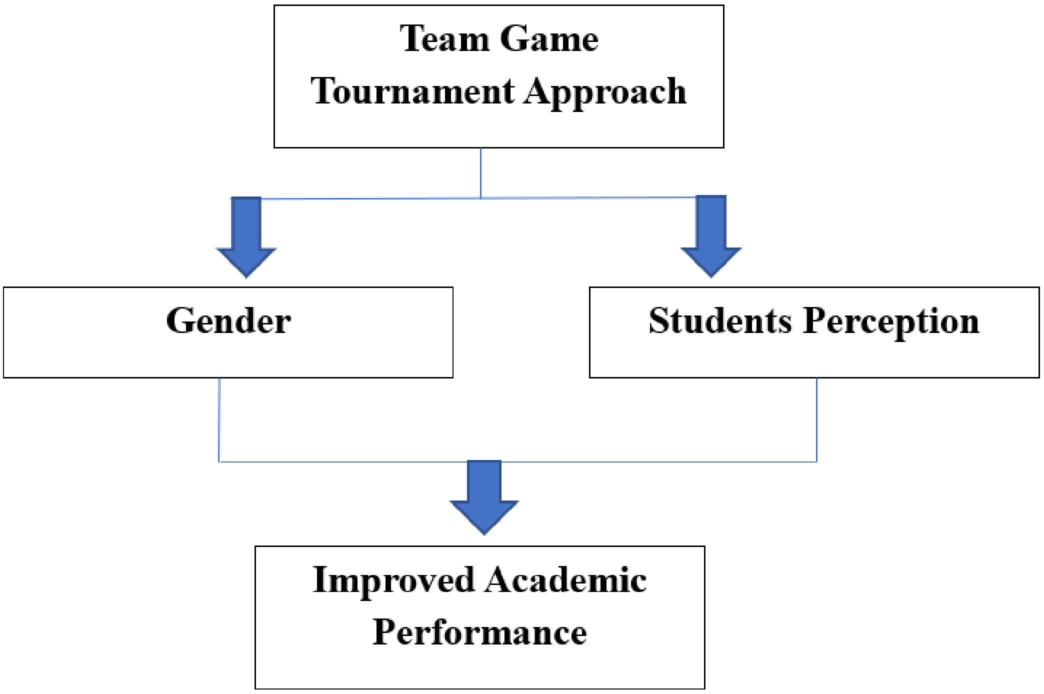

Figure 1: Conceptual Framework

The conceptual framework for this study illustrates the proposed relationships among the key variables investigated. The Team Game Tournament (TGT) approach serves as the primary independent variable. It represents the instructional intervention implemented to enhance students' learning of chemical bonding. The framework assumes that the structured features of TGT such as heterogeneous grouping, academic games, peer interaction, individual accountability, and team rewards create an engaging and collaborative learning environment.

Two important variables are examined in relation to the implementation of TGT: gender and students' perception. Gender is included to determine whether the effect of the TGT approach on academic performance differs between male and female students. It helps to assess whether the strategy promotes equitable learning outcomes or reduces observed disparities in achievement.

Students' perception represents learners' attitudes, motivation, and overall views about the use of the TGT approach in learning chemical bonding. Positive perceptions are expected to enhance engagement, participation, and conceptual understanding, which may subsequently influence performance outcomes.

The ultimate dependent variable in the framework is improved academic performance in chemical bonding. The framework proposes that the use of the TGT approach influences students' perceptions and can help to breach gender disparities in academic performance. This can directly lead to improved academic performance.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter provides the methodology and intervention undertaken to evaluate the effectiveness of Team Game Tournament approach on the academic performance of students.

3.1 Research Design

This study employed a quasi-experimental design, specifically the non-equivalent control group pretest-posttest design**.** The design was deemed appropriate because it allowed the researcher to determine the effect of the Team Game Tournament (TGT) approach on students' academic performance and perceptions without random assignment of participants to groups (Thompson *et al.,* 2024). In educational settings such as senior high schools, intact classes are often used due to administrative and ethical considerations, making quasi-experimental designs suitable for classroom-based interventions (Maciejewski, 2020).

In this design, two intact classes were used: Experimental Group, which was exposed to the Team Game Tournament instructional strategy, and Control Group, which was taught using the conventional learning technique. Both groups were pretested to establish baseline equivalence in academic performance before the treatment and posttested after the intervention to determine any significant differences attributable to the instructional approach.

The quasi-experimental design was chosen because it provides an empirical framework for comparing instructional effects while maintaining a high degree of ecological validity (Miller *et al.*, 2020). It also allows for the measurement of changes in achievement and gender-based differences following exposure to the TGT approach. According to Handley *et al.* (2018), experimental and quasi-experimental designs are particularly effective in assessing cooperative learning strategies since they capture variations in students' cognitive and affective outcomes before and after intervention.

3.2 Research Approach

The study adopted a quantitative research approach. Quantitative research involves the systematic collection and analysis of numerical data to explain, predict, or control phenomena of interest (Hodge, 2020). This approach was considered appropriate because the study sought to measure the extent to which the Team Game Tournament (TGT) instructional approach influences students' academic performance and perceptions in learning the concept of chemical bonding. Quantitative methods allow for the use of statistical tools to establish relationships, make comparisons, and test hypotheses with objectivity and precision (Kittur, 2023).

The quantitative approach was suitable for this study since it aligns with the quasi-experimental design, which relies on measurable variables and numerical data obtained from pretests, posttests, and perception questionnaires. According to Pregoner (2024), the use of a quantitative approach in educational research enhances replicability, minimizes bias, and provides empirical evidence that can be generalized to similar educational contexts.

3.3 Population of the Study

The target population for this study comprised all second-year Senior High School (SHS) students at Tsito Senior High Secondary Technical School in the Volta Region of Ghana during the 2024/2025 academic year. The school offers various academic programs, including General Arts, Business, General Science, and technical programs.

The accessible population consisted specifically of second-year General Arts and Business students, as these groups were available and offered Chemistry as a core subject. This population was selected because the concept of chemical bonding is found in the second-year syllabus.

3.4 Sample and Sampling Techniques

A total of 67 students participated in the study, comprising 32 students in Experimental Group **and** 35 students in Control Group. The participants were selected from two classes of form two General Arts 2 and form two Business 2 students at Tsito Senior High Secondary Technical School in the Volta Region of Ghana. The selection of the classes was guided by administrative and ethical considerations that prevented random reassignment of students to new groups. form two General Arts 2 students formed the experimental group while form two Business 2 students constituted the control group

The study employed a purposive sampling technique to select the participating classes. Purposive sampling was used because the researcher intended to select groups that were comparable in academic ability and exposure to the chemistry curriculum. Both classes had similar class sizes, comparable age ranges, and were taught by the same chemistry teacher, which helped to control teacher-related variability.

Within the selected groups, Experimental Group A received instruction through the Team Game Tournament (TGT) approach, while Control Group B was taught using the conventional lecture-based method. The purposive sampling ensured that both groups were equivalent in terms of prior knowledge and learning environment, making them suitable for quasi-experimental comparison.

3.5 Research Instruments

Two main instruments were employed in the study to collect quantitative data: a Chemistry Achievement Test (CAT) and a Students' Perception Questionnaire (SPQ**).** These instruments were developed by the researcher based on the study objectives and were validated by experts in chemistry education and educational measurement.

3.5.1 Chemistry Achievement Test (CAT)

The Chemistry Achievement Test was designed to assess students' understanding of chemical bonding concepts**,** including ionic bonding, covalent bonding, and metallic bonding. The test comprised 30 multiple-choice items, each with four options (A–D), covering conceptual, computational, and application aspects of bonding. The items were drawn from the approved Ghana Education Service (GES) Chemistry syllabus and relevant West African Senior School Certificate Examination (WASSCE) past questions to ensure content relevance and curriculum alignment.

The CAT was administered as both a pretest and posttest. The pretest established baseline equivalence between Experimental Group and Control Group before the intervention, while the posttest measured academic improvement after the treatment. According to Rogers and Revesz (2019) the use of pretest–posttest measures enhance the accuracy of determining the true effect of instructional interventions in quasi-experimental studies.

3.5.2 Students' Perception Questionnaire (SPQ)

The Students' Perception Questionnaire was developed to assess students' attitudes and perceptions toward learning chemical bonding through the Team Game Tournament (TGT) approach. The instrument consisted of 20 items structured on a five-point Likert scale ranging from 1- strongly disagree, 2-Disagree, 3-Neutral, 4-Agree and 5-Strongly Agree The items focused on dimensions such as learning engagement, motivation, teamwork, and enjoyment of the learning process.

Both instruments were pilot-tested prior to the main study to determine clarity, difficulty level, and estimated completion time. The feedback from the pilot study was used to refine ambiguous items and improve reliability.

3.6 Validity of Instruments

Validity refers to the degree to which an instrument measures what it is intended to measure (Rahardja *et al.,* 2019). To ensure the validity of the research instruments, both the Chemistry Achievement Test (CAT) and the Students' Perception Questionnaire (SPQ) underwent rigorous content and face validation processes.

The content validity of the CAT was established by aligning all test items with the learning objectives of the Ghana Education Service (GES) Chemistry syllabus on Chemical Bonding, as well as relevant concepts found in approved SHS chemistry textbooks. Three experts two lecturers from the Department of Science Education at the University of Education, Winneba, and one experienced SHS chemistry teacher reviewed the items for coverage, accuracy, and relevance to ensure that the test adequately represented the construct of chemical bonding knowledge.

The face validity of the SPQ was similarly established by presenting the questionnaire to two specialists in educational psychology and one expert in chemistry education for review. Their feedback led to the rewording of ambiguous items, adjustment of some Likert-scale statements, and removal of items deemed redundant or outside the study scope.

