BINDURA UNIVERSITY OF SCIENCE EDUCATION

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EXPLORING STUDENTS' DIFFICULTIES IN STUDYING CHEMISTRY

BY

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BINDURA UNIVERSITY OF SCIENCE EDUCATION

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DEDICATION

I dedicate this work to my husband and children.

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ABSTRACT

This study aimed to investigate the multifaceted challenges that hinder student engagement and performance in chemistry education. The research aimed to; identify key factors contributing to students' difficulties in understanding chemistry concepts; to assess the impact of teaching methods on student engagement and learning outcomes, and to recommend strategies to improve retention and performance in chemistry. The study was grounded in behaviourism and social learning theories. These examine how reinforcement, peer interaction, and observational learning shape students' attitudes and comprehension. These theoretical lenses provided insight into both individual learning behaviours and classroom dynamics. A mixed methods approach was used. There were qualitative insights from in-depth teacher interviews. Simple random sampling was used to select 20 students and 5 teachers, ensuring balanced representation and minimizing selection bias. Key findings reveal that students struggle with mathematical applications, laboratory limitations, abstract terminology, and interdisciplinary integration. Motivation emerged as a critical barrier, with chemistry being perceived as a difficult and inaccessible subject. Teachers cited time constraints, resource shortages, and rigid syllabi as impediments to effective instruction. The study concludes that improving chemistry education requires systemic and pedagogical reform. Recommended strategies include integrating technology, diversifying teaching methods, enhancing laboratory access, promoting self-efficacy, and facilitating expert-led seminars. These interventions aim to foster a more inclusive, engaging, and supportive learning environment, ultimately strengthening students' conceptual understanding and academic success in chemistry.

CHAPTER 1: INTRODUCTION

1.0 Introduction

Chemistry is a fundamental science that plays a crucial role in understanding the natural world. Despite its significance, many students face substantial challenges in mastering its concepts. The subject's abstract nature, reliance on mathematical principles, and complex terminology contribute to learning difficulties. Additionally, factors such as ineffective teaching methods, low self-efficacy, and limited access to educational resources further hinder students' comprehension. At Golden Heights High School, these challenges have led to reduced engagement, frustration, and, in some cases, the decision to abandon chemistry altogether. This study seeks to explore the root causes of these difficulties and propose strategies to enhance students' understanding and retention of chemistry concepts.

1.1 Background of the Study

Chemistry is often considered a challenging subject for students due to its complex nature and abstract concepts. According to Musengimana et al. (2021) one area that many students struggle with is understanding chemical equations and balancing reactions. When students encounter chemical equations for the first time, they may find it difficult to comprehend the symbols and formulas used to represent different elements and compounds (Musengimana et al., 2021). Balancing chemical equations, a fundamental skill in chemistry, can also pose a significant challenge for students (Musengimana et al., 2021). Therefore, it is crucial to develop effective study strategies to enhance students' understanding of chemistry. In addition, Zhao and Wang (2022) note that mastering mathematical concepts is essential in the study of chemistry. Areas such as stoichiometry, concentration calculations, and gas laws require a solid understanding of mathematical principles to accurately analyze and solve problems (Zhao & Wang, 2022). The technical language used in chemistry can indeed present obstacles to students' comprehension. Terms may seem daunting and complex at first glance, leading to confusion and frustration among learners.

Students' difficulties in studying chemistry often stem from a lack of interest in the subject. Zhao and Wang (2022) assert that when students do not engage with the material, their motivation to learn diminishes significantly. This disinterest can lead to a superficial understanding of complex concepts, making it harder for them to grasp essential principles. Furthermore, students who perceive chemistry as irrelevant to their lives or future careers may struggle to find the motivation to invest time and effort into their studies (Ghans & Castro, 2021). Negative attitudes towards the subject can also result from previous experiences, such as challenging coursework or ineffective teaching methods. As a result, students may develop anxiety or frustration, further hindering their ability to learn (Ghans & Castro, 2021). Low self-efficacy significantly impacts students' confidence levels in studying chemistry, often leading to anxiety and decreased performance (Moreno, Candido & Ye, 2021). When students doubt their abilities to understand complex concepts or solve challenging problems, they may avoid engaging with the material altogether. This lack of confidence can create a vicious cycle: as they struggle to grasp fundamental ideas, their performance suffers, further eroding their self-belief (Moreno, Candido & Ye, 2021). Furthermore, students with low self-efficacy may be less likely to seek help or participate in collaborative learning opportunities, thereby missing out on valuable support and resources (Ghans & Castro, 2021).

Teaching methods play a crucial role in students' engagement and understanding of chemistry. Silva et al. (2023) assert that passive learning environments, where students primarily receive information through lectures without interaction, often fail to engage them effectively. This traditional approach can lead to disengagement, making it difficult for students to retain information and apply concepts in practical situations (Moreno, Candido & Ye, 2021). In contrast, active learning strategies, such as group discussions, hands-on experiments, and problem-solving activities, tend to be more beneficial (Moreno, Candido & Ye, 2021). Access to resources plays a vital role in students' learning experiences in chemistry. When students have limited access to supplementary materials, such as textbooks, online resources, lab equipment, or tutoring, they may struggle to fully grasp complex concepts and enhance their understanding (Moreno, Candido & Ye, 2021). The absence of diverse learning materials can lead to a narrow perspective on the subject, making it difficult for students to connect theoretical knowledge with practical applications (Silva et al., 2023). Additionally, students may miss out on valuable opportunities for exploration and experimentation, which are essential for mastering chemistry. Without adequate resources, those who are already facing challenges may feel overwhelmed and discouraged, further diminishing their motivation to learn.

1.2 Statement of the Problem

According to Vurayai (2021), students in Zimbabwe frequently encounter significant challenges in studying chemistry, leading to a high dropout rate in the subject. Similarly, students at Golden Heights High School sometimes face challenges when studying chemistry. These difficulties arise from various factors, including a lack of interest in the subject, low self-efficacy, ineffective teaching methods, and limited access to resources (Vurayai, 2021). As students struggle to understand complex concepts, such as chemical equations and mathematical applications, their motivation to engage with the material diminishes (Vurayai, 2021). This disinterest not only hampers their academic performance but also contributes to increased anxiety and frustration. Consequently, as highlighted by Mpofu and Mutseekwa (2022) many students choose to abandon the subject altogether, which has serious implications for their educational and career prospects. Addressing these issues is crucial to improving retention rates in chemistry and ensuring that students can achieve a deeper understanding of this vital discipline (Mpofu & Mutseekwa, 2022). In that regard, it is imperative to identify and implement effective strategies that can help students study chemistry more successfully. These strategies should focus on enhancing engagement, building confidence, and providing the necessary resources to facilitate learning (Mpofu & Mutseekwa, 2022). By adopting a holistic approach that addresses both academic and emotional needs, educators can create a more conducive learning atmosphere, ultimately improving students' performance and retention in chemistry.

1.3 Purpose of the Study

The study aims to explore the challenges students face when studying chemistry and identify effective strategies to mitigate these difficulties. By examining factors such as teaching methodologies, student engagement, resource accessibility, and self-efficacy, the research seeks to provide a comprehensive understanding of the barriers that hinder learning. Additionally, the study will evaluate how teaching approaches influence students’ comprehension and retention of chemistry concepts.

1.4 Aims of the Study

The study intends to explore the challenges faced by students at Golden Heights High School when studying chemistry.

1.5 Research Objectives

1. To identify the key factors contributing to students' difficulties in understanding chemistry concepts.

2. To assess the impact of teaching methods on student engagement and learning outcomes in chemistry.

3. To recommend strategies and interventions that can improve student retention and performance when studying chemistry.

1.5 Research Question

1. What are the challenges faced by students at Golden Heights High School when studying chemistry?

2. What key factors contribute to students' difficulties in understanding chemistry concepts?

3. How do different teaching methods impact student engagement and learning outcomes in chemistry?

4. What strategies and interventions can be implemented to improve student retention and performance in chemistry studies?

1.6 Assumptions of the Study

Students face varying degrees of difficulty in understanding chemistry concepts, regardless of prior academic performance.

A student’s engagement and motivation in chemistry are influenced by both intrinsic interest and external factors, such as teaching methods and available resources.

1.7 Significance of the Study

This study is essential in addressing the challenges students face in studying chemistry, providing valuable insights for educators, policymakers, and students alike. The findings will contribute to evidence-based interventions aimed at improving chemistry education. Furthermore, the study's recommendations can inform policy adjustments, curriculum enhancements, and instructional strategies that foster a more effective learning environment, ultimately strengthening students' comprehension and retention of chemistry concepts.

For policymakers, this study will provide actionable recommendations to guide the development of educational policies aimed at improving chemistry education. It will identify areas within the chemistry curriculum that require revision or enhancement to better align with students' needs and learning challenges. Additionally, the study will promote collaboration among policymakers, educational institutions, and other stakeholders, fostering a supportive network dedicated to advancing chemistry education through evidence-based strategies.

For chemistry teachers, the study will provide insights into which teaching methods are most effective in engaging students and enhancing their understanding of chemistry concepts. The study will offer strategies to foster a more engaging learning environment, which may lead to increased student motivation and interest in chemistry. The findings can serve as a basis for professional development programs, equipping teachers with the tools and knowledge to address challenges in chemistry education effectively.

For students, the study will help identify specific challenges that students face when studying chemistry. The study can also suggest teaching methods that enhance students' comprehension of chemistry concepts. The insights gained can inform educational policies and curriculum developments, ensuring that they better meet the needs of students.

1.8 Limitations of the Study

The duration of the study may limit the depth of analysis, preventing a comprehensive exploration of all factors influencing chemistry education. If the study is conducted in a specific region or type of school, its findings may not apply to students in different areas or educational contexts. The study will be limited by the number of participants, which could affect the generalizability of the findings to the broader student population. Student and teacher perceptions may be subjective, leading to potential biases in the data collected through surveys or interviews.

1.9 Delimitations of the Study

This study focuses on Golden Heights High School, which is centrally located in Shamva District. The school attracts students from diverse backgrounds, including those from both urban and rural areas. This offers a unique perspective on chemistry education challenges. Given its demographic diversity, the findings will reflect a broad range of student experiences and learning difficulties within the subject. The research strictly examines chemistry learning challenges, without extending to other sciences such as physics or biology. This delimitation ensures a focused analysis on chemistry-specific difficulties, allowing for targeted recommendations relevant to improving student comprehension in this subject.

