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INVESTIGATING THE IMPACT OF IMPROVISED CHEMISTRY EXPERIMENTS ON STUDENTS' UNDERSTANDING AND PERFORMANCE ON THE TEACHING AND LEARNING OF CHEMISTRY AT ORDINARY LEVEL. A CASE STUDY OF CHASIYATENDE SECONDARY SCHOOL.

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DECLARATION

I, ROWAN SIMANGELE TARIRO MHLANGA declare that this research project is my original work and has not been submitted to any other institution for the award of any degree or diploma. All sources of information used have been duly acknowledged.

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ABSTRACT

This study investigated the impact of improvised chemistry experiments on students' understanding and performance at Chasiyatende Secondary School, a rural school in Zimbabwe where limited laboratory resources often hinder effective science instruction. The aim was to examine whether the use of improvised materials could enhance conceptual understanding, increase learner engagement, and improve academic performance in chemistry. A mixed-methods design was employed, incorporating pre- and post-tests, questionnaires, teacher interviews, and classroom observations. Findings revealed a significant improvement in students' performance after exposure to improvised experiments, with post-test scores markedly higher than pre-test results. Learners expressed greater motivation and interest, while teachers observed improved engagement, creativity, and problem-solving abilities. Despite these positive outcomes, the study identified several challenges, including a shortage of suitable materials, time constraints, limited teacher training, and safety concerns. Nonetheless, opportunities such as promoting innovation, resourcefulness, and inclusivity in science learning were also highlighted. The study concludes that improvised chemistry experiments offer a practical and effective strategy for enhancing student learning in resource-limited environments. It recommends strengthening teacher capacity through training, encouraging innovative classroom practices, and integrating improvisation into curriculum implementation to improve the teaching and learning of chemistry in under-resourced schools.

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CHAPTER 1 INTRODUCTION

1.1 Introduction

In the ever-evolving landscape of science education, the role of practical work in enhancing students' understanding and performance remains a subject of continuous exploration. Chemistry, in particular, relies heavily on experimentation to bridge theoretical knowledge and real-world application. However, many schools, especially in resource-constrained environments, face challenges in accessing fully equipped laboratories. In response to these limitations, educators have increasingly turned to improvised chemistry experiments, hands-on activities designed using locally available, low-cost materials as a viable alternative.

This chapter introduces the investigation into the impact of such improvised experiments on students' comprehension and academic performance in chemistry. It outlines the background of the study, articulates the problem statement, and presents the objectives and significance of the research. By examining how improvised experiments influence learning outcomes, this study aims to provide insights into innovative and accessible teaching strategies that can foster deeper engagement and improved achievement in chemistry, especially in under-resourced educational settings.

1.2 Background of the Study

Chemistry is a core science subject in secondary education, contributing to students' scientific literacy and preparing them for careers in medicine, engineering, and environmental science. However, its effective teaching and learning require a combination of theoretical instruction and hands-on practical experiments. Practical work helps students visualize abstract concepts, develop critical thinking skills, and foster a deeper understanding of scientific principles. Unfortunately, many secondary schools, particularly in developing countries like Zimbabwe, face significant challenges in providing adequate laboratory facilities, leading to a heavy reliance on theoretical instruction (Achor et al., 2019).

Many government schools in Zimbabwe, including Chasiyatende Secondary School, operate with limited a budget, which affects their ability to procure laboratory equipment and chemicals. The high cost of standard laboratory materials makes it difficult for schools to maintain fully functional chemistry labs. As a result, students often miss out on practical experiences, which are crucial for understanding chemical reactions, bonding, and other fundamental concepts (Ngololo et al., 2020).

While the Zimbabwean government has made efforts to improve science education through initiatives such as the Science, Technology, Engineering, and Mathematics (STEM) policy, many rural schools continue to struggle with inadequate funding. Science subjects require specialized infrastructure, including laboratories, safety equipment, and a consistent supply of reagents, which many schools cannot afford (Mutambara & Bhebe, 2019). This lack of investment in laboratory resources has led to an increasing gap between students in well-funded urban schools and those in under-resourced rural schools like Chasiyatende.

Also, the scarcity of essential laboratory chemicals and equipment such as Bunsen burners, test tubes, beakers, and reagents severely limit the ability of students to perform experiments. This problem is exacerbated by supply chain issues and limited local production of laboratory-grade chemicals. Teachers are often forced to rely on textbook illustrations rather than actual hands-on demonstrations, making it difficult for students to grasp key concepts (Ogunniyi &Olatoye, 2020).

Improvisation of teaching materials and experimental apparatus has emerged as a creative and adaptable approach, especially in schools with limited infrastructure. Improvised experiments make use of locally available materials to simulate standard laboratory practices, allowing learners to experience hands-on learning despite financial or logistical constraints (Oloruntegbe & Odutuyi, 2013). Several studies have suggested that when appropriately designed and integrated into instruction, improvised experiments can stimulate learners' interest and promote conceptual understanding (Eze, Ezeudu, & Okonkwo, 2015).

More recent investigations emphasize the role of contextual learning in science education, highlighting how culturally relevant and accessible methods of instruction contribute to student motivation and retention of knowledge (Opara & Onyekuru, 2020). Furthermore, the flexibility of improvised resources encourages teachers to adopt student-centered methodologies that improve classroom participation and performance (Adegoke, 2016). However, questions still remain about how consistently these benefits are realized across different learning environments.