3.7 Reliability of Instruments

Reliability refers to the consistency of measurement over time or across different sets of items (Revelle & Condon, 2019). To ensure reliability, both instruments were pilot-tested using 30 second-year students from a nearby Senior High School with similar characteristics to the study population but not included in the main sample.

The reliability of the Chemistry Achievement Test (CAT) was determined using the Kuder–Richardson Formula 20 (KR-20), appropriate for dichotomously scored items (right/wrong). The KR-20 coefficient obtained was 0.82, indicating a high level of internal consistency and reliability.

For the Students' Perception Questionnaire (SPQ)**,** the Cronbach's alpha coefficient was computed to assess internal consistency among the Likert-scale items. The alpha value obtained was 0.88, which, according to Vaske *et al.* (2017), demonstrates good reliability for educational and social science instruments.

The combination of expert validation and statistical reliability testing provided strong evidence that the instruments were both valid and reliable for use in measuring students' achievement and perceptions in the context of chemical bonding instruction.

3.8 Data Collection Procedure

The data collection procedure was carefully structured to ensure the systematic administration of instruments and to maintain the validity and reliability of the research findings. The process was carried out in three main phases: the pre-intervention phase, the intervention phase, and the post-intervention phase**.**

3.8.1 Pre-Intervention Phase

Before the commencement of the intervention, the researcher sought formal permission from the headmaster of Tsito Senior High Secondary Technical School and the chemistry teacher of the participating classes. Ethical clearance was obtained from the relevant university ethics committee prior to data collection.

The researcher then met with both classes Experimental Group and Control Group to explain the purpose of the study, assure students of confidentiality, and obtain their informed consent to participate. During this phase, the Chemistry Achievement Test (CAT) was administered to both groups as a pretest to establish their baseline academic performance in the topic of Chemical Bonding. The test lasted for 40 minutes, and all scripts were collected immediately after completion to ensure the integrity of responses.

3.8.2 Intervention Phase

The intervention lasted for four weeks, during which the Team Game Tournament (TGT) approach was implemented in the Experimental Group, while the Control Group continued with lessons taught through the conventional lecture method. Both groups were taught by the same chemistry teacher to ensure instructional consistency.

Each group had one chemistry lesson per week which lasted for 80-minutes, covering the subtopics: Ionic bonding, Covalent bonding, Metallic bonding.

During the TGT sessions, the experimental class followed the five structured steps of the TGT model as outlined by Slavin and Madden (2021). The steps include class presentation, team study, games, tournaments, and recognition of team performance. Students worked collaboratively in mixed-ability teams to solve bonding-related problems, participate in competitive quizzes, and earn points for their groups. This format encouraged peer learning, motivation, and active participation.

WEEK 1 LESSON PLAN

Class: 2 General Arts 2

Duration: 80 minutes

Topic: Chemical Bonding

Sub-topic: Ionic Bonding

1. GENERAL OBJECTIVE

Students will understand ionic bonding as electron transfer between metals and non-metals resulting in electrostatic attraction and formation of ionic compounds.

2. SPECIFIC LEARNING OBJECTIVES

By the end of the lesson, students should be able to:

1. Identify valence electrons of selected elements using bonding cards.
2. Explain ionic bond formation through electron transfer.
3. Predict ions formed by metals and non-metals.
4. Construct correct chemical formulae of ionic compounds.
5. Distinguish ionic bonding from other bonding types conceptually.
6. Collaborate effectively within TGT teams.

3. TEACHING AND LEARNING MATERIALS

- Chemical bonding card sets (74 cards)
- Tournament score sheets
- Instruction sheets for game rules
- Whiteboard and markers
- Periodic table chart
- Exercise books (for team recognition)

4. PRIOR KNOWLEDGE

Students previously learned:

- Atomic structure
- Valence electrons
- Metals vs non-metals

5. LESSON PRESENTATION (TGT STRUCTURE)

PHASE 1: INTRODUCTION / MOTIVATION (10 minutes)

Teacher Activities

- Welcomes students and organizes them into pre-assigned heterogeneous teams.
- Reviews valence electrons using example elements from cards.
- Introduces concept of electron transfer.
- States lesson objectives clearly.

Student Activities

- Sit in teams.
- Respond to oral review questions.
- Observe demonstration using cards.

Guiding Questions

- What happens when atoms gain or lose electrons?
- Which elements tend to lose electrons?

PHASE 2: TEACHER PRESENTATION (DIRECT INSTRUCTION) (15 minutes)

Content Explanation

- Definition of ionic bonding
- Metals lose electrons → cations
- Non-metals gain electrons → anions
- Electrostatic attraction
- Writing ionic compound formulae

Demonstration Using Cards

Example:

- Magnesium card + Oxygen card
- Mg loses $2e^{-} \rightarrow Mg^{2+}$
- O gains $2e^{-} \rightarrow O^{2-}$
- Compound formed → MgO

Teacher Role

- Models step-by-step reasoning.
- Shows how to read valence electron dots.
- Demonstrates formula writing rule.

Students

- Observe.
- Ask questions.
- Take brief notes.

PHASE 3: TEAM STUDY (COOPERATIVE LEARNING) (15 minutes)

Teacher Activities

- Distributes card sets to teams.
- Instructs teams to:
    - Identify valence electrons
    - Predict ions
    - Discuss possible ionic compounds
- Moves around to guide weaker students.

Student Activities

- Examine cards collaboratively.
- Teach peers within teams.
- Practise predicting compounds.

Expected Learning Behaviour

Peer tutoring, discussion, reasoning aloud.

PHASE 4: GAME PHASE (CORE LEARNING ACTIVITY) (20 minutes)

Game Procedure

1. Cards are shuffled and distributed.
2. Students select compatible metal and non-metal.
3. They must:
    - Identify electron transfer
    - Determine ions formed
    - Write correct formula
    - State bonding type

Scoring Criteria

- Correct compound formation → 2 points
- Correct formula → 2 points
- Correct bonding explanation → 3 points
- Team collaboration → 1 point

Teacher Role

- Facilitates gameplay.
- Ensures adherence to rules.
- Provides corrective feedback.

Student Role

- Participate actively.
- Apply bonding principles.
- Support teammates.

PHASE 5: TOURNAMENT PHASE (15 minutes)

Structure

- Students compete with same-ability peers from other teams.
- Each participant explains bonding formation using selected cards.

Teacher Responsibilities

- Organizes tournament groups.
- Records scores.
- Uses scoring rubric below.

TOURNAMENT EXPLANATION RUBRIC

Table 1: Ruberics

Criteria	Excellent (3)	Good (2)	Needs Support (1)
Identification of ions	Correct charges and elements	Minor error	Incorrect
Explanation of electron transfer	Clear and scientific	Partially correct	Incorrect
Chemical formula	Correct	Minor error	Incorrect
Use of scientific terms	Accurate	Limited	Absent

PHASE 6: TEAM RECOGNITION (3 minutes)

Procedure

- Teacher announces winning team.
- Students applaud.
- Best-performing team receives exercise books.
- Positive reinforcement provided.

PHASE 7: CLOSURE / CONSOLIDATION (2 minutes)

Teacher

- Summarizes key ideas:
    - Electron transfer
    - Ion formation
    - Ionic compound formation
- Assigns practice:

  Write formulae for Na + Cl, Ca + O, K + Br.

Students

- Listen.
- Ask final questions.
- Record assignment.

6. ASSESSMENT METHODS

- Observation during team study
- Game performance scoring
- Tournament rubric evaluation
- Oral questioning

7. EXPECTED LEARNING OUTCOMES

Students should demonstrate:

- Conceptual understanding of ionic bonding
- Ability to predict ion formation
- Correct chemical formula writing
- Improved engagement through cooperative competition

WEEK 2 LESSON PLAN

Class: 2 General Arts 2

Duration: 80 minutes

Topic: Chemical Bonding

Sub-topic: Covalent Bonding

1. GENERAL OBJECTIVE

Students will understand covalent bonding as the sharing of electrons between non-metal atoms to achieve stability.

2. SPECIFIC LEARNING OBJECTIVES

By the end of the lesson, students should be able to:

1. Identify elements that form covalent bonds.
2. Explain covalent bonding as electron sharing.
3. Use valence electrons to predict number of bonds formed.
4. Construct simple covalent molecules using bonding cards.
5. Distinguish between single and multiple covalent bonds (conceptually).
6. Work collaboratively within TGT teams to solve bonding tasks.

3. TEACHING AND LEARNING MATERIALS

- Chemical bonding card sets (valence electron dot structures)
- Tournament score sheets
- Instruction sheets for game rules
- Whiteboard and markers
- Periodic table chart
- Exercise books (team recognition)

4. PRIOR KNOWLEDGE

Students learned in Week 1:

- Ionic bonding involves electron transfer
- Metals + non-metals form ionic compounds
- Ions and formula writing

Teacher briefly contrasts ionic bonding with covalent bonding at lesson start.

5. LESSON PRESENTATION (TGT STRUCTURE)

PHASE 1: INTRODUCTION / REVIEW (10 minutes)

Teacher Activities

- Reviews ionic bonding using quick oral questions.

- Introduces today's focus: bonding through sharing of electrons.
- Uses two non-metal cards (e.g., H and Cl) to spark curiosity.
- States lesson objectives.

Student Activities

- Respond to review questions.
- Observe demonstration.
- Predict what happens when two non-metals interact.

Guiding Question

- If neither atom wants to lose electrons, what happens?

PHASE 2: TEACHER PRESENTATION (DIRECT INSTRUCTION) (15 minutes)

Content Explanation

- Definition of covalent bonding
- Occurs between non-metals
- Electron sharing for stability
- Formation of molecules
- Single vs multiple bonds (basic idea)

Demonstration Using Cards

Example:

- Hydrogen (1 valence electron)
- Chlorine (7 valence electrons)
- Share electrons → HCl

Example 2:

- Oxygen + Oxygen → O_2

Teacher Role

- Models reasoning using valence electrons.
- Shows how shared pairs form bonds.
- Emphasizes molecule formation rather than ions.