1.10 Chapter Summary

In conclusion, the challenges faced by students in studying chemistry are multifaceted, stemming from a combination of factors such as limited interest in the subject, low self-efficacy, ineffective teaching methods, and restricted access to resources. Addressing these issues is crucial not only for enhancing students' understanding of complex chemical concepts but also for improving their overall academic performance and retention in the subject. The insights gained from this study can inform targeted interventions and teaching strategies that foster engagement and build confidence among learners.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

This chapter reviews the existing literature on students' difficulties in studying chemistry, focusing on the underlying factors that contribute to these challenges. Drawing from various educational theories, including social learning theory and behaviourism, the discussion highlights how these frameworks can enhance student engagement and comprehension in chemistry. The review also aims to identify research gaps, particularly concerning the effectiveness of differentiated instruction and technology-enhanced learning strategies.

2.1 Theoretical Framework

This study was grounded in two key educational theories which are behaviourism and social learning theory. These frameworks provided insight into how reinforcement and peer interaction influence students' engagement and understanding in chemistry. Together, they guided the analysis of teaching approaches and student learning behaviours in the classroom context.

2.1.1 Behaviourism

According to Firmansyah and Saepuloh (2022), behaviourism emphasizes the role of reinforcement and practice in the learning process. As stated by the theory, behaviours that are reinforced tend to be repeated, while those that are not reinforced may diminish over time (Firmansyah & Saepuloh, 2022). In the context of chemistry education, behaviourism can be applied through the use of formative assessments and feedback. The aim is to identify the best teaching methods that can enhance students' understanding of chemistry. According to Kelley (2021), implementing various activities, such as regular quizzes and assessments, can provide students with immediate feedback on their understanding of chemistry concepts. The aim is to reinforce chemistry concepts in their education. Reinforcement then helps students to identify areas where they excel and areas that need improvement (Kelley, 2021). Moreover, the practice afforded by formative assessments allows students to reinforce their learning and build mastery over time (Kelley, 2021). As they repeatedly encounter and solve problems, their confidence and skills develop. These are the main arguments of the behavioural theory. Zong (2020) further supports this by highlighting the effectiveness of reinforcement learning in mathematics and science education, particularly in promoting retention through repetition. Similarly, Skinner's operant conditioning model has been widely applied in classroom settings to shape desired academic behaviours through structured feedback and rewards (Unwin, 2020).

2.1.2 Social Learning Theory

The social learning theory was also used as another theoretical lens in the study. As highlighted by Dewi et al. (2021), this theory posits that individuals acquire new behaviours, skills, and knowledge by observing others and modelling their actions. Dewi et al. (2021) argue that applying social learning theory in chemistry education can enhance student engagement and understanding of complex concepts. This is because it promotes collaborative learning environments where educators create opportunities for students to engage in group work, discussions, and peer teaching (Firmansyah & Saepuloh, 2022). In these settings, students observe their peers' problem-solving techniques and thought processes (Firmansyah & Saepuloh, 2022). For instance, when students work together on a chemistry problem, they can share diverse perspectives, clarify misunderstandings, and reinforce each other's learning. Furthermore, collaborative environments foster a sense of community, making students feel more comfortable asking questions and expressing their thoughts (Dewi et al., 2021). Li et al. (2021) further demonstrate that integrating social presence and peer interaction in online chemistry instruction significantly improves students' motivation and conceptual understanding. This aligns with the current study's focus on enhancing student engagement through peer-supported learning.

2.2 Challenges Faced by Students

Students encounter a range of challenges when learning chemistry, influenced by both cognitive demands and the subject's abstract nature. While many issues have been documented in the literature, this study focused on selected challenges that appeared most prominently in the target context.

2.2.1 Mathematical Skills

Mathematical skills are essential for success in chemistry, as the subject often intertwines with various mathematical concepts, including algebra and calculus. Iwuanyanwu (2021) asserts that many chemistry problems require students to perform calculations, manipulate equations, and analyze graphs. For instance, understanding stoichiometry involves mastering proportions and ratios, which are fundamentally algebraic. Additionally, concepts such as concentration, pH, and reaction rates demand the application of mathematical formulas and quantitative reasoning. Students who are not confident or familiar with these mathematical foundations often find such tasks daunting. Ye (2024) concurs that this difficulty can lead to a lack of confidence, which further impedes conceptual understanding. Pratomo et al. (2025) found that students across grade levels consistently identified mathematical reasoning as a major barrier to mastering chemistry, particularly in topics like thermochemistry and stoichiometry. Similarly, Hewson (2011) highlights that even students with strong mathematics backgrounds may struggle to transfer procedural knowledge into chemical contexts, especially when problem-solving requires estimation or multi-step reasoning. These findings suggest that the challenge is not merely a lack of mathematical ability, but a disconnect between mathematical knowledge and its application in chemistry. Despite this, limited research has explored how students' unfamiliarity with mathematical representations specifically affects their engagement with chemistry content. This study seeks to address that gap by examining how mathematical difficulties manifest in real classroom settings and how they influence students' overall learning experiences in chemistry.

2.2.2. Laboratory Skills

Laboratory skills are a cornerstone of chemistry education. According to Kelley (2021), practical lab work allows students to apply theoretical concepts in real-world scenarios. However, many students face significant challenges when it comes to conducting experiments accurately and safely. The laboratory environment can be intimidating, particularly for those who lack prior experience or confidence in handling chemicals and equipment (Agustian et al., 2022). Students must learn to follow complex protocols, which often require precise measurements and careful attention to detail (Agustian et al., 2022). Kelley (2021) asserts that missteps in technique can lead to inaccurate results or unsafe situations. Gebremichael et al. (2024) highlight that in many developing contexts, these challenges are compounded by limited access to laboratory resources, inadequate infrastructure, and a shortage of trained technicians, which further restrict students' opportunities for hands-on learning. Similarly, Omiko (2015) emphasizes that without regular exposure to practical work, students may struggle to develop essential scientific attitudes and skills, leading to disengagement and poor academic outcomes. Despite the recognized importance of laboratory work, few studies have explored how these barriers affect students' confidence and motivation in chemistry, particularly in under -resourced schools. This study seeks to address that gap by examining how laboratory-related challenges influence students' learning experiences and attitudes toward chemistry.

2.2.3 Language and Terminology

The specialized vocabulary and terminology of chemistry can pose significant challenges for many students. Quilez (2019) argues that this linguistic complexity creates barriers to understanding, as chemistry is filled with intricate terms that describe abstract processes and reactions. These terms are not only difficult to spell but often require a deep conceptual grasp to use correctly. Tsaparlis (2018) adds that the symbolic language of chemistry, formulas, equations, and notations, further complicates comprehension, especially for students transitioning from rote learning to applied problem-solving. Gafoor and Greeshma (2014) found that many secondary students struggle to decode prefixes and suffixes in chemical terms, which impairs their ability to form conceptual links between topics. Similarly, Wellington and Osborne (2001) emphasize that scientific language is not merely a communication tool but a cognitive barrier when not explicitly taught. Despite these insights, limited research has examined how students in under-resourced contexts navigate chemistry's linguistic demands. This study addresses that gap by exploring how terminology-related difficulties affect students' engagement and conceptual understanding in real classroom settings.

2.2.4 Interdisciplinary Nature

Chemistry is also interdisciplinary. Mazzocchi (2019) concurs that this interdisciplinarity presents a unique set of challenges for students, as it often overlaps with fields such as physics and biology. The integration requires a comprehensive understanding of concepts from multiple disciplines, which can be daunting for many learners. For instance, grasping chemical kinetics involves chemical principles and also an understanding of physical concepts like energy and motion. Similarly, Mazzocchi (2019) highlights that biochemistry demands knowledge of both biological processes and chemical reactions, creating a complex web of interrelated ideas. Students who may excel in one subject might struggle to connect these diverse concepts, leading to gaps in their understanding. This necessity to synthesize information from different fields can be overwhelming, especially when students are already grappling with core chemistry topics (Quilez, 2019). The requirement to shift between disciplines can disrupt their learning flow and contribute to confusion, as they may not see the relevance or application of what they have learned in other subjects (Quilez, 2019). As a result, this interdisciplinary approach can hinder students' ability to fully engage with chemistry.

2.3 Factors Contributing to Student Difficulties

Several underlying factors contribute to the difficulties students face in mastering chemistry. This section highlights key influences identified in this study, including instructional approaches and student-related variables, to better understand their impact on learning outcomes.

2.3.1 Teaching Methods

Teaching methods play a pivotal role in shaping students' experiences and success in studying chemistry. However, certain instructional approaches can inadvertently contribute to learning difficulties. Berhe et al. (2024) assert that traditional lecture-based instruction often emphasizes rote memorization of facts and formulas, which may leave students feeling disengaged and independent from the material. This method frequently fails to accommodate diverse learning styles, making it difficult for some students to grasp abstract concepts that could be better understood through interactive or hands-on experiences. Crucho et al. (2020) similarly note that when instruction is heavily theoretical and lacks practical application, students may struggle to see the relevance of chemistry in real-world contexts. Moreover, a rapid pace of content delivery can overwhelm learners, leaving insufficient time for reflection and conceptual consolidation. Kristen et al. (2017) emphasize that science -based pedagogies such as problem-based learning (PBL) and process-oriented guided inquiry learning (POGIL) are more effective in promoting deep understanding and engagement. Gebremichael et al. (2024) highlight that in many developing contexts, poor instructional methods—combined with large class sizes and limited resources—exacerbate students' difficulties in chemistry. Despite these insights, there remains a gap in research exploring how context-specific instructional practices affect student comprehension and motivation in under-resourced schools. This study addresses that gap by examining the instructional dynamics that shape students' chemistry learning experiences.