The ongoing evolution of science curricula, particularly in developing countries, calls for adaptive strategies that align with local realities while ensuring that core educational outcomes are met. Researchers argue that effective science education requires not only access to resources but also instructional practices that accommodate diverse school settings (Chukwuneke, Okoye, & Ezeudu, 2022). Thus, exploring the specific influence of improvised experiments in Chasiyatende Secondary School. This may provide insights into how localized strategies impact student understanding and academic performance in chemistry.

Another major issue is the high student-to-resource ratio. Even when laboratory facilities are available, they are often insufficient to accommodate the growing number of students. Many governments schools experience overcrowding, making it challenging for teachers to conduct practical experiments for all students. Without individualized attention and hands-on practice, many students struggle to understand complex chemistry topics (Adeosun, 2021).

While some educators have attempted to use improvised instructional materials to counteract laboratory shortages, many lack the necessary training or exposure to effectively implement these methods. Some teachers are unfamiliar with how to design and execute improvised experiments using locally available materials, which limits the widespread adoption of this alternative approach (Mutero et al., 2022).

Due to the lack of practical experiences, many students perceive chemistry as a difficult and abstract subject. Without hands-on learning, students struggle to relate chemistry concepts to real-life situations, leading to low motivation and poor performance in the subject. Many students fail to appreciate the relevance of chemistry in their daily lives, further reducing their interest and engagement (Shumba &Munikwa, 2019).

The challenges highlighted above have led to several negative consequences in the teaching and learning of chemistry at Chasiyatende Secondary School: These problems include; Poor performance in national examinations.

Students at Chasiyatende Secondary School and similar institutions often record low pass rates in chemistry. This is largely attributed to their inability to answer practical-based questions, which require an understanding of experimental procedures and laboratory techniques. Many students struggle with the practical component of science examinations because they have never conducted or observed experiments in real-life situations (Mupa&Chinwada, 2020).

Memorization instead of conceptual understanding.

Without practical exposure, students rely on rote learning rather than developing a true understanding of chemistry concepts. This approach limits their ability to apply knowledge in problem-solving scenarios, reducing their overall scientific competency (Achor et al., 2019).

Another problem is increased educational inequality.The disparity between urban and rural schools continues to grow as students in well-equipped schools gain more hands-on experience, while those in underprivileged schools, such as Chasiyatende, struggle to compete. This educational gap perpetuates inequality, as students from rural schools have lower chances of excelling in science subjects compared to their urban counterparts (Mutero et al., 2022).

Given these challenges, there is a critical need for alternative approaches to chemistry instruction. One promising solution is the use of improvised chemistry experiments, where teachers and students utilize readily available materials such as household products and locally sourced substances to conduct experiments. Studies have shown that improvised instructional materials can enhance students' engagement and comprehension by making science more accessible and relatable (Ogunniyi &Olatoye, 2020).

This study, therefore, aims to explore how implementing improvised chemistry experiments at Chasiyatende Secondary School can improve students' understanding and performance. By evaluating the impact of improvisation, this research seeks to provide a practical, low-cost solution to the problem of inadequate laboratory resources in Zimbabwean secondary schools. If successful, this approach could be recommended for adoption in other under-resourced schools, contributing to improved science education across the country.

1.3 Statement of the Problem

Chemistry is a fundamental science subject that requires both theoretical understanding and practical application. However, many secondary schools in Zimbabwe, particularly rural institutions such as Chasiyatende Secondary School, face significant challenges in providing students with hands-on experimental experiences. The absence of well-equipped laboratories and essential chemicals limits students' ability to conduct experiments, negatively affecting their understanding of abstract concepts and overall performance in the subject (Mupa & Chinwada, 2020).

Key Problems Identified includes, Inadequate Laboratory Facilities. Most government schools in Zimbabwe struggle to provide adequate laboratory facilities due to financial constraints. Chasiyatende Secondary School, like many other rural schools, lacks a fully equipped chemistry laboratory, making it difficult for students to engage in practical work (Mutero et al., 2022). Laboratory experiments play a crucial role in chemistry education, as they help students observe chemical reactions first hand and understand theoretical concepts such as chemical bonding, stoichiometry, and gas laws. The lack of access to practical experiments results in students relying solely on textbook illustrations, leading to superficial learning and poor retention of knowledge (Achor et al., 2019).

Even when laboratory spaces exist, the availability of essential chemicals and equipment remains a major issue. The high cost of purchasing and maintaining laboratory supplies means that many schools operate without fundamental reagents, glassware, and safety equipment (Ngololo et al., 2020). This lack of resources makes it impossible for students to develop laboratory skills, which are essential for excelling in chemistry examinations and future scientific careers.

Studies show that students perform better in science subjects when they actively participate in experiments and hands-on activities (Ogunniyi &Olatoye, 2020). However, at Chasiyatende Secondary School, the reliance on theoretical teaching methods has led to a declining student interest in chemistry. Many students struggle with abstract concepts, leading to high failure rates in national examinations (Mutambara & Bhebe, 2019). Without engaging and interactive learning experiences, students find chemistry difficult and irrelevant to their daily lives.

The lack of practical lessons forces teachers to adopt lecture-based instructional methods, where they explain concepts without demonstrating them through experiments. Research suggests that students learn best through inquiry-based and experiential learning approaches, where they can manipulate materials, make observations, and draw conclusions on their own (Shumba &

Munikwa, 2019). Without this hands-on approach, students struggle to develop essential problem-solving and analytical skills.

Also, the disparity between urban and rural schools in Zimbabwe continues to widen due to differences in resource availability. Urban schools, which are often better funded, provide their students with laboratory experiences that prepare them for higher education and careers in science-related fields. In contrast, students in underprivileged rural schools, such as Chasiyatende, are at a disadvantage, as they lack access to the same quality of science education (Mutero et al., 2022).