Students

- Observe.
- Ask questions.
- Take notes.

PHASE 3: TEAM STUDY (COOPERATIVE LEARNING) (15 minutes)

Teacher Activities

- Distributes bonding cards to teams.
- Provides structured task:
  - Identify valence electrons
  - Predict sharing pattern
  - Build possible molecules
- Monitors collaboration and supports weaker students.

Student Activities

- Discuss bonding possibilities within teams.
- Practise forming covalent molecules.
- Explain sharing process to teammates.

Expected Learning Behaviour

Peer explanation, reasoning, cooperative problem-solving.

PHASE 4: GAME PHASE (CORE LEARNING ACTIVITY) (20 minutes)

Game Procedure

1. Students receive shuffled element cards.
2. They must select compatible non-metal elements.
3. For each pairing, students must:
    - Identify valence electrons
    - Show electron sharing
    - Name molecule formed
    - State bonding type

Scoring Criteria

- Correct molecule formation → 2 points
- Correct bonding explanation → 3 points
- Correct use of valence electrons → 2 points
- Team cooperation → 1 point

Teacher Role

- Facilitates game.
- Ensures scientific accuracy.
- Provides feedback.

Student Role

- Engage actively.
- Justify bonding decisions.
- Support team members.

PHASE 5: TOURNAMENT PHASE (15 minutes)

Structure

- Students compete with peers of similar academic level from other teams.

- Each student receives two element cards and explains:
    - Why atoms share electrons
    - How molecule forms
    - Type of bond

Teacher Responsibilities

- Organizes tournament groups.
- Records individual scores.
- Uses standardized rubric below.

PHASE 6: TEAM RECOGNITION (3 minutes)

Procedure

- Scores from tournament aggregated.
- Teacher announces winning team.
- Class applauds.
- Winning team receives exercise books.
- Positive feedback given to all teams.

PHASE 7: CLOSURE / CONSOLIDATION (2 minutes)

Teacher

- Summarizes key ideas:
    - Non-metals share electrons
    - Molecules are formed
    - Covalent bonding differs from ionic bonding
- Assigns practice:

  Predict bonding in H_2, O_2, H_2O.

Students

- Listen and reflect.
- Record assignment.

6. ASSESSMENT METHODS

- Observation during team study
- Game performance scoring
- Tournament rubric evaluation
- Oral questioning

7. EXPECTED LEARNING OUTCOMES

Students should demonstrate:

- Understanding of electron sharing
- Ability to predict covalent molecule formation
- Improved conceptual comparison of bonding types
- Increased engagement through structured competition

WEEK 3 LESSON PLAN

Class: 2 General Arts 2

Duration: 80 minutes

Topic: Chemical Bonding

Sub-topic: Metallic Bonding

1. GENERAL OBJECTIVE

Students will understand metallic bonding as the electrostatic attraction between positive metal ions and a sea of delocalized electrons.

2. SPECIFIC LEARNING OBJECTIVES

By the end of the lesson, students should be able to:

1. Describe metallic bonding using the electron sea model.

2. Explain how metals conduct electricity and heat.
3. Relate metallic bonding to properties such as malleability and ductility.
4. Identify metals from bonding cards and predict their bonding behaviour.
5. Collaborate effectively within Team Game Tournament groups.

3. TEACHING AND LEARNING MATERIALS

- Chemical bonding card sets (metal elements emphasized)
- Tournament score sheets
- Instruction sheets for gameplay
- Whiteboard and markers
- Periodic table chart
- Exercise books (team recognition)

4. PRIOR KNOWLEDGE

Students previously learned:

- Ionic bonding involves electron transfer
- Covalent bonding involves electron sharing
- Metals tend to lose valence electrons

Teacher links these ideas to collective electron behavior in metals.

5. LESSON PRESENTATION (TGT STRUCTURE)

PHASE 1: INTRODUCTION / REVIEW (10 minutes)

Teacher Activities

- Reviews ionic and covalent bonding briefly.
- Displays several metal element cards.
- Asks students to predict how metals bond with each other.
- States lesson objectives.

Student Activities

- Respond to review questions.
- Observe metal element examples.
- Share predictions.

Guiding Question

- If many metal atoms lose electrons, where do those electrons go?

PHASE 2: TEACHER PRESENTATION (DIRECT INSTRUCTION) (15 minutes)

Content Explanation

- Definition of metallic bonding
- Metal atoms release valence electrons
- Formation of positive metal ions
- Delocalized ―sea of electrons"
- Relationship to metal properties:
    - Electrical conductivity
    - Thermal conductivity
    - Malleability
    - Ductility

Demonstration Using Cards

- Several metal element cards grouped together.
- Teacher models:
    - Loss of valence electrons
    - Formation of electron cloud
    - Attraction between ions and electrons

Teacher Role

- Explains concept using visual analogy.
- Links structure to observable properties.

Students

- Observe.
- Ask questions.
- Take notes.

PHASE 3: TEAM STUDY (COOPERATIVE LEARNING) (15 minutes)

Teacher Activities

- Distributes metal-focused card sets.
- Provides structured task:
    - Identify valence electrons of metals
    - Explain how electrons become delocalized
    - Predict physical properties of metals
- Monitors group interaction.

Student Activities

- Discuss bonding behaviour within teams.
- Explain electron sea concept to peers.
- Connect bonding to metal properties.

Expected Learning Behaviour

Collaborative explanation, conceptual reasoning, peer teaching.

PHASE 4: GAME PHASE (CORE LEARNING ACTIVITY) (20 minutes)

Game Procedure

1. Teams receive mixed element cards.
2. Students identify metals among the cards.

3. For selected metals, students must:
    - Describe metallic bonding process
    - Predict physical properties
    - Compare with ionic or covalent bonding

Scoring Criteria

- Correct identification of metals → 2 points
- Accurate explanation of metallic bonding → 3 points
- Correct property prediction → 2 points
- Team collaboration → 1 point

Teacher Role

- Facilitates gameplay.
- Checks conceptual accuracy.
- Provides feedback.

Student Role

- Participate actively.
- Justify reasoning scientifically.
- Support teammates.

PHASE 5: TOURNAMENT PHASE (15 minutes)

Structure

- Students compete with same-ability peers across teams.
- Each student receives a metal element card and explains:
    - Electron sea model
    - Bonding mechanism
    - Resulting properties of metals

Teacher Responsibilities

- Organizes tournament groups.
- Records scores using rubric below.

PHASE 6: TEAM RECOGNITION (3 minutes)

Procedure

- Scores aggregated.
- Winning team announced.
- Class applause.
- Winning team receives exercise books.
- Encouragement provided to all teams.

PHASE 7: CLOSURE / CONSOLIDATION (2 minutes)

Teacher

- Summarizes:
    - Metallic bonding involves delocalized electrons
    - Bonding explains metal properties
    - Comparison with ionic and covalent bonding
- Assigns practice:

  Explain why metals conduct electricity.

Students

- Listen and reflect.
- Record assignment.

6. ASSESSMENT METHODS

- Observation during team study
- Game performance scoring
- Tournament rubric evaluation

- Oral questioning

7. EXPECTED LEARNING OUTCOMES

Students should demonstrate:

- Understanding of metallic bonding mechanism
- Ability to relate bonding to physical properties
- Improved conceptual comparison of bonding types
- High engagement through structured competition

WEEK 4 LESSON PLAN

Class: 2 General Arts 2

Duration: 80 minutes

Topic: Chemical Bonding

Focus: Ionic, Covalent, and Metallic Bonding Review

1. GENERAL OBJECTIVE

Students will consolidate understanding of ionic, covalent, and metallic bonding and demonstrate mastery through competitive academic gameplay.

2. SPECIFIC LEARNING OBJECTIVES

By the end of the lesson, students should be able to:

1. Distinguish among ionic, covalent, and metallic bonding.
2. Identify bonding type from element combinations.
3. Explain electron transfer, sharing, or delocalization appropriately.
4. Construct correct chemical formulae for ionic compounds.
5. Predict properties of substances based on bonding type.
6. Demonstrate improved performance through TGT competition.

3. TEACHING AND LEARNING MATERIALS

- Chemical bonding card sets (full deck)
- Grand tournament score sheets
- Game instruction sheets
- Whiteboard and markers
- Periodic table chart
- Exercise books (final team recognition)

4. PRIOR KNOWLEDGE

Students have learned:

- Ionic bonding (electron transfer)
- Covalent bonding (electron sharing)
- Metallic bonding (electron sea model)

5. LESSON PRESENTATION (TGT STRUCTURE)

PHASE 1: INTRODUCTION / COMPREHENSIVE REVIEW (10 minutes)

Teacher Activities

- Reviews three bonding types using guided questioning.
- Draws comparison table on board:

Table 2: Bond type comparison

Bond Type	Particles	Electron Behavior	Example
Ionic	Metal + Non-metal	Transfer	NaCl
Covalent	Non-metals	Sharing	H_2O
Metallic	Metals	Delocalized	Cu

- States lesson objectives and explains grand tournament structure.

Student Activities

- Respond to review questions.
- Contribute examples.

- Prepare for competition.

PHASE 2: TEAM STUDY (REVISION WITH CARDS) (15 minutes)

Teacher Activities

- Distributes full card sets.
- Provides structured revision tasks:
  - Form ionic compound
  - Form covalent molecule
  - Identify metallic bonding situation
- Guides discussion and clarifies misconceptions.

Student Activities

- Revise bonding concepts collaboratively.
- Practise explanations.
- Prepare weaker members for tournament.