2.3.2 Motivation and Attitude

Students' interest and motivation in chemistry are critical factors that influence their engagement and ability to tackle challenging concepts. Musengimana, Kampire, and Ntawiha (2021) assert that when students possess a genuine curiosity about the subject, they are more likely to invest time and effort into understanding complex material. Conversely, a lack of interest can lead to apathy, making it difficult for students to connect with the curriculum. Some perceive chemistry as a daunting and abstract subject, which further diminishes their motivation to engage deeply with the content (Kousa et al., 2018). Negative experiences in previous courses or a belief that they are not good at science can foster a fixed mindset, leading to reluctance in confronting difficult topics (Kousa et al., 2018). Furthermore, if students do not see the relevance of chemistry to their everyday lives or future careers, their motivation to learn may wane (Musengimana et al., 2021). This disinterest often results in superficial learning, where students memorize information for exams without truly understanding the underlying principles. Bolte et al. (2013) emphasize that motivation is not static but shaped by classroom climate, teacher enthusiasm, and perceived task value. Similarly, Omari et al. (2024) found that integrating interactive tools such as educational robotics significantly boosted students' motivation in chemistry, even among those previously disengaged. Despite these insights, few studies have explored how motivational barriers manifest in under-resourced schools or how students' perceptions of chemistry evolve. This study addresses that gap by examining the motivational dynamics that influence students' willingness to engage with chemistry content in real classroom settings.

2.4 The Impact of Teaching Methods

Teaching methods play a central role in shaping student engagement and comprehension. This section explores how different instructional strategies influence students' ability to grasp chemistry concepts, drawing attention to both strengths and potential drawbacks.

2.4.1 Traditional Teaching Methods

As stated earlier, traditional lecture methods, while informative, often result in passive learning experiences for students. Berhe et al. (2024) note that lectures typically involve one-way communication, where students listen without actively engaging with the material. This lack of interaction can diminish interest and motivation, making it difficult for learners to connect meaningfully with the content. Without opportunities for discussion, inquiry, or collaboration, students may feel like passive recipients rather than active participants in their education. Crucho et al. (2020) further argue that when instruction is heavily theoretical and lacks practical application, students may struggle to see the relevance of chemistry in real-world contexts. Moreover, the pace at which content is delivered can overwhelm learners, leaving little room for reflection or conceptual consolidation. Awad (2017) emphasizes that such approaches often fail to accommodate diverse learning styles, particularly in complex subjects like chemistry that require both abstract reasoning and hands-on exploration. While alternative pedagogies such as active learning and inquiry-based instruction have gained traction, their integration into mainstream chemistry classrooms remains uneven. This study contributes to ongoing conversations by examining how traditional methods shape students' engagement and comprehension, particularly in contexts where instructional innovation may be constrained by systemic or resource-related factors.

2.4.2 Learning Techniques

Active learning techniques are vital for enhancing student engagement and improving learning outcomes in chemistry. Eichler and Peeples (2016) assert that methods such as group discussions, problem-solving sessions, and hands-on experiments actively involve students in the learning process. This participation fosters collaboration and encourages students to share ideas, ask questions, and engage with their peers, leading to higher levels of engagement. When students feel involved in their learning, they are more likely to develop a deeper connection with the material. Furthermore, Salame, Patell, and Suleman (2019) highlight that active learning allows students to apply theoretical concepts to real-world scenarios, which significantly improves retention and understanding. By engaging in practical applications, students can see the relevance of chemistry in everyday life, making the subject more meaningful. This hands-on approach helps reinforce learning, as students are more likely to remember information they have actively worked with. Paulson and Faust (2020) emphasize that even modest shifts toward active learning, such as brief peer discussions or in-class problem-solving, can significantly enhance conceptual understanding in chemistry. Similarly, Bonwell and Eison (1991) argue that active learning strategies promote higher-order thinking, including analysis and synthesis, which are essential for mastering complex scientific content. While these benefits are well-documented, the extent to which active learning is consistently implemented in chemistry classrooms, particularly in resource-constrained environments, remains underexplored. This study contributes to that conversation by examining how active learning is experienced and perceived by students in a real-world school context.

2.5 Strategies for Improvement

Improving student engagement is essential for fostering deeper learning in chemistry. This section outlines specific strategies employed or recommended in this study to support learners more effectively and address the barriers identified.

2.5.1 Use of Technology

It has been stated that the use of technology in chemistry education can enhance student engagement and learning outcomes. Nwafor, Ibe, and Muoneke (2022) assert that interactive simulations, virtual labs, and multimedia presentations can capture students' attention, making abstract concepts more tangible and relatable. These tools also cater to diverse learning styles, allowing visual, auditory, and kinesthetic learners to interact with the material in ways that resonate with them, thereby fostering a more inclusive learning environment. Moreover, Tigaa and Sonawane (2020) highlight that technology enhances conceptual visualization, enabling students to explore complex topics dynamically. Simulations can demonstrate chemical reactions or molecular interactions that may be difficult to visualize in traditional settings. Additionally, technology often provides immediate feedback, allowing students to assess their understanding in real time and adjust their learning strategies accordingly. Alhashem and Alfailakawi (2023) found that pre -service chemistry teachers who used virtual labs before hands-on sessions demonstrated significantly higher engagement and conceptual clarity. Similarly, Atif et al. (2024) emphasize that technology integration not only improves problem-solving skills but also transforms passive learning environments into interactive, student-centered spaces. While the benefits are increasingly recognized, the extent to which such tools are accessible and effectively implemented in resource-constrained schools remains uneven. This study contributes to that conversation by exploring how technology-supported instruction is perceived and experienced by students in real classroom contexts.

2.5.2 Formative Assessments

Formative assessments play a crucial role in enhancing student engagement and learning outcomes in chemistry. Nsabayezu et al. (2023) assert that incorporating regular quizzes and feedback sessions encourages students to interact with the material continuously, rather than relying on last-minute cramming. This sustained engagement fosters deeper conceptual understanding, as students are prompted to reflect on their learning and identify knowledge gaps. Additionally, formative assessments provide valuable insights into students' progress and areas of difficulty, enabling teachers to offer timely interventions and personalized support. Ismail and Osman (2024) emphasize that formative assessment strategies—such as peer feedback, self-assessment, and diagnostic questioning—not only improve academic performance but also promote metacognitive awareness and differentiated instruction. Similarly, Okoye et al. (2023) found that students exposed to formative assessment techniques demonstrated higher knowledge retention and greater confidence in applying chemistry concepts. While the benefits are well-documented, the extent to which these practices are systematically embedded in everyday instruction, especially in under-resourced classrooms, remains uneven. This study contributes to that conversation by exploring how formative assessment is implemented and experienced in real-world chemistry learning environments.

2.5.3 Differentiated Instruction

Differentiated instruction is an approach in chemistry education that addresses the diverse needs of students. Ibnuzaman et al. (2024) assert that this approach offers tailored resources such as videos, articles, and interactive simulations. By doing so, educators can cater to different learning styles and ensure that students have access to materials that resonate with them. This variety helps engage learners who may struggle with traditional teaching methods and allows them to explore concepts at their own pace. Rahayu and Rosti (2023) emphasize that flexible grouping further enhances this approach by organizing students into groups based on their skill levels. This strategy enables targeted instruction, allowing teachers to provide support that is appropriate for each group's needs. Advanced learners can tackle more challenging problems, while those requiring additional help receive focused guidance on foundational concepts. Temirov (2024) adds that differentiated instruction improves students’ conceptual understanding and scientific interest by aligning content with individual readiness and prior knowledge. Similarly, Hakimah et al. (2024) found that customized pedagogical kits in chemistry classrooms significantly reduced misconceptions and improved students’ attitudes toward the subject. While these findings underscore the potential of differentiated instruction, its consistent implementation, particularly in large or under-resourced classrooms, remains a challenge. This study contributes to that conversation by examining how differentiated strategies are applied and experienced in real-world chemistry learning environments.

2.5.4 Scaffolding

Scaffolding techniques are essential for supporting student learning in chemistry, particularly when tackling complex topics. Broman, Bernholt, and Parchmann (2018) assert that providing step-by-step guidance enables educators to break down intricate concepts into manageable parts, making it easier for students to grasp the material. This structured approach builds confidence as learners progress, allowing them to master foundational elements before advancing to more complex content. Additionally, Ibnuzaman et al. (2024) highlight the value of concept maps, which encourage students to create visual representations of relationships between concepts. These tools enhance understanding by helping learners visualize how ideas interconnect, while also serving as effective study aids that support knowledge retention. Okorie (2014) emphasizes that concept mapping fosters metacognitive reflection, enabling students to monitor their understanding and identify misconceptions. Similarly, the Royal Society of Chemistry (2021) notes that scaffolding strategies, such as guided practice, worked examples, and structured questioning, are particularly effective in chemistry, where abstract reasoning and symbolic representation often pose challenges. While scaffolding is widely recognized as a best practice, its consistent and adaptive use in chemistry classrooms remains an area of pedagogical development. This study contributes to that conversation by examining how scaffolding techniques are applied and experienced in real-world instructional settings.

2.6 Summary

In conclusion, the exploration of students' difficulties in studying chemistry reveals a multifaceted landscape influenced by various factors, including mathematical skills, laboratory techniques, specialized terminology, and the interdisciplinary nature of the subject. The application of educational theories such as social learning theory and behaviourism underscores the importance of collaborative and interactive learning environments in enhancing student engagement and comprehension. However, significant gaps remain in the research regarding the effective integration of differentiated instruction, scaffolding, and technology in chemistry education. Addressing these gaps is essential for developing targeted strategies that cater to diverse learning needs, ultimately fostering a more inclusive and effective educational experience.

CHAPTER 3: RESEARCH METHODOLOGY

3.0 Introduction

This chapter outlines the research methodology employed in this study to explore the difficulties students face in studying chemistry. It details the research design, which utilizes a survey approach to collect quantitative data, complemented by qualitative insights from in-depth interviews. The chapter also discusses the research paradigm, population, sampling methods, and data collection techniques, emphasizing the mixed methods approach. Additionally, it highlights the importance of reliability and validity in ensuring accurate findings, as well as the ethical considerations that guide the research process

3.2 Research Design

A survey research design was used. Structured questionnaires were distributed to capture students' experiences with mathematical reasoning, laboratory access, and motivation. The design enabled efficient data collection from a broad sample, allowing for the identification of recurring patterns and correlations. Watson et al. (2017) highlight that survey methods are particularly effective in educational research for capturing large-scale trends and student perceptions. The survey's practicality and scalability made it ideal for this context, especially given time and resource constraints. Watson et al. (2017) emphasize that surveys are easy to administer and analyse, supporting timely synthesis of findings. To enhance response accuracy, the questionnaire was anonymous, reducing social desirability bias and encouraging honest feedback. While surveys may lack depth (Sardar, 2023), this limitation was mitigated by including open-ended items and triangulating results with qualitative data from teacher interviews. Pilarska (2021) notes that such integration aligns well with constructivist paradigms, allowing researchers to interpret subjective experiences while identifying broader trends. This approach ensured a balanced understanding of both individual challenges and systemic patterns in chemistry education.