A viable solution to the lack of laboratory resources is the use of improvised chemistry experiments. This approach involves utilizing locally available materials such as vinegar, baking soda, lemon juice, and charcoal as substitutes for standard laboratory chemicals. Improvised experiments have been shown to enhance student engagement and understanding of scientific concepts in resource-limited settings (Adeosun, 2021). By incorporating these low-cost experiments into the curriculum, teachers can bridge the gap between theory and practice.

To successfully implement improvised experiments, teachers need specialized training in designing and conducting experiments using alternative materials. Professional development workshops can equip educators with the necessary skills to create engaging practical lessons, even in the absence of conventional laboratory facilities (Ogunniyi &Olatoye, 2020).

In addition to improvised experiments, schools can enhance chemistry education by integrating digital resources such as virtual laboratories, instructional videos, and simulations. These tools can help students visualize chemical processes that they may not be able to observe in real life due to resource constraints (Ngololo et al., 2020).

Also, government policies should prioritize funding for science education, particularly in rural schools. Additionally, partnerships with local industries and non-governmental organizations (NGOs) could provide financial support and donations of laboratory equipment to underprivileged schools (Mutambara & Bhebe,

To add on, teachers should adopt student-centered instructional methods that encourage active participation. Inquiry-based learning, problem-solving activities, and group experiments using improvised materials can improve students' conceptual understanding and motivation (Shumba & Munikwa, 2019).

By addressing these challenges through the implementation of improvised experiments, teacher training, digital tools, and increased funding, this study seeks to enhance chemistry education at Chasiyatende Secondary School. If successful, these strategies could serve as a model for other schools facing similar resource constraints, ultimately improving the quality of science education across Zimbabwe.

1.4 Research Aim

This study aims to investigate the effects of implementing improvised chemistry experiments on students' understanding and performance at Chasiyatende Secondary School.

1.5 Research Objectives

- To assess the impact of improvised chemistry experiments on students' conceptual understanding of key chemistry topics at Chasiyatende Secondary School.
- To evaluate the effect of improvised experiments on students' academic performance by comparing test scores before and after their implementation.
- To identify challenges and opportunities in implementing improvised chemistry experiments in a resource-limited school environment.

1.6 Hypothesis

The implementation of improvised chemistry experiments significantly improves students' understanding and academic performance in chemistry at Chasiyatende Secondary School.

1.7 Significance of the Study

This study is important as it addresses the critical challenge of inadequate laboratory facilities in secondary schools, particularly at Chasiyatende Secondary School. By exploring the use of improvised chemistry experiments, the research provides an innovative, cost-effective solution to enhance students' understanding and performance in chemistry. The findings of this study will have far-reaching benefits for various stakeholders in the education sector.

The study is important because it seeks to bridge the gap between theoretical learning and practical application in chemistry education. Many students in under-resourced schools struggle with abstract chemistry concepts due to the absence of hands-on experiences (Mupa & Chinwada, 2020). By investigating the effectiveness of improvised experiments, this research provides a realistic alternative that ensures all students, regardless of their school's financial standing, have access to practical science education.

This study directly benefits students by improving their conceptual understanding, engagement, and academic performance in chemistry. With improvised experiments, they can develop critical thinking and problem-solving skills essential for higher education and future careers in science-related fields (Ogunniyi & Olatoye, 2020). Chemistry teachers, especially in resource-limited schools, will gain practical knowledge on how to design and implement improvised experiments. This will enhance their instructional methods, making chemistry lessons more interactive and effective (Mutero et al., 2022). The study provides school leaders with insights into cost-effective strategies for improving science education without relying solely on expensive laboratory equipment. The findings can guide policymakers in developing strategies to enhance science education in rural schools. If successful, this approach can be integrated into the national curriculum to ensure equitable access to quality science education (Mutambara & Bhebe, 2019). This study lays the foundation for further research on innovative teaching strategies, contributing to the body of knowledge in science education.

The study is important because it improves student engagement and interest in Chemistry. Practical experiments make learning chemistry more exciting and relatable, leading to increased student motivation and participation in lessons (Shumba & Munikwa, 2019). It also enhances academic performance by providing students with hands-on experiences, the study helps them grasp complex concepts more effectively, leading to better examination results. The use of improvised experiments ensures that students in underprivileged schools receive the same level of practical exposure as their peers in well-equipped urban schools by promoting equity in science education. It also encourages creativity and innovation thus teachers and students will develop creative problem-solving skills by using locally available materials for experiments and also Instead of relying on expensive, imported chemicals and equipment, schools can adopt locally sourced alternatives, making science education more affordable and sustainable.

This study is crucial as many schools in Zimbabwe continue to struggle with limited resources for science education. The demand for STEM (Science, Technology, Engineering, and Mathematics) professionals is growing, yet many students are discouraged from pursuing science careers due to poor exposure to practical experiments. By implementing improvised chemistry experiments, schools can immediately enhance learning experiences and prepare students for future STEM opportunities (Ngololo et al., 2020).

The study has both immediate and long-term impacts. In the short term, it provides a solution to improve chemistry education at Chasiyatende Secondary School, benefiting current students and teachers. In the long term, if successful, the findings can be scaled up to other schools facing similar challenges across Zimbabwe and other developing countries. This approach has the potential to revolutionize science education in resource-limited settings, ensuring that all students receive quality practical training regardless of their school's financial status (Achor et al., 2019).