Expected Behaviour

Peer tutoring, cooperative reasoning, strategic preparation.

PHASE 3: GRAND GAME PHASE (20 minutes)

Integrated Bonding Challenge

Teams receive mixed bonding tasks using cards.

Students must:

1. Identify bonding type
2. Explain electron behaviour
3. Construct compound or describe structure
4. Predict properties

Scoring Criteria

- Correct bonding type → 2 points
- Accurate scientific explanation → 3 points
- Correct formula or structure → 2 points
- Team collaboration → 1 point

Teacher Role

- Facilitates game.
- Ensures fairness and accuracy.
- Encourages scientific reasoning.

Student Role

- Apply cumulative knowledge.
- Engage actively in team decision-making.

PHASE 4: GRAND TOURNAMENT (25 minutes)

Structure

- Students compete with similar academic-level peers from other teams.
- Each participant completes one comprehensive bonding task using cards.

Possible Tournament Tasks

- Predict bond type for given elements
- Explain bonding mechanism
- Write ionic formula
- Describe properties based on bonding

Teacher Responsibilities

- Organizes tournament groups.
- Records scores systematically.
- Uses standardized rubric below.

PHASE 5: FINAL TEAM RECOGNITION (5 minutes)

Procedure

- Tournament scores aggregated across all weeks.
- Teacher announces overall winning team.
- Class applauds enthusiastically.
- Winning team receives exercise books.
- Teacher commends effort of all teams.

PHASE 6: CLOSURE / TRANSITION TO POST-TEST (5 minutes)

Teacher

- Summarizes key conceptual connections:
    - Electron transfer → ionic bonding
    - Electron sharing → covalent bonding
    - Delocalized electrons → metallic bonding
- Reinforces importance of bonding in explaining material properties.
- Informs students that post-test follows after intervention.

Students

- Reflect on learning experience.
- Ask final questions.

6. ASSESSMENT METHODS

- Observation during revision
- Game performance scoring
- Grand tournament rubric evaluation
- Comparative performance across weeks

The control group, on the other hand, received traditional teacher-centered instruction involving explanations, note-taking, and question-and-answer sessions without group competition.

3.8.3 Post-Intervention Phase

At the end of the four-week period, both groups were administered posttest the, which was the same Chemistry Achievement Test (CAT) used for the pretest but with rearranged question order to minimize recall bias. The test measured academic gains resulting from the instructional approach. Subsequently, the Students' Perception Questionnaire (SPQ) was administered to students in the experimental group only, to collect data on their perceptions of the TGT approach in learning chemical bonding. All responses were collected anonymously.

Finally, the researcher coded, scored, and entered all quantitative data into IBM SPSS Statistics (version 27) for analysis. Descriptive statistics (means, standard deviations) and inferential tests (independent samples t-tests and Cohen's d effect size) were used to address the research questions and test the stated hypotheses.

3.9 Experimental Procedure

The experimental procedure was designed to determine the effect of the Team Game Tournament (TGT) cooperative learning approach on students' academic performance and perception in the topic of Chemical Bonding. A quasi-experimental design was employed. The study involved two classes from Tsito Senior High Secondary Technical School, one assigned as the experimental group and the other as the control group. Both groups were taught by the same chemistry teacher to ensure uniformity in instructional delivery, duration, and curriculum content.

Step 1: Selection and Orientation of Participants

Two Form Two science classes were purposively selected because they had similar academic backgrounds and had not yet been taught Chemical Bonding in the chemistry syllabus. The researcher explained the objectives and procedures of the study to both classes and emphasized voluntary participation, confidentiality, and anonymity.

Step 2: Administration of the Pretest

Prior to the teaching intervention, both groups were administered a Chemistry Achievement Test (CAT) to assess their prior knowledge of Chemical Bonding. The test comprised multiple-choice and structured items covering ionic, covalent, and metallic bonding. The pretest served as a baseline measure for comparing academic improvement after the intervention. Scores from this test were recorded and later analyzed to verify group equivalence at the start of the experiment.

Step 3: Implementation of the Treatment

The treatment spanned four weeks, with both groups receiving three 80-minute lessons per week. The experimental group received instruction through the Team Game Tournament (TGT) model, following the stages proposed by Slavin (2014):

1. **Class Presentation:** The teacher introduced each subtopic using brief explanations, examples, and visual aids.
2. **Team Study:** Students were organized into heterogeneous teams of 4–5 members (mixed by ability, gender, and participation level). They discussed key concepts, solved bonding problems collaboratively, and prepared for the tournament sessions.

3. **Games:** Students participated in quiz-based games designed to test their understanding of the material. Each correct response earned points for their respective teams.
4. **Tournaments:** Representatives from each team competed at “tournament tables” with peers of similar ability levels. Winners earned points contributing to their team’s total score.
5. **Team Recognition:** Teams were ranked based on cumulative points, and outstanding groups were acknowledged to foster motivation and collective responsibility.

The control group was taught the same content using the conventional lecture method, which involved direct instruction, note-taking, and teacher-led questioning without team-based competition. Both groups were exposed to the same instructional objectives, time frame, and learning materials to ensure parity of treatment except for the instructional strategy.

Step 4: Administration of the Posttest

After the four-week instructional period, both groups were administered the posttest, which was identical in content and structure to the pretest but reordered to prevent recall bias. The test measured the students’ academic gains following the intervention. The scores obtained were compared to determine the impact of the TGT approach relative to the traditional method.

Step 5: Administration of Students’ Perception Questionnaire

Following the posttest, students in the experimental group completed a Students’ Perception Questionnaire (SPQ) designed to assess their attitudes, engagement, and perceptions toward learning through the TGT approach. The SPQ contained Likert-type items covering aspects such as motivation, collaboration, enjoyment, and perceived learning improvement. Responses provided qualitative insight into how students experienced the cooperative learning environment.

Step 6: Data Scoring and Analysis

All completed tests and questionnaires were collected, coded, and scored by the researcher. The data were entered into IBM SPSS Statistics (version 26) for analysis. Descriptive statistics (means, standard deviations) and inferential statistics (independent samples *t*-test, paired samples *t*-test, and Cohen's d effect size) were used to answer the research questions and test the hypotheses.

3.10 Data Analysis Techniques

Data collected from the pretest, posttest, and the Students' Perception Questionnaire (SPQ) were analyzed using both descriptive and inferential statistical methods to address the study's research objectives and hypotheses. The analysis was conducted using the Statistical Package for the Social Sciences (SPSS, version 27)**.**

3.10.1 Analysis of Academic Performance

To assess students' academic performance before and after the intervention, the mean scores and standard deviations of both the experimental and control groups were computed for the pretest and posttest.

- The paired samples t-test was employed to compare pretest and posttest mean scores within each group, establishing whether there was a statistically significant improvement in students' performance after instruction.
- The independent samples t-test was used to compare the posttest mean scores between the experimental and control groups, determining the effect of the

Team Game Tournament (TGT) approach relative to the conventional teaching method.

To determine the magnitude of the difference, Cohen's d effect size was calculated using the formula:

$$d = \frac{M_1 - M_2}{SD_{pooled}}$$

where M1 and M2 represent the means of the two groups, and SD_{pooled} is the pooled standard deviation. The resulting *d* values were interpreted according to Cohen's (1988) convention:

- $0.2 \leq d < 0.5$: small effect
- $0.5 \leq d < 0.8$: medium effect
- $d \geq 0.8$: large effect

These analyses were used to address research question One , which compared academic performance across instructional methods.

3.10.2 Analysis of Gender Differences

To evaluate the effect of TGT on male and female students' academic performance, the posttest scores of male and female students within the experimental group were compared using an independent samples ***t***-test**.** This addressed research Question Two, revealing whether gender differences existed in students' learning outcomes under the TGT strategy.

Effect sizes were also computed to assess the strength of gender-related differences in academic gains.

3.10.3 Analysis of Students' Perception of TGT

Data obtained from the Students' Perception Questionnaire (SPQ) were analyzed using descriptive statistics, including means, standard deviations. The items were organized under thematic constructs including collaboration, motivation, interest in learning, *and* perceived understanding of content.

3.10.4. Statistical Significance and Assumptions

All inferential analyses were tested at a 0.05 level of significance ($\alpha = 0.05$)**.** Assumptions of normality and homogeneity of variance were examined before applying *t*-tests. Normality was verified through the Shapiro–Wilk test, while the Levene's test was used to assess equality of variances. Data that violated these assumptions were handled through appropriate transformations or non-parametric alternatives.

3.10.5 Data Presentation

Results of the analyses were presented in tables and figures for clarity and ease of interpretation. Tables summarized the descriptive and inferential statistics, while graphs illustrated trends and group differences. The findings were subsequently discussed in Chapter Four with supporting literature.

3.11 Ethical Considerations

Ethical principles were strictly adhered to throughout the conduct of this study to ensure that the rights, dignity, and welfare of all participants were respected. The study was carried out in accordance with standard educational research ethics as outlined by Ramrathan *et al.* (2017) and the Ghana Education Service (GES) ethical guidelines for educational research.

Prior to data collection, formal approval was obtained from the Headmaster of Tsito Senior High Secondary Technical School and the Municipal Directorate of Education. A letter of introduction from the researcher's institution was presented to the school authorities, explaining the objectives, duration, and procedures of the study. This permission granted access to the students, school facilities, and official cooperation during the research.

Participants were informed of the nature and purpose of the study, the voluntary nature of their participation, and their right to withdraw at any time without penalty. Since participants were senior high school students, consent was obtained both from the students and their chemistry teacher, who acted as a gatekeeper. Clear explanations were given regarding the activities involved in the experiment, such as pretesting, lessons, tournaments, and posttesting. Students who agreed to participate signed an informed consent form before inclusion in the study.