3.2 Research Paradigm

The constructivist paradigm was adopted in this study. It supported the exploration of students' lived experiences by emphasizing the contextual and subjective nature of learning. This approach enabled the researcher to interpret how students understood and navigated the challenges they faced in chemistry. The paradigm encouraged rich, detailed data collection through participant engagement, offering insights that aligned with educational inquiry (Pilarska, 2021). It also facilitated trust and collaboration during the research process. However, as stated by Sardar (2023) the paradigm sometimes poses limitations such as potential researcher bias and restricted generalizability. These were addressed by maintaining a reflexive journal to monitor personal assumptions and using member checking to verify findings with participants. These strategies strengthened the credibility and authenticity of the results.

3.3 Research Methodology

A mixed methods approach was used in the study. This methodology integrated both quantitative and qualitative techniques, enabling the researcher to capture statistical trends alongside students' personal experiences. The approach enhanced the depth and breadth of the findings, offering a more holistic understanding of the research problem (Dawadi, Shrestha, & Giri, 2021). One key advantage of this methodology is the triangulation of data, which improves the validity of results by allowing cross-verification between numerical patterns and narrative insights (Timans, Wouters, & Heilbron, 2019. It also provided flexibility in addressing complex educational issues that could not be fully understood through a single method. HoweChart he approach presented challenges, including the increased time and resources required for data integration and the potential for methodological imbalance. These were addressed by clearly defining the sequencing of data collection and using a convergent design to ensure equal emphasis on both strands. This strategy supported coherence and strengthened the inherent power of the study.

3.4 Population and Sampling

Understanding who participates in a study and how they are selected is fundamental to ensuring the relevance and reliability of the research findings. In this regard, identifying the appropriate population and employing a robust sampling strategy are crucial steps.

3.4.1 Population

The population of the study comprised chemistry students and teachers at Golden Heights High School. Participants were selected based on their direct involvement in chemistry instruction and learning. This group included individuals with varied academic backgrounds and classroom experiences, offering a broad perspective on the challenges faced in studying chemistry.

3.4.2 Sampling

Simple random sampling was used in this study. This method was used to select five chemistry teachers and twenty chemistry students, ensuring that each individual had an equal chance of being chosen. The approach was advantageous due to its simplicity and ability to reduce selection bias, thereby enhancing the representativeness of the sample (Shah, 2023). Willie (2024) asserts that this sampling method facilitates straightforward statistical analysis which supports the validity of the findings. However, the method had limitations. It required a complete and accessible sampling frame, which was not readily available. Additionally, it was less effective in capturing subgroup variations within the population. These challenges were addressed by compiling a verified list of eligible participants in advance and stratifying the sample pool before random selection to ensure balanced representation across key characteristics.

3.5 Data Collection Methods

Effective data collection is central to generating meaningful insights in research. This study employed a combination of tools to gather both quantitative and qualitative information, ensuring a well-rounded understanding of the challenges students face in learning chemistry

3.5.1 In-depth Interviews

In-depth interviews were used in the study. The interviews were conducted with teachers to uncover the specific difficulties their students encountered. The advantage of this method is that it captures rich, nuanced data that quantitative approaches might have overlooked, offering a comprehensive understanding of participants' experiences (Deterding & Waters, 2021). The flexibility of in-depth interviews also allows the researcher to adapt questions based on responses (Knott et al., 2022). Establishing rapport with participants encouraged openness, particularly when discussing sensitive or complex issues. However, the method presented certain challenges. According to Coleman (2019), in-depth interviews can be time-consuming both for researchers and participants. Additionally, they may introduce interviewer bias if reflexivity is not maintained. These limitations were addressed by scheduling interviews with adequate time buffers, using a semi-structured guide to maintain consistency, and keeping a reflexive journal to monitor the researcher's influence on the data collection process. These strategies helped ensure the credibility and ethical integrity of the findings.

3.5.2 Questionnaire

A questionnaire was utilised in the research. It was distributed to students to capture their perspectives on the difficulties they encountered. This method allowed for efficient data collection from a large number of respondents, enhancing the generalizability of the findings (Taherdoost, 2022). The questionnaire was easy to administer and analyse. This enabled the timely synthesis of results. Its anonymous format encouraged honest responses, which contributed to more accurate insights into students' experiences. However, as Rahman (2024) notes, questionnaires may limit the depth of responses and can be affected by misinterpretation of questions. To address these issues, the questionnaire was piloted to refine clarity and structure, and closed-ended items were supplemented with optional open-ended questions to allow for elaboration where necessary.

3.6 Data Analysis Methods

Visualization was used in this study as a method of data analysis. It enabled the researcher to present complex information in accessible formats, such as charts and graphs, making patterns and trends easier to interpret. This approach simplifies the analysis process and supports quicker comprehension of findings by both academic and non-specialist audiences (Kennedy & Allen, 2017; Koh et al., 2024). Visualization also enhanced the communication of results by offering a visually engaging medium that highlighted key insights effectively. However, as Unwin (2020) notes, visualizations can sometimes oversimplify data or lead to misinterpretation if not carefully designed. To address these concerns, the researcher employed clear labelling, consistent scales, and triangulated visual outputs with descriptive statistics to ensure accuracy and clarity in interpretation.

Thematic analysis was also used to analyse the interview data. This method enabled the researcher to identify recurring patterns in participants' responses and interpret the underlying meanings. Verbatim quotes were included to preserve the authenticity of participants' voices and to illustrate key themes. These themes were then supported with relevant literature to strengthen the interpretation and situate findings within existing research (Braun & Clarke, 2019). Thematic analysis offered flexibility and depth, allowing for a nuanced understanding of the challenges students faced in learning chemistry.

3.7 Reliability and Validity

Reliability was ensured in this study by using established measurement tools and conducting a pilot test of the questionnaire to identify and correct inconsistencies before the main data collection. This approach helped confirm that the instrument produced stable and consistent results under similar conditions as recommended by Cohen, Manion, and Morrison (2017). Validity was strengthened in this study through multiple strategies aimed at ensuring the questionnaire accurately captured the challenges students faced in learning chemistry... To further enhance content and construct validity, the researcher conducted a pilot test and used cognitive interviewing techniques, a method recommended by Willis (2015), to assess how students interpreted each question. This helped identify ambiguous wording and ensured that items were understood as intended.

3.8 Ethical Issues

The study was conducted after obtaining a permission letter from the university and approval from the school, ensuring compliance with institutional guidelines. Informed consent was obtained from all participants, with the study's purpose, procedures, and their right to withdraw at any time clearly explained. Confidentiality of information was maintained by securely storing personal data and using it solely for research purposes. These measures fostered trust and respect between the researcher and participants throughout the study.

3.9 Chapter Summary

In summary, the study utilised a survey research design to collect quantitative data, supplemented by qualitative insights from in-depth interviews with teachers. Simple random sampling was employed to select participants, ensuring a representative sample of both chemistry teachers and students. Data collection included questionnaires designed to capture students' perspectives on their challenges. Measures to ensure reliability and validity were implemented, alongside ethical considerations to protect participants' rights, ultimately aiming to enhance understanding and improve chemistry education outcomes.

CHAPTER 4: DATA PRESENTATION, ANALYSIS AND DISCUSSION/INTERPRETATION

4.0 Introduction

This chapter presents the findings of the study, analysing data on student engagement, teaching methods, and chemistry learning challenges. It highlights key issues such as mathematical difficulties, laboratory resource constraints, interdisciplinary learning struggles, and motivation concerns. Additionally, it examines effective teaching strategies, including multimedia integration, peer collaboration, and expert consultancy. Proposed interventions focus on improving student retention and performance through enhanced support resources, active learning, and motivational approaches. The findings provide a foundation for targeted improvements in chemistry education, aligning with scholarly perspectives and academic best practices.

4.2 Response Rate

The response rate reflects full participation from all selected respondents, indicating strong engagement with the research process. This high level of involvement enhances the credibility of the findings and suggests that the data accurately represent the experiences and perspectives of both students and teachers. Table 4.1 below shows the number of planned and completed responses for both questionnaires and interviews.

Table 4.1 Response Rate

Instrument	Planned	Completed	Percentage Response
Questionnaires	20	20	100%
Interviews	5	5	100%
Total	25	25	100%

The response rate for the study was 100%, with all 20 students completing the questionnaires and all 5 teachers participating in interviews. This high level of engagement ensures that the findings accurately reflect the perspectives of both students and educators. A response rate above 60% is generally considered strong in academic research, indicating reliable and meaningful data collection

4.3 Demographic Information of Respondents

Understanding the demographic profile of participants is crucial for contextualizing the study's findings. Gender and age distribution offer insights into the diversity of experiences and learning needs among students and teachers.

4.3.1 Gender Distribution

While gender was not the primary focus of the study, subtle differences in engagement and perception suggest that gender dynamics may influence how students interact with chemistry content and pedagogy. Figure 4.1 below presents the gender distribution of respondents.