1.8 Delimitation

This study is confined to Chasiyatende Secondary School in Chivi District, Masvingo Province. The study is conducted in a rural school where students face challenges due to a lack of standard laboratory equipment. The findings, however, may be applicable to other resource-limited schools in Zimbabwe and beyond. Urban schools typically have better access to laboratory resources; therefore, this study does not include them to maintain focus on under-resourced institutions. In addition, the study only investigates chemistry education, as chemistry is highly dependent on laboratory experiments compared to other subjects. Also, the research concentrates on topics that require experimental verification, such as chemical reactions, acids and bases, and stoichiometry. Topics that do not rely on practical experiments, such as atomic theory and nomenclature, are not the primary focus. The study involves Form 3 and Form 4 students, as they are at a critical stage of preparing for national examinations. Lower-level students (Form 1 and Form 2) are excluded because their curriculum is more foundational and less dependent on laboratory work. To measure the impact of improvised experiments, students are divided into two groups: one experiencing improvised practical lessons and the other following the traditional theory-based approach. The research is conducted over a three-month period, allowing sufficient time for implementing improvised experiments and assessing their impact.

The choice of a government school is deliberate; as such institutions often face resource constraints, making them ideal settings to explore the viability of improvised instructional materials. Chasiyatende Secondary School represents the challenges faced by many other public institutions in Zimbabwe. The findings from this study can help policymakers design cost-effective strategies that can be applied to multiple government schools, ensuring a wider. The Zimbabwean government has emphasized the importance of STEM education, and this study supports efforts to enhance science teaching in rural schools.

By defining these boundaries, the study remains focused, manageable, and relevant, ensuring that the findings contribute to practical solutions for improving chemistry education in resource-limited settings.

1.9 Organisation of the Study

This study is structured into five chapters, each contributing to a comprehensive understanding of the impact of improvised chemistry experiments on students' learning and performance at Chasiyatende Secondary School. The organization ensures a logical flow from problem identification to data analysis and interpretation.

Chapter One presents the introduction, which outlines the research background, statement of the problem, research aim, objectives, and hypotheses. It also highlights the significance, limitations, and delimitations of the study, along with definitions of key terms. This chapter sets the foundation by explaining the need for investigating improvised chemistry experiments and their potential to improve science education in resource-limited schools.

Chapter Two is the literature review, which explores previous studies related to the use of improvised teaching materials in science education. It examines theoretical frameworks supporting hands-on learning and practical experiments, including constructivist and experiential learning theories. Additionally, the chapter discusses findings from global and regional studies on improvised experiments, highlighting gaps in research that this study aims to address.

Chapter Three details the research methodology, describing the design, population, sample selection, and data collection methods. The study employs a quasi-experimental design, with a control group (traditional teaching) and an experimental group (improvised experiments). The chapter also outlines the research instruments, such as pre-tests, post-tests, and student/teacher interviews. Ethical considerations, reliability, and validity of the study are also discussed.

Chapter Four presents the data analysis, findings, and discussion. Quantitative data from test scores is analyzed to determine whether students in the experimental group performed better than those in the control group. Qualitative data from student and teacher feedback is also examined to assess engagement, attitudes, and perceived challenges of using improvised experiments. The findings are compared with existing literature to draw meaningful conclusions.

Chapter Five concludes the study with a summary of findings, conclusions, and recommendations. It highlights key results and their implications for students, teachers, school administrators, and policymakers. The chapter also suggests areas for future research, such as expanding the study to multiple schools or investigating the long-term effects of improvised experiments on students' interest in Chemistry.

Overall, this structured approach ensures a clear, systematic investigation, providing valuable insights into the effectiveness of improvised chemistry experiments in improving students' understanding and performance.

1.10 Chapter Summary

Chapter One introduced the study by examining the persistent issue of limited laboratory resources in schools like Chasiyatende Secondary school and how this affects students' performance in chemistry. It highlighted the need for alternative teaching strategies, such as improvised experiments, to bridge the gap between theory and practice. The chapter established the statement to the problem, identifying the challenges teachers face and how improvisation may serve as a solution to enhance student engagement and conceptual understanding.

It outlined the specific aims and research objectives guiding the investigation, while also explaining the significance of the study to improving science education in resource-constrained settings. Additionally, the chapter presented the underlying, scope (delimitations), of the research.

In essence, the chapter laid the ground work for exploring practical, low-cost approaches to science teaching in under-resourced environments.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

In this chapter, the researcher explains the effects of implementing improvisation of chemistry experiments on the performance of learners in chemistry. In this regard, the writer will focus on the availability of improvised materials and conduct an experiment to test the level of understanding of key topics taught using improvised materials and those taught without improvised materials. Literature on challenges and opportunities in implementing improvised chemistry experiments in a resource-limited school environment will be reviewed.

2.2 Theoretical Framework

This study is guided by Jerome Bruner's theory of instruction and the social constructivist theory both of which emphasizes active, meaningful learning through interaction with the environment and others.

2.2.1 Jerome Bruner’s Learning Theory

Bruner introduced the concept of learning by discovery. Bruner is of the view that learning is effectively engaged in if the learner is giving the opportunity to discover facts by him/herself. Bruner argues that mere presentation of information will not enhance effective solution of a problem. The theory stresses cognitive effectiveness. Because of this, some referred to Bruner’s theory of learning as Bruner’s theory of cognitive development. Bruner believed that learning by discovery begins when science teacher purposefully (intentionally) creates (present) a problem and present it to the students by introducing some inconsistencies (contradictions) among source of information which are giving in the process of instruction. According to Bruner such inconsistencies lead to intellectual discomfort that will stimulate (motivate) the students to initiate individual discoveries through cognitive restructuring (internal reorganization).