To protect participants' identities, personal names were not recorded on any research instruments. Instead, coded identification numbers were assigned to each participant's responses during data entry and analysis. All data were stored securely, accessible only to the researcher. Findings were presented in aggregate form to prevent identification of any individual or class.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

This chapter presents the results and discussions of the results in relation to the research questions. The demographic data of the respondents was first presented followed by the data obtained to address the research questions.

4.1 Research question one: What is the difference in academic performance between students taught the concept of chemical bonding using the Team Game Tournament (TGT) approach and those taught using the conventional learning technique?

H_{01}: There is no statistically significant difference in the academic performance of students taught the concept of chemical bonding using the Team Game Tournament (TGT) approach and those taught using the conventional learning technique.

A paired samples *t*-test was conducted to compare the pretest and posttest academic performance scores of students in the Control Group. The mean pretest score was $M = 11.34$ ($SD = 1.59$), while the mean posttest score was $M = 11.97$ ($SD = 1.87$).

The mean difference between the pretest and posttest scores was −0.63, with a standard deviation of 1.93. The 95% confidence interval for the mean difference ranged from −1.29 to 0.03. The results showed that the difference was not statistically significant, $t(34) = -1.93$, $p = .06$. The effect size, as measured by Cohen's *d*, was 1.93. Table 3 presents the results on the paired samples t-test conducted to compare the pretest and posttest scores of students in the Control Group.

Table 3: Paired Sample t-test of Pretest and Posttest of Control Group

	Mean	Pretest M (SD)	Posttest M (SD)	Std. Deviation	95% Confidence Interval of the Difference		t (34)	Sig. (2-tailed)	Cohen's d
					Lower	Upper			
Pretest – Post-test	-.63	11.34±1.59	11.97±1.87	1.93	-1.29	0.03	-1.93	0.06	1.93

A paired samples *t*-test was also performed to determine the difference between the pretest and posttest scores of students in the Experimental Group**.** The results indicated that the mean pretest score (M = 10.72, SD = 2.10) was substantially lower than the mean posttest score (M = 18.66, SD = 4.19). The mean difference was −7.94 with a standard deviation of 4.56. The 95% confidence interval for the mean difference ranged from −9.58 to −6.29. The difference was statistically significant, $t(31) = -9.85$, $p = .00$. The effect size measure using Cohen's d was 4.56, indicating a very large effect size. Table 4 presents the results on the paired samples t-test conducted to compare the pretest and posttest scores of students in the experimental group.

Table 4: Paired Sample t-test of Pretest and Posttest of Experimental Group

	Mean	Pretest M (SD)	Post test M (SD)	Std. Deviation	95% Confidence Interval of the Difference		t (31)	Sig. (2-tailed)	Cohen's d
					Lower	Upper			
Pretest - Postest	-7.94	10.72±2.10	18.66±4.19	4.56	-9.58	-6.29	-9.85	0.00	4.56

In Table 5, Levene's test for equality of variances was statistically significant, F = 12.41, p < .001, indicating that the assumption of homogeneous variances was violated. Consequently, the results for equal variances not assumed were reported.

The Experimental Group recorded a mean score of 18.66 (SD = 4.19), while the Control Group obtained a mean score of 11.97 (SD = 1.87). The mean difference between the two groups was 6.68. The independent samples t-test revealed a statistically significant difference in academic performance between the two groups, t(42.04) = 8.29, p < .001. The 95% confidence interval of the mean difference ranged from 5.06 to 8.31. The effect size, measured using Cohen's d, was 3.20.

Table 5 presents the results of the independent samples t-test comparing the academic performance of students in the Experimental Group and the Control Group on the posttest of chemical bonding.

Table 5*:* Independent Sample t-test between Experimental Group and Control Group Post test Scores

Test	Levene's Test for Equality of Variances		Group	Mean	Mean Difference	t(42.04)	95% Confidence Interval of the Difference		Sig. (2-tailed)	Chen's d
	F	Sig.					Lower	Upper		
Equal variances not assumed	12.41	<.001	Experimental	18.66±4.19	6.68	8.29	5.06	8.31	<.001	3.20
			Control	11.97±1.87						

4.2 Research question two: What is the effect of the Team Game Tournament approach on the academic performance of male and female students in learning the concept of chemical bonding?

H_{02}: There is no statistically significant difference in the academic performance of male and female students taught the concept of chemical bonding using the Team Game Tournament (TGT) approach.

The results of the independent samples t-test examining the effect of the Team Game Tournament (TGT) approach on the academic performance of male and female students in the Experimental Group are as follows:.

Levene's test for equality of variances was not statistically significant, F = 0.61, p = .44, indicating that the assumption of homogeneity of variances was met. Therefore, the results for equal variances assumed were reported.

The mean score for male students was 18.15 (SD = 4.72), while female students recorded a mean score of 19.00 (SD = 3.89). The mean difference between male and female students was −0.85. The independent samples t-test showed no statistically significant difference in academic performance between male and female students, t(30) = −0.55, p = .58. The 95% confidence interval of the mean difference ranged from −3.96 to 2.27. The effect size, measured using Cohen's d, was 4.24.

Table 6 presents the results of the independent samples t-test examining the effect of the Team Game Tournament (TGT) approach on the academic performance of male and female students in the Experimental Group.

Table 6*:* Independent Sample t-test between Male and Female Students in the Experimental group Post test Scores

Test	Levene's Test for Equality of Variances		Group	Mean	Mean Difference	t(30)	95% Confidence Interval of the Difference		Sig. (2-tailed)	Chen's d
	F	Sig.					Lower	Upper		
Equal variances assumed	0.61	0.44	Male	18.15±4.72	-0.85	-0.55	-3.96	2.27	0.58	4.24
			Female	19.00±3.89						

4.3 Research question three: What are the perceptions of students regarding the use of the Team Game Tournament approach in learning chemical bonding?

The descriptive statistics of students' perceptions regarding the use of the Team Game Tournament (TGT) approach in learning chemical bonding are presented as follows:

For Engagement and Motivation, students reported mean ratings ranging from 3.38 to 3.59. The highest mean was recorded for the item ‗I often felt bored during TGT sessions" (M = 3.59, SD = 1.43), while the lowest mean was for ‗TGT lessons kept me actively involved throughout the class" (M = 3.38, SD = 1.39). The overall mean score for engagement and motivation was 3.50 (SD = 1.21).

Under Collaboration and Communication, mean scores ranged from 3.13 to 3.69. The item ‗TGT gave me more opportunities to discuss ideas with classmates" recorded the highest mean (M = 3.69, SD = 1.23), whereas ‗Working in teams during TGT helped me understand bonding ideas better" had the lowest mean (M = 3.13, SD = 1.16). The overall mean for this dimension was 3.48 (SD = 0.83).

For Understanding and Learning Gains, the mean scores varied between 3.34 and 3.50. The highest mean was reported for ‗TGT improved my ability to solve chemical bonding problems" (M = 3.50, SD = 1.22), while the lowest mean was for ‗TGT helped me understand the difference between ionic, covalent and metallic bonds" (M = 3.34, SD = 1.33). The overall mean score was 3.44 (SD = 0.83).

Regarding Confidence, item means ranged from 3.44 to 3.78. Students reported the highest mean for ‗I felt uncomfortable answering questions during tournaments" (M = 3.78, SD = 1.26), while ‗I now feel better prepared for chemistry tests on bonding because of TGT” recorded the lowest mean (M = 3.44, SD = 1.37). The overall mean for confidence was 3.58 (SD = 0.65).

In the Enjoyment dimension, mean scores ranged from 3.13 to 3.59. The item ‗I would like my teacher to use TGT for other chemistry topics” recorded the highest mean (M = 3.59, SD = 1.34), whereas ‗The game and tournament parts made learning fun and interesting” had the lowest mean (M = 3.13, SD = 1.45). The overall mean score for enjoyment was 3.54 (SD = 1.05).

For Fairness, the mean ratings ranged from 3.40 to 3.97. The item ‗The way teams were formed made sure everyone could participate” recorded the highest mean (M = 3.97, SD = 1.26), while ‗The scoring and award system in TGT was fair to all students” recorded the lowest mean (M = 3.40, SD = 1.48). The overall mean score for fairness was 3.68 (SD = 0.64).

Table 7 presents the descriptive statistics of students’ perceptions regarding the use of the Team Game Tournament (TGT) approach in learning chemical bonding, organized under six perception dimensions.

Table 7: Perception of Students towards the use of Team Game Tournament Approach in Learning

Variable	Mean	Std. Deviation
Engagement & Motivation (EM)		
I often felt bored during TGT sessions.	3.59	1.43
I felt more motivated to study chemical bonding when learning through TGT.	3.53	1.61
TGT lessons kept me actively involved throughout the class.	3.38	1.39
Overall mean	**3.50**	**1.21**
Collaboration & Communication (CM)		
TGT gave me more opportunities to discuss ideas with classmates.	3.69	1.23
My teammates explained concepts to me in ways that made sense.	3.63	1.18
Working in teams during TGT helped me understand bonding ideas better.	3.13	1.16
Overall mean	**3.48**	**0.83**
Understanding & Learning Gains (UL)		
TGT improved my ability to solve chemical bonding problems.	3.50	1.22
After TGT activities I could better explain why atoms form particular bonds.	3.47	1.37
TGT helped me understand the difference between ionic, covalent and metallic bonds.	3.34	1.33
Overall mean	**3.44**	**0.83**
Confidence (C)		
I felt uncomfortable answering questions during tournaments.	3.78	1.26
My confidence in answering bonding questions increased after TGT.	3.53	1.34
I now feel better prepared for chemistry tests on bonding because of TGT.	3.44	1.37
Overall mean	**3.58**	**0.65**
Enjoyment (E)		
I would like my teacher to use TGT for other chemistry topics.	3.59	1.34
I enjoyed learning chemical bonding more with TGT than with the usual lecture method.	3.34	1.45
The game and tournament parts made learning fun and interesting.	3.13	1.45
Overall mean	**3.54**	**1.05**
Fairness (F)		
The way teams were formed made sure everyone could participate.	3.97	1.26
Stronger students dominated the teams and tournaments too often.	3.66	1.20
The scoring and award system in TGT was fair to all students.	3.40	1.48
Overall mean	**3.68**	**0.64**

N=32, 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly

Agree

4.4 Discussion

4.4.1 Research question one: What is the difference in academic performance between students taught the concept of chemical bonding using the Team Game Tournament (TGT) approach and those taught using the conventional learning technique?