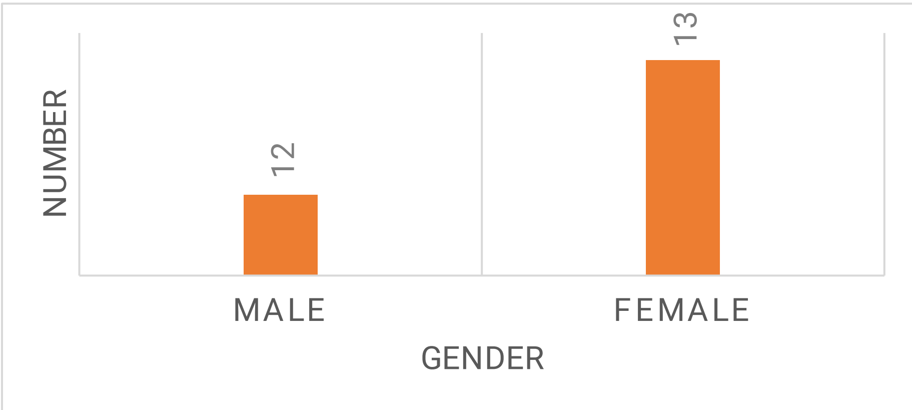

Figure 4.1: Gender Distribution

The gender distribution of the study participants consists of 48% males and 52% females, indicating a nearly balanced representation. This distribution allows for diverse perspectives on chemistry learning challenges and preferred teaching methods.

4.3.2 Age Distribution

Age-related factors appeared to shape students' preferences for instructional methods and their ability to articulate learning challenges. Figure 4.2 below presents the age distribution of respondents.

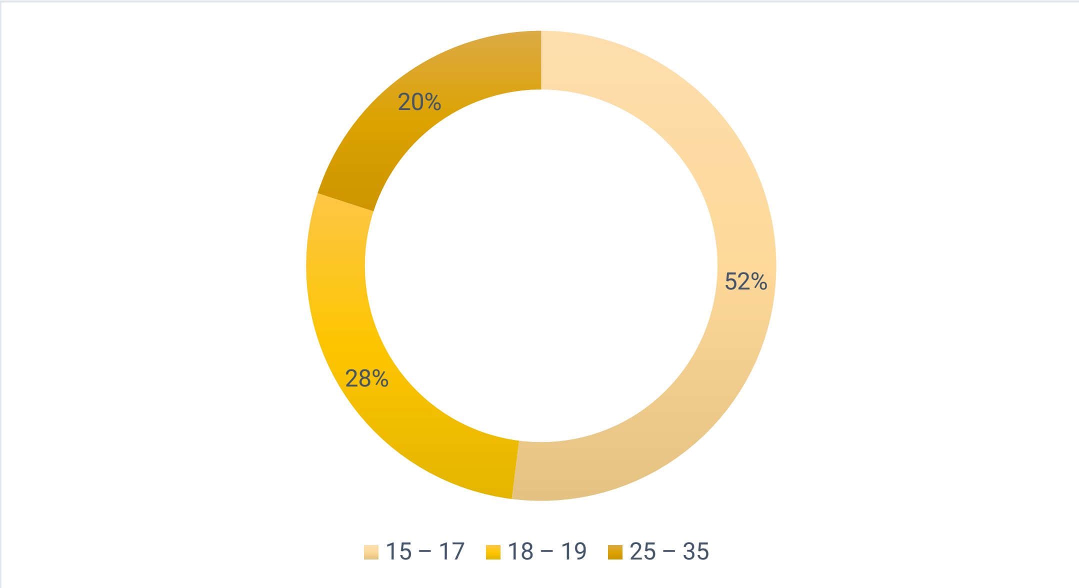

Figure 4.2: Age Distribution

The age distribution of respondents indicates that 52% are between 15 and 17 years old, forming the largest group. 28% fall within the 18 to 19-year-old category, representing a significant portion transitioning into higher education levels. The remaining 20% belong to the 25 to 35-year-old range, comprising individuals likely engaged in professional or continuing education. Since the study includes both teachers and students, this varied demographic provides insights into different learning needs and perspectives on chemistry education.

4.4 Challenges Faced by Students

Teachers and students highlighted areas of concern. The key issues include mathematical reasoning, laboratory access, terminology, interdisciplinary integration, and motivation. These challenges are examined through student responses and teacher interviews, offering a nuanced understanding of how various factors interact to hinder learning.

4.4.1 Questionnaire Responses

Various themes emerged from the student questionnaires, reflecting a wide range of experiences and perceptions regarding chemistry learning. Students expressed challenges related to mathematical reasoning, laboratory access, terminology, interdisciplinary integration, and motivation. Figure 4.3 below summarizes the main difficulties students reported in studying chemistry.

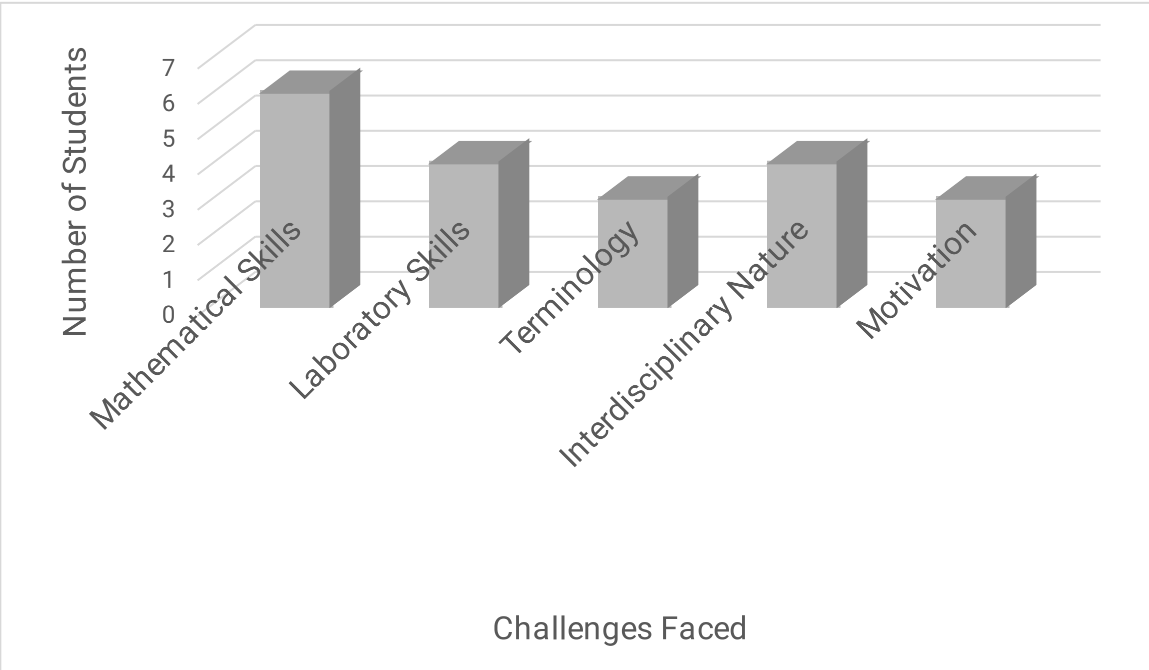

Figure 4.3 Challenges Faced by Students

The findings show that 30% of students face difficulties due to mathematical skills. They mentioned how they struggle with calculations and formula applications. 20% encounter challenges with laboratory skills, particularly practical experiments and handling equipment. 15% of students struggle with chemistry terminology. They mentioned that they find technical language overwhelming. 20% experience difficulties with interdisciplinary connections. They sometimes fail to link chemistry with other subjects. Lastly, 15% of students report motivation issues. They cited a lack of interest and engagement. These results highlight the need for targeted interventions to enhance comprehension, confidence, and resource accessibility in chemistry education.

4.4.2 Complex Calculations

The findings indicate that students struggle with complex calculations and the need to memorize chemistry formulas, which affects their confidence and performance. One respondent shared;

> *"Students often find it difficult to apply mathematical principles in chemistry, especially when dealing with equations and conversions."*

Another respondent noted;

> *"Many learners struggle with recalling formulas accurately, making problem-solving challenging."*

A third respondent added;

> *"Memorization without understanding leads to mistakes during assessments, as students rely on rote learning rather than conceptual grasp…. Even simple mole calculations become overwhelming when students lack foundational math skills."*

Johnson (2018) concurs that mathematics plays a fundamental role in chemistry, particularly in quantitative analysis, reaction rates, and stoichiometry. He asserts that proficiency in mathematical concepts directly impacts a student's ability to navigate chemistry coursework successfully. This reinforces the importance of strong mathematical foundations in chemistry learning. Brown (2019) also acknowledges the impact of foundational knowledge gaps in STEM subjects, arguing that weak mathematical skills create significant barriers to learning chemistry effectively. He suggests reinforcing mathematical concepts early in science education to mitigate these challenges.

4.4.3 Inadequate Equipment

The findings indicate that students face challenges in developing laboratory skills due to a shortage of resources and limited access to diverse chemicals, which affects their practical grasp of chemistry concepts. One respondent shared;

> *"Students often struggle with hands-on experiments because our lab lacks essential chemicals. This prevents them from fully understanding reaction mechanisms."*

Another respondent noted;

> *"Practical work should reinforce theoretical concepts, but the absence of necessary reagents forces us to rely on demonstrations rather than student participation."*

A third respondent explained;

> *"Many students are eager to experiment, yet the limited supply of basic chemicals means they rarely get the opportunity to conduct individual tests."*

A another respondent stated;

> *"Without sufficient materials, practical lessons become more theoretical, reducing student engagement and limiting skill development in laboratory techniques."*

Supporting this, Patel (2020) highlights that access to laboratory resources is crucial for effective chemistry education, emphasizing that inadequate supplies hinder students' ability to develop experimental competence and reinforce theoretical knowledge. In support, Harris (2016) discusses the relationship between laboratory resources and student performance, emphasizing that hands-on experiments improve conceptual understanding and critical thinking. He advocates for increased investment in laboratory infrastructure to enhance scientific learning.

4.4.4 Interdisciplinary Learning

The findings indicate that some students struggle with the interdisciplinary nature of chemistry, particularly in harmonizing its connections with biology and other sciences. One respondent shared;

> *"Many students fail to see how chemistry complements biology, especially in areas like biochemistry and molecular interactions."*

Another respondent noted;

> *"Students often treat subjects separately rather than integrating concepts, which leads to difficulties in understanding broader scientific principles."*

A third respondent explained;

> *"The overlap between chemistry and physics, such as thermodynamics and atomic structure, can be confusing for students who compartmentalize learning rather than seeing the connections."*

A final respondent stated;

> *"Without interdisciplinary integration, students struggle with real-world applications of chemistry, making problem-solving in science more difficult."*

Supporting this, Thompson (2017) acknowledges that chemistry serves as a foundational subject that interlinks various scientific disciplines, emphasizing that difficulties in interdisciplinary learning can hinder students' ability to grasp scientific concepts holistically. Stevens (2018) acknowledges interdisciplinary learning in STEM education and highlights the need for integrated teaching models that connect chemistry with biology and physics to improve student comprehension.