2.2.2 Social constructivism theory

The theoretical framework for this study is social constructivism, a theory developed by Lev Vygotsky and Jean Piaget (Richardson, 2005). Constructivism aspects in educational foundation are to construct knowledge of the learners through social and cognitive processes. Ground the discussion in educational theory, referencing thinkers like Piaget and Vygotsky, who provide a strong epistemological basis for constructivism. This perspective emphasizes the importance of social interaction and collaboration in learning, providing valuable insights into effective teaching and learning strategies for science education (Waks, 2024). Social constructivism provides educators with a framework for creating, engaging and effective learning experiences that support students' cognitive growth. Therefore, practical sessions serve as a valuable complement to theoretical instruction in chemistry, enabling students to apply their knowledge and develop a deeper understanding of complex concepts. Active student engagement in chemistry lessons is crucial for developing crucial science skills, as it fosters an understanding of chemical reactions and their real-world applications. According to social constructivism, social elements influence the way groups of individuals construct their understanding and formal knowledge while engaged in learning processes.

2.3 Improvised Instructional materials

Improvised instructional materials are teaching materials designed and produced from the available local materials in order to promote effective teaching and learning in schools. They are materials that are used in the absence of the original or the ideal objects to bring about the same learning effect that the standard materials would have brought (Ahmed2008). Ndirangu et al .(2003) investigated the effective use of improvised materials to carry out improvised experiments designed by chemistry teachers during their teaching practice. This study presented evidence that improvised teaching aids designed by chemistry teachers during practice had a great influence in the teaching of chemistry in schools. These materials were found to be durable and could last for a longer time to enhance effective teaching and learning of science in school that are unable to afford expensive standardized instructional materials. Science teachers should be encouraged to make their own teaching resources from the locally available materials to teach science.

Overall, improvisation of instructional materials in science teaching particularly chemistry is an attempt to adapt and make use of local resources in the teaching/learning process when the readymade materials are not available or are in shortfall or not within the reach of the users. The improvised instructional materials could be produced by the teacher and the students.

2.4 Academic achievement in chemistry

Academic achievement refers to a successful accomplishment or performance in particular subject area. It is indicated by grades, marks and scores of descriptive commentaries. Academic performance also refers to how students deal with their studies and how they cope with or accomplish different tasks given to them by their teachers in a fixed time or academic year. Fajola (2008), used the notion of academic self-concept in referring to Individuals' knowledge and perceptions about themselves in academic achievements, and convictions that they can successfully perform a given academic task at designated levels.

2.5 Impact on Conceptual Understanding.

Improvised instructional materials are teaching materials designed and produced from the available local materials in order to promote effective teaching and learning in schools. They are materials that are used in the absence of the original or the ideal objects to bring about the same learning effect that the standard materials would have brought (Ahmed 2008). This study presents evidence that improvised teaching aids designed by science teachers during practice has a great influence in the teaching of science in schools. These materials are found to be durable and could last for a longer time to enhance effective teaching and learning of science in schools that are unable to afford expensive standardized instructional materials. Science teachers should be encouraged to make their own teaching resources from the locally available materials to teach science.

Science teachers put greater emphasis on the use of improvisation in science lessons. According to Adeniran (2006), the improvisation process of instructional materials makes students exposed to creativity, innovation, imagination and curiosity, which are essential to chemistry teaching and learning. Hence, improvisation should not be the prerogative of teachers only. Rather, students should be also being engaged as integral parts of the process (Aina, 2013). Learning science should start with hands-on experiments that the pupils are familiar with and not with abstract definitions of scientific concepts. Low cost apparatus from locally available materials assume to enrich the capacity to observe, explain and do real science (Sileshi,2012). Thus, as students apply various facets of their intelligence for the purpose of understanding their natural environment, they are also held accountable for their observations, inferences, and conclusions.

When teachers and students use improvised instructional materials, it could lead to the discovery of new knowledge, and students' talents may be discovered. Using improvised instructional materials assist teachers economically and may make students more interactive. Beyond these, it makes students make use of their intellectual ability in the process of teaching and learning (Onasanya & Omesewo 2011). A very important opportunity of using improvised materials for experiments is that, it enables learners to participate fully in the actual construction of the apparatus and gives them more ideas about how such materials work. Again, improvised instructional materials bring home to the classroom, and clarify unfamiliar principles and concept of science to learners. More so, when teachers improvise instructional materials for teaching, teachers' develop their potentials.

The provision and use of available instructional materials for teaching lay a sound basis for scientific and reflective thinking among students. It enables the students to connect abstract concepts taught, to real life experiences known to them. It also encourages students towards the development of creative abilities, strengthens enquiry, discovery, and investigative methods in science. Furthermore, it provides a frame of reference on which students can key their attention during classroom activities. It enables teachers to think of cheaper, better and faster methods of making teaching and learning process easier for students, affords students the opportunity of becoming familiar with resources in their environments. Attah (2014) stated that improvised materials proved superior to standard material in eliciting higher achievement and retention in chemistry students. Therefore, it is obvious that improvisation encourages hands on learning and it is vital for students' high retention in chemistry.

Fajola (2008) however noted that improvisation demands adventure, creativity, curiosity and perseverance on the part of the teacher. Such skills are only realizable through well-planned training programs on improvisation. Fajola (2008) looked at improvisation from the level of creativity involved. These levels involve substitution and construction. Substitution in improvisation simply implies the techniques whereby an already local material is used in place of a piece of equipment that is not available whereas construction involves making of a new instrument to serve in place of the unavailable original one where substitution is not possible. Ogunleye (2002) however asserted that improvisation provides a cognitive 'bridge' between students abstract and real experience of teaching and learning. Ahmed (2010) claimed that instructional materials ensure that the learners see, hear, feel, recognize, and appreciate as they learn utilizing almost all the five senses at the same time. The use of teacher produced improvised instructional materials and exposure of students to resources available in their immediate environment for instruction at this level brings students to real world of activities and may help students gain scientific skills.