H_{01}: There is no statistically significant difference in the academic performance of students taught the concept of chemical bonding using the Team Game Tournament (TGT) approach and those taught using the conventional learning technique.

The paired sample t-test results for the control group showed a small increase in students' academic performance from the pretest (M = 11.34, SD = 1.59) to the posttest (M = 11.97, SD = 1.87). The mean difference between the pretest and posttest scores was −0.63. The test result indicated that this difference was not statistically significant, t(34) = −1.93, p = .06, as the p-value exceeded the .05 significance level.

The 95% confidence interval of the mean difference ranged from −1.29 to 0.03, which included zero, further confirming the absence of a statistically meaningful improvement. However, the effect size was large (Cohen's d = 1.93), suggesting that although the change was not statistically significant, there was a noticeable practical difference in scores. Overall, the results indicated that instruction using the conventional learning technique led to only a marginal improvement in students' performance in chemical bonding.

Moreover, the paired sample t-test for the experimental group revealed a substantial improvement in students' academic performance following the intervention. The mean pretest score was 10.72 (SD = 2.10), while the mean posttest score increased markedly to 18.66 (SD = 4.19). The mean difference between the pretest and posttest scores was −7.94.

The result showed that the difference was statistically significant, t(31) = −9.85, $p < .001$. The 95% confidence interval of the mean difference ranged from −9.58 to −6.29, which did not include zero, indicating a reliable improvement in performance. The effect size was very large (Cohen's d = 4.56), demonstrating a strong practical impact of the intervention.

These results indicated that the Team Game Tournament approach produced a significant and meaningful improvement in students' understanding and performance in chemical bonding.

The findings from independent sample t-test indicated a clear and statistically significant difference in academic performance between students taught chemical bonding using the Team Game Tournament (TGT) approach and those taught using the conventional learning technique. Students in the Experimental Group achieved substantially higher posttest scores than those in the Control Group. The results of Levene's test showed that the assumption of homogeneity of variances was violated, and therefore the unequal-variances t-test was appropriately interpreted. The t-test results revealed a statistically significant difference in mean scores in favour of the Experimental Group, leading to the rejection of the null hypothesis. This result demonstrated that instruction using the TGT approach was more effective in facilitating students' understanding and mastery of chemical bonding concepts than the conventional teacher-centred method.

The large mean difference observed between the two groups suggested that the TGT approach provided students with more effective learning opportunities than the traditional approach. Chemical bonding is often regarded as one of the most abstract and challenging topics in senior high school chemistry, as it requires learners to link macroscopic properties of substances to microscopic and symbolic representations of atomic interactions. Conventional instructional methods, which are often dominated by lectures, note-taking, and teacher explanations, may limit students' active engagement with these abstract ideas. In contrast, TGT incorporates cooperative learning, structured peer interaction, academic games, and competition, which likely promoted deeper cognitive processing of the content and encouraged more meaningful learning experiences.

The very large effect size reported for the difference in academic performance further indicated that the impact of the TGT approach was not only statistically significant but also educationally meaningful. Such a large effect size implied that the improvement in students' achievement was substantial and unlikely to be attributable to chance or minor instructional variations. This finding suggested that the TGT approach had a strong practical impact on students' learning of ionic, covalent, and metallic bonding concepts, possibly by providing repeated opportunities for concept rehearsal, immediate feedback, and clarification of misconceptions through peer discussion.

The findings of this study were consistent with a wide range of existing empirical studies that have demonstrated the effectiveness of the Team Game Tournament strategy in improving students' academic achievement in science-related subjects. Panggabean *et al.* (2021) reported that students exposed to the TGT strategy in physics achieved significantly higher scores compared to those taught using conventional methods. Moreover, Nadrah (2023) found that senior secondary school students taught chemistry using TGT outperformed their peers taught through lecture-based instruction. These studies attributed the improved performance to the interactive and student-centred nature of the TGT strategy, which actively involves learners in the construction of knowledge.

Beyond chemistry, research conducted in other science and mathematics contexts has also supported the superiority of TGT over conventional methods. Studies by Nofriansyah *et al.* (2024) and Riyanti *et al.* (2024) showed that TGT enhanced students' conceptual understanding and achievement due to its emphasis on collaboration, peer tutoring, and structured academic competition. These authors argued that the tournament and game elements motivate students to prepare adequately, participate actively, and pay closer attention during lessons, thereby improving academic outcomes.

The findings also aligned with Goddard *et al.* (2015), which emphasizes that structured group activities with individual accountability and group rewards tend to produce higher achievement than traditional instruction. In the TGT approach, students were required to contribute to their teams' success during tournaments, which likely encouraged individual effort and accountability. This structure may have discouraged passive learning and promoted active participation, unlike conventional classrooms where some students may remain disengaged.

Within the Ghanaian senior high school context, the results of this study were particularly important. Classrooms are often large, content-driven, and examination-oriented, which may constrain active learning. The observed effectiveness of TGT suggested that cooperative and game-based strategies can be successfully implemented in Ghanaian classrooms to enhance students' understanding of difficult chemistry concepts. Similar findings have been reported in Ghanaian and sub-Saharan African studies, where learner-centred and cooperative strategies significantly improved students' performance compared to traditional teaching methods (Sakata *et al.*, 2024).

Overall, the findings demonstrated that teaching chemical bonding using the Team Game Tournament approach resulted in significantly higher academic performance compared to the conventional learning technique. The rejection of the null hypothesis was therefore supported by both the statistical evidence from the present study and a strong body of existing literature. This result underscored the effectiveness of TGT as a viable instructional strategy for improving students' achievement in complex chemistry topics such as chemical bonding.

4.4.2 Research question two: What is the effect of the Team Game Tournament approach on the academic performance of male and female students in learning the concept of chemical bonding?

H_{02}: There is no statistically significant difference in the academic performance of male and female students taught the concept of chemical bonding using the Team Game Tournament (TGT) approach.

The results of the independent samples *t*-test for male and female students within the Experimental Group indicated that there was no statistically significant difference in academic performance between the two gender groups following instruction with the Team Game Tournament (TGT) approach. The Levene's test for equality of variances was not statistically significant, indicating that the assumption of homogeneity of variances was met, and thus the equal variances assumed results were appropriate for interpretation. The analysis showed that female students recorded a slightly higher mean score than male students; however, this difference was small and not statistically significant. Consequently, the null hypothesis was not rejected.

This finding suggested that the TGT approach was equally effective for both male and female students in learning chemical bonding concepts. The absence of a significant gender difference implied that the instructional strategy provided comparable learning opportunities for students regardless of gender. In chemistry education, where previous studies have sometimes reported gender-related disparities in achievement often favouring male students in problem-solving tasks or abstract reasoning the present result indicated that such disparities can be minimized through the use of cooperative and interactive instructional strategies like TGT.

One possible explanation for this outcome is that the TGT approach emphasizes teamwork, shared responsibility, and peer support rather than individual competition alone. Within the team structure, both male and female students are encouraged to contribute, explain concepts to one another, and participate actively in problem-solving activities. This collaborative environment may reduce performance anxiety, particularly for students who might feel less confident in traditional, teacher-centred, or highly competitive classroom settings. As a result, both genders may benefit equally from the instructional method.

The finding of no significant gender difference is consistent with several empirical studies on cooperative learning and TGT. Novritasari *et al.* (2022) reported that male and female students taught using TGT in secondary school science achieved comparable achievement scores, suggesting that the approach promotes gender equity in learning outcomes. Also, Hendra & Rahayu (2020) found that cooperative and game-based instructional strategies reduced gender gaps in achievement by encouraging inclusive participation and peer-assisted learning. These studies suggest that when learning tasks are structured around collaboration and mutual support, gender-based performance differences tend to diminish.

The present finding also aligns with broader cooperative learning literature, which indicates that well-structured group learning environments promote equitable participation and achievement among learners (Aprilya *et al.,* 2025). According to these scholars, cooperative learning strategies foster positive interdependence and individual accountability, ensuring that all group members regardless of gender are actively engaged in the learning process. In the context of TGT, the use of games and tournaments encourages participation from all students, as team success depends on the contribution of each member.

From a Ghanaian educational perspective, this result is particularly relevant. In some senior high school classrooms, cultural and social factors may influence classroom participation, sometimes leading to differences in confidence and engagement between male and female students. The finding that male and female students performed similarly under the TGT approach suggested that the strategy may help create a more gender-inclusive learning environment. This outcome supported earlier Ghanaian studies which found that learner-centred and cooperative strategies promote more balanced participation and achievement across genders in science subjects (Sakata *et al.,* 2024).

Although the reported effect size was large, the lack of statistical significance indicated that the observed mean difference between male and female students was not reliable within the present sample. This emphasized that the TGT approach did not systematically favour one gender over the other in terms of academic performance. Instead, its effectiveness appeared to be broadly distributed across students.

In conclusion, the findings demonstrated that the Team Game Tournament approach had a similar effect on the academic performance of both male and female students in learning chemical bonding. The null hypothesis was therefore retained. This result, supported by existing literature, suggested that TGT is a gender-neutral instructional strategy capable of enhancing learning outcomes without reinforcing gender disparities in chemistry achievement.