4.4.5 Motivation

The findings indicate that chemistry is one of the least popular subjects at the school, with only a small number of students choosing to pursue it at A-level. Its reputation as a difficult subject has been reinforced by instances of students struggling and failing the course. One educator respondent shared;

> *"Many students perceive chemistry as too challenging, which discourages them from selecting it as a subject for advanced studies."*

Another respondent noted;

> *"Low enrolment at A-level is partly due to past students struggling with the subject, creating a cycle where newer students fear taking chemistry."*

A third respondent explained;

> *"Some students develop anxiety about chemistry even before taking the subject because they hear stories of others failing."*

A final respondent stated;

> *"The complexity of chemistry, combined with its reliance on mathematical concepts, makes students hesitant to pursue it beyond the required level."*

Supporting this, Williams (2016) observes that chemistry has long been regarded as one of the more demanding sciences, emphasizing that student perceptions of difficulty play a significant role in enrolment trends and academic performance. Grant (2017) concurs about the role of motivation in science education, emphasizing that student perceptions of difficulty influence learning attitudes. He argues that fostering a growth mindset and resilience is key to improving retention in complex subjects like chemistry.

4.5. The Impact of Teaching Methods

Teaching methods significantly shape students' engagement and comprehension in chemistry. Teacher and student perspectives were reviewed in order to evaluate the effectiveness of different instructional strategies.

4.5.1 Questionnaire Responses

Students shared diverse opinions on their preferred teaching methods in chemistry, highlighting the instructional strategies that most effectively support their learning. The questionnaire responses revealed a strong preference for practical experiments, visual aids, peer collaboration, and clear teacher explanations. Figure 4.4 below displays students' preferred teaching methods in chemistry.

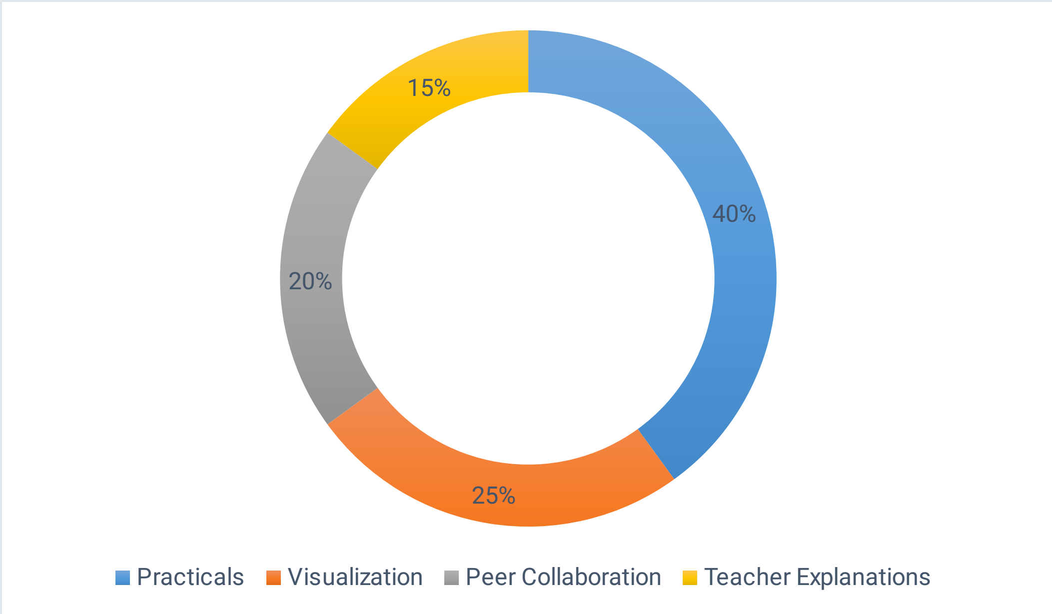

Figure 4.4 Student Preferred Teaching Methods

Students were asked their preferred teaching methods in chemistry. The findings indicate that 25% of students preferred visualization techniques, such as charts, diagrams, and multimedia tools, to enhance their understanding of chemistry concepts. 40% favoured practicals. They highlighted that hands-on experiments are the most effective method for learning. 20% of students preferred peer collaboration, valuing group discussions and teamwork in problem-solving. 15% relied on teacher explanations, appreciating structured guidance for complex topics. These preferences suggest that incorporating more visual aids and interactive approaches could improve engagement and comprehension in chemistry education.

4.5.2 Diverse Teaching Styles

The findings indicate that while diversifying teaching methods is crucial for enhancing chemistry learning, time constraints often limit the ability to fully address each student's unique learning needs. One respondent shared;

"We try to incorporate different instructional techniques, but there is rarely enough time to personalize lessons for every student."

Another respondent noted;

"Some students benefit from visualization tools, while others prefer hands-on experiments, yet managing this balance within limited lesson periods is challenging."

A third educator respondent explained;

"We recognize that every student has a distinct learning style, but pacing the syllabus while ensuring inclusivity remains a struggle."

A final respondent stated;

"While we aim to diversify approaches, practical limitations like time and resources make it difficult to fully support individualized learning methods."

Carter (2015) acknowledges that accommodating diverse learning styles in science education is ideal, but practical constraints such as class duration and curriculum requirements often hinder full implementation. Richards (2019) supports the idea that diverse teaching strategies improve student engagement by catering to different cognitive processes, reinforcing the need for adaptable lesson designs in science education.

4.5.3 Motivation

The findings indicate that motivational teaching plays a significant role in encouraging students who show enthusiasm for chemistry, helping them to stay engaged and excel in the subject. One respondent shared;

"When we notice a student who is genuinely interested in chemistry, we make a conscious effort to support and encourage them to deepen their understanding."

Another respondent noted;

"Providing incentives, such as recognition for outstanding performance, has

helped some students remain committed to their chemistry studies."

A third respondent explained;

> *"Students respond positively when their enthusiasm is acknowledged, and this encouragement has led some to pursue chemistry beyond the required levels."*

A final respondent stated;

> *"Motivating students who already show interest is an effective strategy, although its success depends on the individual student's level of commitment."*

Robinson (2018) supports the view that fostering student motivation through encouragement and academic incentives can enhance learning outcomes, especially in subjects perceived as challenging like chemistry. Taylor (2017) concurs that the correlation between motivation and academic performance, noting that students who receive consistent encouragement are more likely to excel in challenging subjects like chemistry.

4.5.4 Supplementary Lessons

The findings indicate that offering extra lessons has been a strategy to provide students with additional learning time beyond regular class sessions. However, balancing these sessions with other academic commitments remains a challenge. One respondent shared;

> *"Extra lessons help reinforce difficult concepts, but students often struggle to find time due to their workload in other subjects."*

Another respondent noted;

> *"We try to use extra lessons effectively, but scheduling conflicts and student fatigue sometimes limit their impact."*

A third respondent explained;

> *"While additional sessions allow for deeper exploration of chemistry, students*

must also manage their time wisely across different subjects."

A final respondent stated;

> *"Not all students can attend extra lessons consistently, which affects the overall effectiveness of this approach."*

Miller (2017) acknowledges that supplementary lessons can enhance subject comprehension, yet time constraints and competing academic priorities often limit student participation. Davies (2018) confirms the role of supplementary lessons in science education, arguing that structured reinforcement outside standard coursework significantly improves student retention and confidence.

4.6 Strategies for Improvement

Improving student retention and performance in chemistry requires a multifaceted approach. Various strategies have been cited by the respondents. Some of the recommended strategies include technology integration, peer collaboration, motivational incentives, and expert-led support.

4.6.1 Questionnaire Responses

Students expressed a variety of ideas regarding strategies to improve retention and performance in chemistry. Their responses emphasized the value of technology integration, collaborative study groups, motivational incentives, and access to support resources. Figure 4.5 below outlines students' suggested strategies to improve chemistry learning.

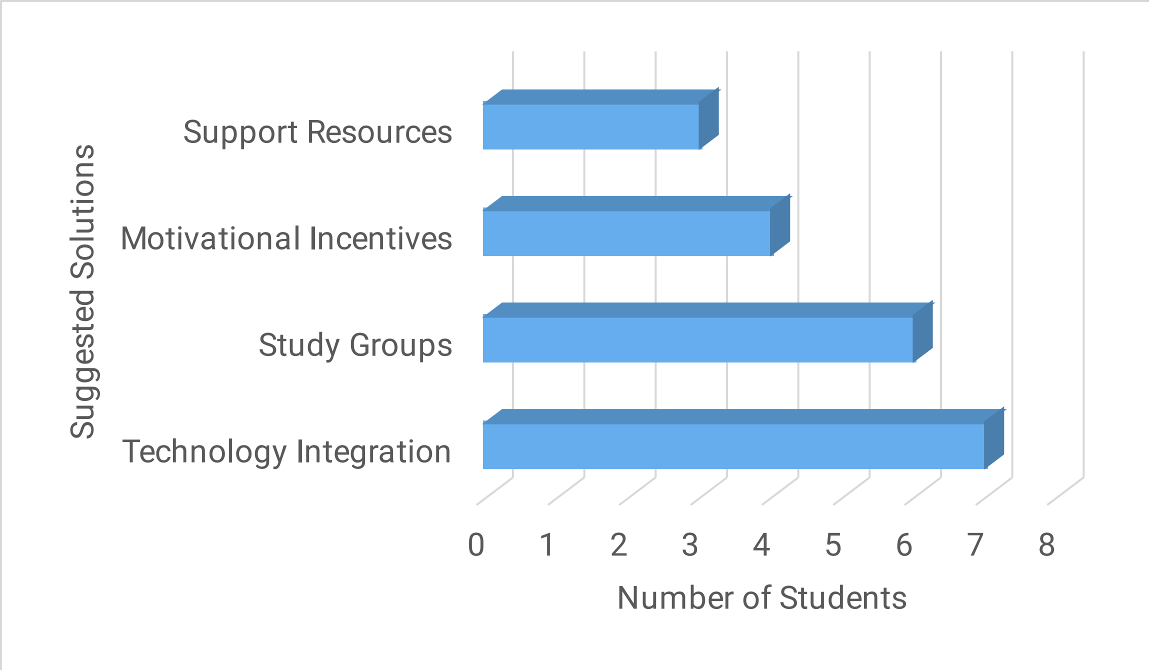

Figure 4.5 Strategies to Enhance Retention and Performance

The findings reveal that 35% of the respondents believe that integrating various technologies, such as multimedia tools and interactive platforms, could significantly enhance chemistry learning. Another 30% indicated that forming study groups focused on chemistry would be beneficial for improving comprehension and retention. Additionally, 20% suggested that motivational incentives, such as academic rewards or recognition, could help increase engagement. The remaining 15% emphasized the importance of access to additional support resources, including tutoring and reference materials. These insights highlight the need for diverse strategies to optimize student success in chemistry education.