2.6 Student Attitudes and Engagement

Students' attitudes can influence learning outcomes (Kurniawanetal, 2018). Students with positive attitudes improve their learning achievement. Learners' positive attitude towards the subject stimulates their interest and potential to study that subject in the future. Academic achievement considerably depends on attitude towards chemistry (Cukrowskaetal, 1999). Students with positive attitudes perform better than negative ones (Xuetal, 2013). Attitudes refer to feelings of likes or dislikes of a subject (Kurniawanetal, 2018). If students find the subject relevant to them in the society in which they live, they develop a positive attitude towards it, and hence they are interested in learning the subject. Students with negative attitudes are not interested in studying the subject and do not spend more time concentrating on the content of the same subject.

The improvement in the learning of complex concepts depends on innovative teaching methods. These methods attract students' attention, make them interested in the subject and boost their attitudes. Therefore, measuring students' attitudes after learning with a new teaching method may be critical in predicting their feelings on the new method, whether it is effective in improving their academic achievement, and attitudes. To this end, several studies have shown that active learning methods facilitate students' understanding of the taught science topics and contribute to an increase in their attitudes towards chemistry after being supported by teaching methods which involves use of improvised models.

Engagement is a multifaceted construct that broadly includes three elements: behavioral engagement, emotional engagement, and cognitive engagement (Sukor, Ayub, AbRashid & Halim, 2021). Engagement among students is typically regarded as one of the finest indicators of learning and personal growth (Abubakaretal, 2018). The level of focus, interest, optimism, and passion that student's exhibit when learning or being taught is referred to as their level of student engagement. Learning via doing so improves students interest in motivation for, and comprehension of chemistry ideas (Shana & Abulibdeh, 2020). According to Barkley (2010), motivated students are passionate and enthusiastic about what they are learning. When students invest psychologically in learning, there is student engagement. In actuality, student involvement is essential for learning, performance, and academic success (Leeetal,2019; Nizeyimana & Osman,2014).

Therefore, practical work allows students to use all the five senses during learning because while they are experimenting, they can see, hear, touch, taste and also smell the products of experiments (Kölleretal, 2015). This promotes active participation, and engagement in learning and it draws students attention to the lesson. It is exploration-based learning in which students build their levels of confidence and creativity, occasioning improved performance and sustained motivation to learn (Afyusisye & Gakuba, 2022). Similarly, according to Kuhetal (2007) opined that, engagement in learning was related to students' participation in effective educational activities, both inside and outside the classroom. Students performance remains the most useful academic tool for determining the success of or failure in the achievement of learning objectives. However, the frequency of the students willing engagement is of vital important because there is an assumed direct proportionality between the level of engagement and performance of the students. It is therefore based on this background that this study set to explore students' engagement on practical chemistry lessons among secondary school students at Chasiyatende Secondary School.

Unfortunately, the engagement of most students in chemistry is low (Vainoetal.,2012). Students who are not well engaged do not listen to or pay attention to the learning process. Such a low level of engagement among students in chemistry may be associated with the type of instruction used (Han, 2021). Teachers who incorporate active Learning into their lessons gives students more opportunities to participate, making it easier for everyone to meet learning objectives (Chans&Castro, 2021; Lancasteretal, 2013). To boost students' learning engagement in chemistry, classes may need to use active learning strategies, such as addressing representations and students develop interest in the subject (Lancaster etal, 2013; Upahi& Ramnarain, 2019).

2.7 Effects of improvisation on student performance.

Teaching chemistry in secondary schools is done through practicals and theory work. Typically, the term practicals mean experiences in school settings where students interact with materials to observe and understand the natural world. The practicals are mainly done as student experiments in the laboratory and as teacher demonstrations either in laboratories or in classrooms, while the theory is often done in the classroom (Twoli, 2006). Wellington (1998), describes chemistry practicals as teacher demonstrations or as class experiments where all learners are on similar tasks, working in small groups or a circus of experiments with small groups of learners engaged in different activities, rotating in a carousel.

Chemistry practical classes (experiments) are believed to help students in understanding theories and chemical principles which are difficult or abstract (Lagowski, 2002). Practicals offer several opportunities to students such as handling of chemicals safely and with confidence, acquiring hands-on experience in using instruments and apparatus, developing scientific thinking and enthusiasm to chemistry, developing basic manipulative and problem-solving skills, developing investigative skills, identifying chemical hazards and learning to assess and control risks associated with chemicals (Lagowski, 2002). Although chemistry teaching and learning essentially involves practical work and has a long tradition of student experimental work in schools, questions have been raised about the appropriate role and the reality of what is actually achieved by the practical work especially with continued decline in performance in the subject.

There are two main ways of performing chemistry practicals. These are: demonstration experiments and class experiments lessons. Demonstration experiments are those lessons where the teacher performs the experiments as students observe. The demonstration can be performed in the laboratory, classroom or outside the classroom. The teacher performs a demonstration using bought or improvised apparatus. The demonstrations can be performed with or without learner participation and are used to illustrate concepts and to promote inquiry (Sharpe, 2012).