4.4.3 Research question three: What are the perceptions of students regarding the use of the Team Game Tournament approach in learning chemical bonding?

The findings of this study revealed that students generally held positive perceptions toward the use of the Team Game Tournament (TGT) approach in learning chemical bonding. Across all perception dimensions engagement and motivation, collaboration and communication, understanding and learning gains, confidence, enjoyment, and fairness the overall mean scores were above the midpoint of the response scale, indicating favorable student attitudes toward the instructional strategy. These results suggested that students perceived TGT as an effective and engaging method for learning the abstract concepts of ionic, covalent, and metallic bonding.

In terms of engagement and motivation, students reported moderately high levels of motivation and active involvement during TGT lessons. The overall mean score for this dimension indicated that the approach helped sustain students' interest in chemical bonding lessons. This finding suggested that the game-based and competitive elements of TGT captured students' attention and encouraged consistent participation. However, the relatively high mean score for the item indicating boredom suggested that some students occasionally experienced disengagement, likely during repeated tournament sessions or when tasks did not sufficiently vary in complexity. This mixed response reflected that while TGT generally enhanced motivation, its effectiveness depended on thoughtful implementation and lesson pacing. Similar observations have been reported in previous studies, which found that game-based cooperative learning increases motivation but may become less engaging if activities are overly repetitive (Fonseca *et al*., 2023; Ryan & Rigby, 2019).

Regarding collaboration and communication, students expressed positive perceptions of opportunities for interaction with peers. The high mean scores for items related to discussion and peer explanations indicated that students valued the collaborative nature of TGT. Working in teams appeared to facilitate peer tutoring and collective problem-solving, which are critical for understanding complex chemistry concepts. The slightly lower mean for understanding bonding ideas through teamwork suggested that while collaboration was beneficial, some students may still have relied on instructor clarification for deeper conceptual understanding. These findings were consistent with earlier research indicating that cooperative learning strategies improve interaction skills and academic discourse among students, thereby supporting conceptual learning (Park *et al*., 2019; Chen & Liu, 2023).

In relation to understanding and learning gains, students perceived that TGT contributed positively to their comprehension of chemical bonding concepts. The overall mean for this dimension suggested that students believed the approach improved their problem-solving abilities and conceptual explanations related to bonding.

With respect to confidence, students generally reported increased confidence in answering chemical bonding questions following exposure to TGT. However, the high mean score for discomfort during tournaments indicated that some students experienced anxiety when responding in competitive situations. This suggested that while TGT enhanced confidence over time, the tournament aspect may initially create pressure for some learners. Previous studies have similarly reported that academic competitions can simultaneously motivate and induce anxiety, particularly among less confident students, and have emphasized the importance of supportive team environments to mitigate such effects (Adipat *et al*., 2021; Chang & Yeh, 2021).

Students' responses under the enjoyment dimension showed that learners largely enjoyed learning chemical bonding through TGT and expressed willingness to use the approach for other chemistry topics. This indicated that students perceived the instructional strategy as enjoyable and preferable to traditional lecture-based instruction. Nevertheless, the lower mean scores for items related to the fun and interest of the game elements suggested that enjoyment levels varied among students. This variation may reflect differences in individual learning preferences or familiarity with game-based learning formats. Existing literature has similarly reported that while most students enjoy cooperative games, individual differences influence how engaging such methods are perceived to be (Engels & Freund, 2020).

Concerning fairness, students expressed strong positive perceptions regarding team formation, participation, and scoring systems within the TGT approach. The high overall mean score for fairness suggested that students felt the learning environment was inclusive and equitable. However, responses indicating that stronger students sometimes dominated teams highlighted a potential challenge in cooperative group work. This finding echoed concerns raised in cooperative learning research, which cautions that without careful role assignment and teacher monitoring, dominant students may overshadow less confident peers (Sujatha & Vinayakan, 2022; Bhandari, 2020). Nonetheless, the positive overall perception suggested that such issues did not overshadow the general sense of fairness experienced by students.

In summary, the findings demonstrated that students held largely positive perceptions of the Team Game Tournament approach in learning chemical bonding. Students perceived TGT as engaging, collaborative, confidence-enhancing, enjoyable, and fair, despite some reported discomfort during competitive activities and concerns about unequal participation within teams. These findings were consistent with previous research indicating that TGT and other cooperative learning strategies foster positive learning experiences and supportive classroom environments (Anggraini *et al*., 2025; Karina *et al.,* 2025). Overall, the positive perceptions reported by students supported the continud use of TGT as an effective instructional strategy for teaching complex chemistry concepts at the senior high school level.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Overview

This chapter presents information on the summary of major findings, conclusion and recommendation to stakeholders in science education. It further suggests arears where further research will be appropriate.

5.1 Summary of Findings

1. The study found a statistically significant difference in academic performance between students taught chemical bonding using the Team Game Tournament approach and those taught using the conventional learning technique. Students in the Experimental Group achieved higher mean posttest scores than those in the Control Group. The independent samples *t*-test indicated that the difference in performance was statistically significant, and the large effect size showed that the impact of the TGT approach was substantial in practical terms. These results demonstrated that the TGT approach was more effective than the conventional method in improving students' understanding and achievement in chemical bonding.

2. The findings showed that there was no statistically significant difference in the academic performance of male and female students taught chemical bonding using the TGT approach. Although female students recorded a slightly higher mean score than male students within the Experimental Group, the difference was not significant. This indicated that the TGT approach benefited male and female students equally, suggesting that the instructional strategy was gender-neutral and did not favour one gender over the other in terms of academic performance.

3. The study revealed that students generally had positive perceptions of the use of the Team Game Tournament approach in learning chemical bonding. Students reported favourable views across all perception dimensions, including engagement and motivation, collaboration and communication, understanding and learning gains, confidence, enjoyment, and fairness. Overall mean scores for all perception categories were above the midpoint of the scale, indicating that students found the TGT approach engaging, collaborative, and beneficial to their learning. Despite some reported discomfort during competitive tournament activities and concerns about dominance by stronger students, the overall perception of TGT remained positive.

In summary, the findings of the study demonstrated that the Team Game Tournament approach significantly improved students' academic performance in chemical bonding when compared with the conventional teaching method, was equally effective for both male and female students, and was positively perceived by students as an engaging and effective instructional strategy. These findings collectively supported the effectiveness and suitability of the TGT approach for teaching chemical bonding at the senior high school level.

5.2 Conclusions

The study investigated the effect of the Team Game Tournament (TGT) approach on senior high school students' academic performance and perceptions in learning chemical bonding. Based on the findings of the study, several conclusions were drawn in line with the research questions and hypotheses.

First, it was concluded that the Team Game Tournament approach was more effective than the conventional learning technique in enhancing students' academic performance in chemical bonding. Students who were taught using the TGT approach achieved significantly higher posttest scores than those taught through the traditional method. This indicated that the use of cooperative learning, structured games, and academic tournaments promoted better understanding and mastery of chemical bonding concepts, including ionic, covalent, and metallic bonding.

Secondly, the study concluded that the Team Game Tournament approach had a similar effect on the academic performance of male and female students. There was no statistically significant difference in the performance of male and female students taught using the TGT approach. This suggested that the instructional strategy provided equal learning opportunities for students regardless of gender and was effective in promoting gender equity in achievement within chemistry classrooms.

Third, it was concluded that students generally perceived the Team Game Tournament approach positively. Students viewed the approach as engaging, motivating, collaborative, enjoyable, and fair. They also perceived that TGT contributed to improved understanding, confidence, and participation in learning chemical bonding. Although some students reported discomfort during competitive tournament activities and noted that stronger students occasionally dominated team activities, these concerns did not outweigh the overall positive perceptions toward the approach.

Overall, the study concluded that the Team Game Tournament approach is an effective, inclusive, and student-centered instructional strategy for teaching chemical bonding at the senior high school level. The combination of improved academic performance, equitable outcomes across gender, and positive student perceptions supports the adoption of TGT as a viable alternative to conventional teaching methods in chemistry education.

5.3 Recommendation

Based on the findings of the study, the following recommendations are made for Tsito Senior High Secondary Technical School**:**

1. **Adoption of the Team Game Tournament approach in teaching chemical bonding and related topics:**

Given that students taught using the Team Game Tournament approach demonstrated significantly higher academic performance than those taught using the conventional method, it is recommended that chemistry teachers at Tsito Senior High Secondary Technical School adopt the TGT approach when teaching chemical bonding. The school management should encourage the integration of TGT into regular classroom practice, particularly for abstract chemistry topics, as a strategy for improving students' academic performance.

2. **Use of the TGT approach to promote gender equity in chemistry classrooms:**

Since the study found no significant difference in the academic performance of male and female students taught using the TGT approach, it is recommended that chemistry teachers at Tsito Senior High Secondary Technical School use TGT as an instructional strategy to provide equal learning opportunities for both male and female students. Teachers should structure teams carefully to ensure mixed-gender participation and encourage balanced contribution during group activities so that all students benefit equally from collaborative learning.

3. **Improving implementation of TGT to sustain positive student perceptions:**

In view of the generally positive student perceptions of the TGT approach, coupled with some reported discomfort during tournaments and concerns about dominance by stronger students, it is recommended that chemistry teachers at Tsito Senior High

Secondary Technical School refine the implementation of TGT. Teachers should vary game activities, assign clear roles within teams, and emphasize supportive peer interaction to reduce anxiety and ensure fair participation. This will help maintain high levels of motivation, engagement, and enjoyment while maximizing the instructional benefits of the TGT approach.