4.6.2 Use of Multimedia

The findings indicate that incorporating multimedia tools, such as videos, internet resources, and digital platforms, has become increasingly valuable in enhancing chemistry learning. This approach supports diverse learning styles and improves student engagement. One respondent teacher shared;

> *"Using videos to illustrate complex chemical reactions has helped students visualize processes that are otherwise difficult to grasp."*

Another respondent noted,

> *"Digital simulations allow students to experiment virtually, making up for limited access to laboratory resources."*

A third respondent explained;

> *"Online platforms provide interactive exercises that reinforce key chemistry concepts, encouraging independent learning beyond the classroom."*

A final respondent stated;

> *"Multimedia resources have proven effective, but integrating them consistently within the curriculum requires careful planning and accessibility."*

Supporting this, Anderson (2021) emphasizes that multimedia tools enhance conceptual understanding in science education by providing dynamic visualizations and interactive learning experiences, which can bridge gaps in traditional teaching methods. Nelson (2021) concurs that technology-enhanced learning improves knowledge retention in STEM education, stating that digital tools create immersive environments that support diverse learning styles.

4.6.3 The Use of Active Teaching Methods

The findings indicate that emphasizing collaborative and active learning methods enhances student engagement and improves comprehension in chemistry. Interactive approaches encourage participation and deeper understanding of complex topics. One respondent shared;

> *"Group discussions allow students to exchange ideas and clarify concepts, making learning more dynamic and meaningful."*

Another respondent noted;

"Hands-on activities and peer collaborations foster critical thinking, helping students approach chemistry problems with confidence."

A third respondent explained;

"Active learning strategies, such as problem-solving exercises and inquiry-based learning, encourage students to explore chemistry concepts beyond rote memorization."

A final respondent stated;

"While collaborative methods are effective, ensuring that all students engage equally remains a challenge, requiring careful facilitation."

Bennett (2020) supports the perspective that active and collaborative learning significantly enhances knowledge retention in science education, as students learn best when actively involved in the process rather than passively receiving information. Mason (2018) affirms the role of collaborative learning in chemistry education, stating that study groups improve conceptual understanding and provide social support that enhances academic motivation.

4.6.4 Expert Consultancy

The findings indicate that inviting examiners and subject-matter experts to conduct seminars can significantly enhance student understanding and performance in chemistry. Direct engagement with specialists offers valuable insights and exam-focused guidance. One respondent shared;

"Students benefit immensely when examiners explain common mistakes and best practices for answering chemistry questions effectively."

Another respondent noted;

"Having experts share real-world applications of chemistry helps students connect classroom learning with industry practices, making the subject more engaging."

A third respondent explained;

"Specialized seminars provide clarity on complex topics, allowing students to hear different approaches to problem-solving beyond standard teaching methods."

A final respondent stated;

"While expert-led sessions are highly beneficial, organizing them consistently requires institutional support and investment in the subject."

Reynolds (2019) confirms that expert-led interventions and examiner workshops contribute to improved academic outcomes, as students gain direct exposure to subject expectations and real-world applications. Rogers (2016) supports the need for expert-led seminars in STEM education, arguing that students benefit from specialized knowledge that enhances conceptual clarity and exam performance.

4.6.5 Promoting Self Efficacy

The findings indicate that promoting self-efficacy and ensuring student motivation are crucial for improving engagement in chemistry learning. Encouraging students to actively participate and develop confidence in their abilities fosters better academic outcomes. One respondent shared;

"Students perform better when they are encouraged to take ownership of their learning and apply problem-solving strategies independently."

Another respondent noted;

"Building student confidence in chemistry requires creating an environment where they feel capable of tackling challenges without fear of failure."

A third respondent explained;

"Motivation improves when students see progress in their understanding, making them more willing to engage in complex chemistry concepts."

A final respondent stated;

"Supporting students in developing a growth mindset is key. This helps them recognize that mastery comes with effort and persistence."

Supporting this, Zimmerman (2017) emphasizes that self-efficacy is a strong predictor of academic success, highlighting that students who believe in their ability to succeed are more likely to persist in challenging subjects like chemistry. Lawson (2020) acknowledges the role of self-efficacy in science education, highlighting that students with higher confidence levels in their abilities demonstrate improved persistence and academic success.

4.7 Discussion

The findings show that students face several challenges in studying chemistry, particularly with complex calculations, laboratory limitations, and interdisciplinary connections. Many struggle with applying mathematical principles in chemistry, as formula memorization and conversions can be difficult. Teachers note that laboratory shortages hinder practical learning, forcing students to rely on demonstrations rather than hands-on experiments. Some students also find it challenging to connect chemistry with biology and physics, leading to fragmented understanding. Additionally, low motivation affects student engagement, with chemistry perceived as a difficult subject due to past failures. The findings show that students face several challenges in studying chemistry, particularly with complex calculations, laboratory limitations, and interdisciplinary connections. Many struggle with applying mathematical principles in chemistry, as formula memorization and conversions can be difficult. Teachers note that laboratory shortages hinder practical learning, forcing students to rely on demonstrations rather than hands-on experiments. Some students also find it challenging to connect chemistry with biology and physics, leading to fragmented understanding. Additionally, low motivation affects student engagement, with chemistry perceived as a difficult subject due to past failures. Several scholars support the challenges outlined in chemistry education. Johnson (2018) concurs that mathematical proficiency is essential for mastering chemistry, highlighting its role in quantitative analysis and problem-solving. Patel (2020) acknowledges that laboratory resource shortages hinder students' ability to develop experimental competence, limiting hands-on learning. Thompson (2017) affirms the interdisciplinary nature of chemistry, stating that its connections with biology and physics are crucial for conceptual understanding but can be difficult for students to integrate. Williams (2016) supports the view that chemistry's reputation as a demanding subject affects student enrolment and motivation. Additionally, Zimmerman (2017) confirms that self-efficacy plays a significant role in academic success, reinforcing the need for supportive learning environments. These scholars collectively validate the findings of the study.

The findings indicate that diverse teaching methods significantly impact student engagement and learning outcomes in chemistry. Practical experiments enhance comprehension, allowing students to apply concepts hands-on. Visualization techniques, including multimedia tools, improve understanding of complex processes. Peer collaboration fosters problem-solving and knowledge retention. While teacher explanations provide structured guidance, time constraints often hinder full personalization of lessons. Motivational strategies, such as academic incentives, encourage students to pursue chemistry with confidence. These methods collectively contribute to improved engagement, making chemistry more accessible and increasing overall student performance. Several scholars support the impact of teaching methods on student engagement and learning outcomes in chemistry. Anderson (2021) concurs that multimedia tools enhance conceptual understanding, providing dynamic visualizations that make complex topics more accessible. Bennett (2020) acknowledges the benefits of active learning, highlighting that peer collaboration fosters deeper engagement and improves knowledge retention. Carter (2015) supports the idea that diverse teaching styles are crucial for inclusivity, though time constraints pose challenges. Robinson (2018) reinforces the importance of motivation, stating that academic incentives encourage students to pursue chemistry with confidence.

The findings suggest several strategies to improve student retention and performance in chemistry. Technology integration, such as multimedia tools and interactive platforms, enhances engagement and comprehension. Study groups encourage peer collaboration, reinforcing understanding through discussion and teamwork. Motivational incentives, including academic recognition, boost student confidence and commitment. Access to additional support resources, such as tutoring and reference materials, provides targeted assistance for struggling learners. Expert consultancy, including seminars and examiner insights, helps students align their learning with academic expectations. These interventions collectively aim to create a more supportive and engaging learning environment, fostering long-term success in chemistry education. Several scholars support strategies for improving student retention and performance in chemistry. Anderson (2021) highlights that technology integration, such as multimedia tools, enhances engagement by providing interactive learning experiences. Bennett (2020) affirms the importance of peer collaboration in reinforcing understanding and retention. Robinson (2018) underscores motivational incentives, noting that student recognition fosters confidence and persistence. Reynolds (2019) advocates for expert consultancy, stating that interactions with examiners improve comprehension and academic alignment. Zimmerman (2017) acknowledges the role of support resources in building self-efficacy, asserting that targeted assistance strengthens learning outcomes. Collectively, these scholars validate interventions that create a more engaging and effective chemistry learning environment.

4.8 Summary

In summary, the study highlights key challenges students face in chemistry, including mathematical difficulties, laboratory resource constraints, and interdisciplinary learning struggles. It highlights the importance of diverse teaching methods such as multimedia tools, peer collaboration, and expert consultancy in improving engagement and comprehension. Proposed strategies, including motivational incentives and enhanced support systems, aim to improve student retention and performance. By addressing these challenges with targeted interventions, chemistry education can become more accessible and effective, fostering deeper understanding and academic success.

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter presents the concluding remarks of the study. It draws together key insights from the preceding chapters. It revisits the research objectives and summarizes the major findings and highlights the systemic and pedagogical challenges that hinder student performance in O-Level Chemistry. The chapter also reflects on the implications of these findings for educational practice and policy. In addition, it offers evidence-based recommendations aimed at improving chemistry teaching and learning in under-resourced contexts.

5.1 Summary

Chapter One introduced the study's focus on the challenges affecting student performance in O-Level Chemistry within under-resourced educational contexts. It outlined the problem statement particularly in rural schools. The chapter justified the study's relevance by linking chemistry proficiency to national development goals and STEM career pathways. Key objectives were defined: to identify barriers to effective chemistry learning, explore student and teacher perceptions, and recommend actionable interventions. The significance of the study was framed around improving pedagogical practices and resource allocation. The chapter also briefly described the study's scope, limitations, and assumptions, establishing a foundation for the inquiry. The introduction concluded by positioning the research within broader educational reform efforts.