According to Millar (2009), many science teachers believe that practicals lead to better learning and indeed better performance because all students understand and remember things better if we have done them ourselves, however, many educators have expressed concern they are not effective in promoting learning. Since the importance of practical work in school science is widely accepted, it is also important that the nature of the practicals be supportive to learning (Dillon, 2008). For many students, what goes on in the laboratory in form of practical work is said to contribute little to their learning of chemistry or to their learning about chemistry and its methods (Millar, 2009).

Student academic achievement in both the experimental and control groups used in the study are evaluated using the researcher created chemistry student achievement tests. Two student achievement tests: a pre-test and a post-test are constructed and used by the researcher. Pre-tests are administered as formative evaluations to assess student pre-treatment chemistry academic abilities (Creswell,2005). A post-test is administered as summative assessment after every treatment period to measure student academic gain in chemistry (Ormrod, 2003). The topic is conveniently chosen.

2.8 Overcoming Challenges in Improvised Chemistry Experiments in Resource-Limited Schools

Most improvised materials lack precision and accuracy in measurement which may eventually undermine the exact outcome of the experiment (Aina, 2013). Sometimes the cost involved in designing these materials may be more expensive than buying the original ones. Again, the available material may not be suitable or appropriate for the lesson and can subsequently yield unexpected results. This can make learning more difficult and frustrating. Sometimes improvised materials may be expensive, and there may not be enough to teach a big class.

Furthermore, improvisation demands creativity, adventure, curiosity and perseverance on the part of the teacher, such skills can be realized through training programs with the instructional materials. The perception of some teachers towards improvisation could also affect other teachers positively or negatively in the production of instructional materials.

Chemistry is a difficult Science subject to teach, especially in rural areas. Most teachers believe that lack of access to resources and equipment to teach chemistry in these areas is a major obstacle to effective teaching (Laidlaw et al 2009). The unavailability of resources in rural schools restricts teachers' ability to be effective in facilitating teaching and learning process. The provision of an enriching educational experience relies on adequate resources in schools, such as science materials and equipment. Making teaching and learning materials accessible is recognized as vital in providing better learning opportunities to students. The scarcity of resources has a negative influence on the quality of education in remote schools and hence affects the academic performance of students in chemistry. Inadequate resources for teaching and learning usually results in teachers having a less positive impact on students' development (Lingamand Lingam, 2013).

Teachers play a vital role in any education system, and students' learning in the classroom, but the quality of delivery has been adversely affected in rural schools due to challenges they faced such as lack of adequate resources (Shadreck 2012). There is a need for teachers to use indigenous materials in place of the standardized instructional materials to enhance teaching and learning especially in rural areas where resources are scarce.

2.9 Chapter summary

Broadly, improvisation of instructional materials in science teaching particularly chemistry is an attempt to adapt and make use of local resources in the teaching/learning process, when the ready-made materials are not available or are in shortfall or not within the reach of the users and students produced improvised instructional materials are those materials produced by the students which serves the same purpose with the standard material. Theoretically, Bruner discovery theory and Piaget's cognitive theory of learning were reviewed but this study is anchored on Piaget's cognitive theory which is referred to as stage theory of cognitive development. According to Piaget, children develop knowledge by inventing or constructing reality out of experience and thus mix their observation with their ideas about how the world works based on Piaget's theory. This study is built to find out the effect of improvised materials on student's academic achievement and performance in chemistry. From the reviewed studies, impact of improvised experiments on students understanding and performance have been discussed.

CHAPTER 3 RESEARCH METHODOLOGY

3.1 Introduction

This chapter is built upon the theoretical and empirical literature review that was developed in the previous chapter. This chapter encompasses details on the research methodology, including the framework for the study, the intended population, approaches for determining sample size, techniques used for data collection, adherence to research procedures, methods for assessing reliability and validity, as well as the processes involved in data analysis. The study used a descriptive research design. According to (Patten, 2020 Nov), descriptive research designs are often used in primary research because they enable data collecting and summation. According to (Coolican, 2017) descriptive research designs are generally used to answer questions about the What, Why, and How of a certain event.

3.2 Research Paradigm

The study adopted a positivist approach. This approach is built on the principle of universal laws and focuses on the presence of a shared reality that can be widely acknowledged. Positivism emphasizes the importance of facts that are observable, reproducible, and verifiable (Anderson, 1998). Frequently referred to as the "scientific method," positivism advocates for studying social phenomena using methods similar to those applied in physical sciences. It suggests that tools and methodologies utilized in natural sciences apply to social sciences as well. Additionally, positivism values direct experience and empirical evidence, rejecting abstract notions and subjective perspectives (Crotty, 1998). All research investigations possess a philosophical foundation, but the investigation questions direct the research in terms of stance/assumptions, strategy, and proper methods to use.

3.3 Research Design

This study employed a descriptive research approach, which involved gathering data to detail events and systematically organizing, categorizing, illustrating, and explaining the findings. A descriptive design was chosen to facilitate the examination and interpretation of the impact of improvised chemistry experiments on students conceptual understanding and performance at Chasiyatende Secondary School. This approach was suitable because it captured the characteristics of the study while enabling the collection of thorough and accurate field data for analysis. The research design served as the fundamental framework outlining the procedures for conducting the study. As noted by Bernard (2017), it acted as a blueprint guiding the selection of methods for data collection and analysis. To ensure both internal and external validity, data from multiple sources were integrated for comprehensive analysis and discussion, minimizing potential inaccuracies. Descriptive studies aimed to provide insights by addressing questions such as "who," "what," and "how" (Babbie, 2002).