5.4 Suggestions for Further Research

Based on the findings of the study and in line with the three research questions, the following suggestions are made for further research:

1. Further research could examine the effectiveness of the approach when applied to other chemistry topics such as stoichiometry, acids and bases, rates of reaction, and electrochemistry. Conducting similar studies in these areas would help determine whether the positive impact of TGT on academic performance is consistent across different content areas within senior high school chemistry.
2. Moreover, further research could involve larger sample sizes and multiple schools to confirm the gender-neutral effects of the strategy. Future studies could also explore additional gender-related variables such as classroom participation, confidence, and attitudes to provide a deeper understanding of how TGT supports equitable learning outcomes for male and female students.
3. Also, further research could employ mixed-methods or qualitative designs to explore students' experiences in greater depth. Interviews, focus groups, and classroom observations could be used alongside questionnaires to better understand factors such as tournament-related anxiety, peer dominance, and motivational differences among students. Such studies would provide richer

insights into how the TGT approach can be refined to enhance students' engagement, enjoyment, and confidence during chemistry lessons.

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APPENDICES

APPENDIX A

STUDENT QUESTIONNAIRE

1. Student ID (code) _______
2. Gender: ☐ Male ☐ Female
3. Age: ______ years
4. Class/Stream: ___________ (e.g., General Arts, Business)

Response scale (tick one for each statement)

1 = Strongly Disagree

2 = Disagree

3 = Neutral

4 = Agree

5 = Strongly Agree

Perception items

Engagement & Motivation

1. I felt more motivated to study chemical bonding when learning through TGT.
2. TGT lessons kept me actively involved throughout the class.
3. I often felt bored during TGT sessions.

Collaboration & Communication

4. Working in teams during TGT helped me understand bonding ideas better.

5. TGT gave me more opportunities to discuss ideas with classmates.

6. My teammates explained concepts to me in ways that made sense.

Understanding & Learning Gains

7. TGT helped me understand the difference between ionic, covalent and metallic bonds.

8. After TGT activities I could better explain why atoms form particular bonds.

9. TGT improved my ability to solve chemical bonding problems.

Confidence

10. My confidence in answering bonding questions increased after TGT.

11. (R) I felt uncomfortable answering questions during tournaments.

12. I now feel better prepared for chemistry tests on bonding because of TGT.

Enjoyment

13. I enjoyed learning chemical bonding more with TGT than with the usual lecture method.

14. I would like my teacher to use TGT for other chemistry topics.

15. The game and tournament parts made learning fun and interesting.

Fairness

16. The way teams were formed made sure everyone could participate.

17. The scoring and award system in TGT was fair to all students.

18. Stronger students dominated the teams and tournaments too often.

APPENDIX B

TEST

SECTION A: Multiple Choice Questions (20 marks)

Choose the correct answer from the alternatives. Each item carries 1 mark.

1. A chemical bond is formed mainly because atoms:

   A. want to change into ions

   B. want to complete their outermost shells

   C. want to increase their mass number

   D. want to change into isotopes

2. Which of the following pairs of elements will most likely form an ionic bond?

   A. Hydrogen and oxygen

   B. Sodium and chlorine

   C. Carbon and oxygen

   D. Nitrogen and hydrogen

3. Ionic bonds are typically formed between:

   A. two nonmetals

   B. two metals

   C. a metal and a nonmetal

   D. noble gases

4. A **cation** is:

   A. a negatively charged ion

   B. an atom that has gained electrons

   C. an ion formed by electron loss

   D. a neutral particle

5. Which of the following is an example of an ionic compound?

   A. H_2O

   B. CO_2

   C. NaCl

   D. CH_4

6. A single covalent bond involves:

   A. one electron

   B. two electrons shared

   C. two electrons transferred

   D. four electrons shared

7. The molecule that contains double covalent bonds is:

   A. H_2

   B. CO_2

   C. NH_3

   D. HF

8. Which of the following is nonpolar?

   A. HCl

   B. H_2O

   C. O_2

   D. NH_3

9. Metallic bonding occurs mainly because metal atoms:

   A. share valence electrons

   B. transfer electrons

   C. form a sea of delocalized electrons

   D. break down into ions

10. The malleability of metals is due to:

    A. strong repulsion between ions

    B. freely moving electrons

    C. ability to form covalent bonds

    D. tightly bonded ions

11. A covalent compound is expected to have:

    A. high melting point

    B. ability to conduct electricity in molten state

    C. low melting point

    D. strong electrostatic attraction

12. Which of the following is the formula for magnesium oxide?

    A. MgO

    B. Mg_2O

    C. MgO_2

    D. Mg_2O_3

13. The bond between hydrogen and chlorine in HCl is:

    A. ionic

    B. metallic

    C. polar covalent

    D. nonpolar covalent

14. The ability of an atom to attract electrons is known as:

    A. ionization energy

    B. electronegativity

    C. electron affinity

    D. atomic radius

15. A molecule containing three shared pairs of electrons is:

    A. HCl

    B. N_2

    C. H_2

    D. O_2

16. Metals conduct electricity because they possess:

    A. loosely held electrons

    B. tightly bound electrons

    C. ionic bonds

    D. covalent bonds

17. Which of the following compounds contains both ionic and covalent bonds?

    A. NH_4Cl

    B. NaCl

    C. CH_4

    D. $CaCl_2$

18. A neutral atom of oxygen has 8 electrons. How many electrons does it need to gain to become stable?

    A. 1

    B. 2

    C. 3

    D. 4

19. The compound CO_2 is linear because:

    A. carbon forms two double bonds

    B. oxygen is more electronegative

    C. it contains ionic bonds

    D. electrons are transferred

20. Chlorine forms a chloride ion by:

    A. losing one electron

    B. gaining one electron

    C. sharing one electron

    D. forming a metallic bond

SECTION B: Structured Questions (20 marks total)

Answer all questions. Show working where necessary.

Question 21 (5 marks)

(a) Define an ionic bond. (2 marks)

(b) Using electron transfer, show how **calcium (Ca)** reacts with **chlorine (Cl)** to form calcium chloride. (3 marks)

Question 22 (5 marks)

(a) What is a covalent bond? (2 marks)

(b) Draw the Lewis structure for **NH_3** and explain why the molecule is polar. (3 marks)

Question 23 (5 marks)

(a) Explain metallic bonding. (2 marks)

(b) State two properties of metals and relate each to metallic bonding. (3 marks)

Question 24 (5 marks)

(a) State two differences between ionic and covalent compounds. (2 marks)

(b) Why do ionic compounds conduct electricity when molten but not when solid? (3 marks)

CHEMICAL BONDING ACHIEVEMENT TEST (CBAT) — MARKING SCHEME

SECTION A — Multiple Choice Questions (20 marks)

Award 1 mark for each correct answer.

Qn	**Correct Answer**	**Qn**	**Correct Answer**
1	B	11	C
2	B	12	A
3	C	13	C
4	C	14	B
5	C	15	B
6	B	16	A
7	B	17	A
8	C	18	B
9	C	19	A
10	B	20	B

Total for Section A = 20 marks

SECTION B — Structured Questions (20 marks)

Question 21 (5 marks)

(a) Define an ionic bond. (2 marks)

Award full marks for any of the following scientifically correct definitions:

- –An ionic bond is the electrostatic attraction between positively and negatively charged ions."
- OR: –A chemical bond formed when electrons are transferred from a metal atom to a nonmetal atom."

Mark allocation:

Correct idea of *electron transfer* — 1 mark

Correct idea of *electrostatic attraction* — 1 mark

(b) Using electron transfer, show how calcium reacts with chlorine to form $CaCl_2$. (3 marks)

Award as follows:

- Ca atom loses 2 electrons to form **Ca^{2+}** (1 mark)
- Each Cl atom gains 1 electron to form **Cl^-** (1 mark)
- Correct final formula: **$CaCl_2$** (1 mark)

Accept ionic diagram, electron transfer diagram, or ion notation.

Question 22 (5 marks)

(a) What is a covalent bond? (2 marks)

Award full marks for:

- –A covalent bond is formed when two atoms share a pair of electrons."

Mark allocation:

Mention of *sharing electrons* — 1 mark

Mention of *between two atoms* OR *mutual sharing* — 1 mark

(b) Draw the Lewis structure for NH_3 and explain why it is polar. (3 marks)

Mark breakdown:

- Correct Lewis structure: N with 3 single bonds to H and 1 lone pair (2 marks)
- Explanation of polarity:
  - Molecule is *asymmetrical* due to lone pair
  - Dipole does not cancel

    → (Any correct reason = 1 mark)

Question 23 (5 marks)

(a) Explain metallic bonding. (2 marks)

Award full marks for:

- ~~"~~Metallic bonding is the attraction between positively charged metal ions and a sea of delocalized electrons."

Mark allocation:

Delocalized (free) electrons — 1 mark

Positive metal ions/lattice attraction — 1 mark

(b) State two properties of metals and relate each to metallic bonding. (3 marks)

Award 1.5 marks each (1 mark for property + 0.5 for explanation):

Examples:

- **Electrical conductivity** — due to delocalized electrons.
- **Malleability/ductility** — layers of ions slide without breaking bonds.
- **High melting points** — strong attraction in metallic lattice.

(Any two correct linked explanations → **3 marks**)

Question 24 (5 marks)

(a) State two differences between ionic and covalent compounds. (2 marks)

Award **1 mark each** for any correct differences:

Examples:

- Ionic compounds have high melting points; covalent compounds have low melting points.
- Ionic compounds conduct electricity when molten; covalent compounds do not conduct.
- Ionic bonds involve electron transfer; covalent bonds involve electron sharing.

(b) Why do ionic compounds conduct electricity when molten but not when solid? (3 marks)

Award marks as follows:

- Solid: ions are fixed/not free to move → **1 mark**
- Molten: ions become mobile → **1 mark**
- Movement of ions allows conduction of electricity → **1 mark**

TOTAL MARKS: 40

Section A = 20 marks

Section B = 20 marks

Grand Total = 40 marks