Chapter Two critically reviewed existing literature on chemistry education. It focused on barriers to student achievement and strategies for improvement. It examined global and regional studies that highlighted issues such as inadequate resources, teacher-centered instruction, and poor mathematical preparedness. The review also explored student attitudes, motivation, and the role of practical work in conceptual understanding. The chapter integrated three theoretical frameworks. The Self-Determination Theory explains how autonomy, competence, and relatedness influence motivation. Intersectionality Theory contextualizes how overlapping social identities affect educational access. The Diffusion of Innovations Theory illuminated how new teaching practices spread within schools. These frameworks provided a lens to interpret findings and guide recommendations. The literature review identified gaps in localized research, particularly in rural Zimbabwean contexts, and justified the study's qualitative approach.

Chapter Three detailed the qualitative methodology employed to explore student and teacher experiences in O-Level Chemistry. A case study design was adopted. The focus of the study was Golden Heights High School in Shamva. Data was collected through semi-structured interviews with students and teachers. This was supplemented by classroom observations and document analysis. The chapter justified qualitative methods as appropriate for capturing nuanced perceptions and contextual realities. Sampling strategies ensured diversity in participant backgrounds, while ethical considerations were rigorously upheld. Thematic analysis was used to interpret data. Reflexivity was emphasized, with the researcher acknowledging positionality and potential biases. The methodology chapter also addressed trustworthiness through triangulation and member checking.

Chapter Four presented and discussed the study's findings, organized into key themes. Students reported difficulty with calculations, abstract concepts, and lack of practical exposure due to insufficient lab materials. Teachers highlighted systemic issues such as overcrowded syllabi, limited professional development, and reliance on traditional teaching methods. Negative student attitudes were found to hinder engagement and performance. The discussion linked these findings to the theoretical frameworks: Self-Determination Theory explained motivational deficits, Intersectionality illuminated how socioeconomic factors shaped access, and Diffusion of Innovations contextualized resistance to pedagogical change. The chapter emphasized the interplay between structural and psychological barriers. It concluded by identifying leverage points for reform, including improved resource allocation, diversified teaching strategies, and motivational support.

Chapter Five provided concluding reflections on the study. It synthesized key findings and reaffirmed that resource limitations, ineffective pedagogical approaches, and negative student attitudes collectively undermine achievement. The chapter emphasized that these barriers are not isolated but interlinked. They require systemic and context-sensitive interventions. Drawing from both empirical data and theoretical insights, the study concluded that improving chemistry education demands more than curriculum reform, it requires investment in infrastructure, teacher support, and student motivation. The chapter presented five targeted recommendations which are strengthening mathematical foundations, enhancing laboratory access, diversifying teaching methods, promoting motivation, and leveraging expert support. These were grounded in the study's findings and designed to be actionable within low-resource settings.

5.2 Conclusions

The study concludes that students at Golden Heights High School face multifaceted challenges in understanding chemistry. Chief among these is the difficulty with mathematical applications, particularly in solving equations and performing conversions. Many students struggle to recall formulas and apply them conceptually. This undermines their confidence and performance. Laboratory limitations further compound these difficulties. The lack of essential chemicals and equipment restricts hands-on experimentation. This forces reliance on demonstrations that fail to reinforce theoretical knowledge. Terminology also emerged as a barrier, with students finding the technical language overwhelming and inaccessible. Additionally, the interdisciplinary nature of chemistry creates confusion for learners who compartmentalize subjects rather than integrating concepts. It overlaps with biology, physics and other subjects. Motivation is another critical factor. Chemistry's reputation as a difficult subject discourages students from pursuing it at advanced levels. These findings suggest that students' difficulties stem from a combination of cognitive, resource-based, and affective challenges.

It is concluded that teaching methods significantly influence students' engagement and comprehension in chemistry. The study found that students respond most positively to practical experiments, which allow them to apply concepts in real-world contexts. Visualization techniques, such as diagrams, multimedia tools, and simulations, also enhance understanding, especially for abstract topics. Peer collaboration fosters deeper engagement, enabling students to clarify concepts through discussion and shared problem-solving. However, teacher explanations remain essential for structured guidance, particularly when introducing complex material. Despite these benefits, time constraints and resource limitations often hinder the full implementation of diverse teaching strategies. Teachers reported difficulty in personalizing instruction due to syllabus pacing and limited lesson periods. Motivational teaching, including recognition and encouragement, was found to sustain interest among enthusiastic learners. Supplementary lessons offer additional support but are constrained by students' academic workload.

The study also concludes that several targeted strategies can enhance student retention and performance in chemistry. Technology integration, such as multimedia tools, simulations, and online platforms, was identified as a key intervention. These resources cater to diverse learning styles and compensate for limited laboratory access. Study groups emerged as another effective strategy. They promote peer collaboration and reinforce understanding through shared learning. Motivational incentives, including academic recognition and encouragement, were found to boost student confidence and commitment. Access to support resources, such as tutoring, reference materials, and expert-led seminars, provides additional scaffolding for struggling learners. Teachers emphasized the value of inviting examiners and specialists to offer exam-focused guidance and real-world applications, which deepens conceptual clarity. Promoting self-efficacy is also crucial; students who feel capable and supported are more likely to persist in chemistry. These strategies collectively foster a more engaging and inclusive learning environment. However, their success depends on institutional commitment, resource availability, and consistent implementation. By adopting these interventions, schools can create a more supportive framework that empowers students to overcome challenges and succeed in chemistry.

5.3 Recommendations

The following recommendations have been made in light of the study;

It is recommended for the government to invest in laboratory infrastructure across secondary schools to support practical chemistry instruction. Limited access to essential chemicals and equipment restricts students' ability to engage in hands-on experimentation, which is vital for reinforcing theoretical knowledge.

Policymakers should revise the national curriculum to ensure that chemistry instruction is supported by foundational mathematics. Many students face challenges in applying mathematical concepts such as formula manipulation, conversions, and quantitative reasoning within chemistry. Embedding interdisciplinary modules that link mathematics and chemistry will help bridge this gap.

Policymakers should establish formal programs that facilitate regular engagement between schools and subject-matter experts, including examiners and industry professionals. Expert-led seminars can provide students with targeted guidance on examination techniques, clarify common misconceptions, and contextualize chemistry within real-world applications.

Teachers should adopt a range of instructional strategies that address diverse learning needs and promote deeper engagement with chemistry content. Approaches such as visualization tools, inquiry-based learning, peer collaboration, and concept mapping can help students grasp abstract concepts more effectively.

Teachers should actively foster student motivation by recognizing academic effort and demonstrating the relevance of chemistry to everyday life and future careers. Strategies may include celebrating achievements, organizing career talks, and integrating real-world applications into lesson content.

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Appendix A: Research Permission Letter

Golden Heights Academy

2370/1

Shamva

04/04/2025

The Project Coordinator

Bindura University of Science Education

Ref: The above school has granted permission to Miss Dzuda to carry out her Research Project.

I, as the deputy Headmaster of Golden Heights Academy have allowed Miss Dzuda to carry out her Research using interviews and student questionnaires at the school premises for her Research Project

Yours faithfully

Mutizwa O. (0776161076)

Golden Heights Academy

04 APR 2025

Cell. 0773 655 176 / 0774 398 370
0772 404 650
2370/1 Golden Heights, Shamva

Appendix B: Interview Guide for Teachers

Data Collection Tool 2: Students

Questionnaire Guide

Respondent Number: ……………………………………………

Age: ………………………….... **Sex:** ……………………………

Date: ……………………………

Preamble

My name is Tariro Dzuda, and I am a student at Bindura University of Science Education (BUSE), studying for a Bachelor of Science Education in Chemistry. The title of my research is "**Exploring Students' Difficulties in Studying Chemistry: Case of Golden Heights High School".** In this section, I will be collecting interview data to understand your opinions and experiences related to chemistry learning.

The information you provide will remain confidential and will be used solely for academic purposes.

Questions

1. **What are the most common challenges students face when learning chemistry in your classes?**
2. **In your experience, which chemistry concepts do students struggle with the most, and why?**
3. **How do your teaching methods impact student engagement and understanding of chemistry?**
4. **What strategies have you found effective in helping students grasp difficult chemistry concepts?**
5. **How do students' attitudes toward chemistry influence their ability to learn and retain information?**
6. **What role do learning resources (textbooks, lab equipment, technology) play in student performance?**
7. **How do you address students who lack confidence in their chemistry abilities or fear the subject?**
8. **What changes or improvements would you recommend to make chemistry education more effective at Golden Heights High School?**

Appendix C: Questionnaire for Students

Data Collection Tool 2: Students

Questionnaire Guide

Respondent Number: ____

Age: ____

Sex: ____

Date: ____

Preamble

My name is Tariro Dzuda, and I am a student at Bindura University of Science Education (BUSE), studying for a Bachelor of Science Education in Chemistry. The title of my research is "**Exploring Students' Difficulties in Studying Chemistry: Case of Golden Heights High School".** In this section, I will be collecting interview data to understand your opinions and experiences related to chemistry learning.

The information you provide will remain confidential and will be used solely for academic purposes.

Questions

1. **What are the biggest challenges you face when studying chemistry?**

Mathematical Skills ☐

Laboratory Skills ☐

Terminology ☐

Interdisciplinary Nature ☐

Motivation ☐

2. **Are there specific chemistry topics or concepts that you struggle with the most?**

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3. How would you describe your level of interest in chemistry? What factors influence your attitude toward the subject?

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4. How do teaching methods in chemistry classes affect your understanding of the subject?

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5. Do you feel confident in your ability to solve chemistry problems? If not, what makes it difficult for you?

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6. What kind of learning resources (textbooks, online materials, lab equipment) do you have access to for studying chemistry? Do they help you learn effectively?

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7. Have you ever used group discussions or peer collaboration to improve your understanding of chemistry? If yes, how effective was it?

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8. What changes or improvements would you suggest to make chemistry education more engaging and easier to understand?

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