3.4 Research Methodology

This study employed a descriptive research design to explore the challenges and opportunities in implementing improvised chemistry experiments. Two primary research instruments were utilized: structured questionnaires (Appendix A and Appendix B) and semi-structured interviews on Appendix C using questionnaires. Data were collected by administering 14 questionnaires to 2 teachers and 12 pupils at Chasiyatende Secondary School in Chivi District. All 14 questionnaires were fully completed and returned. The questionnaire for the pupils was supervised by the researcher to ensure clarity and completeness. In addition to the questionnaires', semi-structured interviews were conducted with the participating teachers. These interviews (Appendix D) aimed to gather deeper insights into their experiences and perspectives regarding the implementation of improvised experiments. The interviews were recorded with the participants' consent and later transcribed for analysis. The questionnaire included four-point Likert scale items, allowing respondents to express their level of agreement with various statements. The response options were Strongly Agree, Agree, Disagree, and Strongly Disagree. The items were developed based on the reviewed literature to ensure relevance and validity. Data analysis involved calculating frequency counts and percentages for the questionnaire responses, while thematic analysis was applied to the interview transcripts to identify key themes and patterns. Throughout the study, the researchers emphasized the purpose of the research, assured participants of their anonymity, and clarified that participation was voluntary.

3.5 Target Population

A population refers to the complete set of individuals, objects, or instances that share identifiable characteristics, while the target population represents the specific group to which a researcher intends to apply their study findings (Mugenda, 2003). The term population encompasses all entities or occurrences central to the focus of a study (Patten, 2020, Nov). It consists of uniform items or events that capture the interest of the researcher. The population for this study is made up of learners and teachers at Chasiyatende Secondary School in Chivi district. These participants will collectively suggest improvised materials to employ for effective teaching and learning of chemistry.

3.6 Sampling Frame

The target population was identified using a sampling frame that comprised science subject learners and teachers at Chasiyatende Secondary School in Chivi district.(Cooper, 2014) described a sampling frame as a comprehensive list of all elements within a population from which a sample is chosen. The target population generally encompass units, roles, institutions, or individuals within a given organization.

3.7 Sample Size and Sample Technique

Purposive sampling is used to select teachers in this study because it gave extensive and detailed information on many aspects of the problems under study. As a result, the sample size was twelve, because this form of study considered every aspect of the cosmos, and the conclusions were more accurate and credible. Kombo (2006) defines sampling as the process of choosing representative elements from a population to be part of a research study referring to the researcher's technique or procedure for selecting sample items.

3.8 Data Collection Instruments

The study primarily relied on questionnaires (and interview guide as the main tool for gathering primary data. Creswell J.W. and Creswell (2017) explain that primary data refers to information collected first-hand, which retains its originality. The study incorporated both qualitative and quantitative data and utilized structured, closed-ended questionnaires for data collection. These questionnaires were distributed exclusively to 12 learners and 2 teachers (Appendix C) at Chasiyatende Secondary School in Chivi district. The self-administered format enabled the collection of primary data and provided deeper insights. The tool was designed to gather statistically significant information regarding respondents' views on the topic through pre-determined questions.

Kothari (2008) emphasized that questionnaires are an effective instrument for research as they allow the collection of large volumes of information within a short timeframe. The standardised format of the questionnaires simplified the research process, as responses could be easily coded and analyzed. According to Saunders (2003), the rationale for using a questionnaire is the efficiency gained by asking all participants the same set of questions, making it a streamlined approach to gather responses before analysis.

The questionnaire employed a five-point Likert scale, where:

- 1 = strongly agree
- 5 = strongly disagree.

It was structured into sections aligned with the study's objectives to ensure a comprehensive exploration of the research focus.

3.9 Data Collection Methods

To obtain reliable and relevant information for this study, data collection methods were carefully selected to align with the research objectives. A combination of qualitative and quantitative approaches was employed to ensure a comprehensive understanding of improvised chemistry experiments. These methods provided direct insights from both teachers and learners, enabling the researcher to gather factual evidence, capture perceptions and analyze academic performance through measurable outcomes

3.9.1 Data Collection Procedure

All respondents (learners, teachers) were provided with an introductory letter explaining the objectives of the study. The questionnaires underwent a pilot test, and the respondents were informed ahead of time about the research activities. During the data collection phase, participants completed the questionnaires on their own. Additionally, the questionnaires were distributed and a hard copy was kept for evidence.

3.9.2 Primary Data

The research utilized primary data, this is information obtained directly from its source. This type of data was gathered firsthand by a researcher prior to performing any statistical evaluations or analysis. The researcher collected responses from questionnaires.

3.9.3 Secondary Data

The research complemented its primary data with information sourced from secondary materials. Secondary data refers to data originally collected as primary information but later utilized by others as secondary resources. As explained by Kothari (2004), secondary data can be obtained through various channels, including libraries, online platforms, and literature. Secondary information was gathered from libraries, websites, newspapers, academic journals, books, financial reports, and magazines. Additionally, a frequency analysis was conducted to ensure relevance to the research objectives.

3.10 Pilot Testing

Before administering the research tools to participants, pre-testing was performed to verify both their validity and reliability, as well as to ensure that the questions were clear, relevant, and easy to comprehend. The pilot study served to evaluate the dependability and accuracy of the research instruments. Yin (2017) describes a pilot study as a preliminary evaluation conducted before the primary study to assess the validity and reliability of the tools. The primary objective of this pilot study was to identify and address any shortcomings within the research tools. Additionally, the study provided insights into respondents' comprehension and interpretation of the questionnaire items. Any issues discovered during this phase were corrected before initiating the comprehensive study. A total of 5 students participated in the pilot phase, but they were excluded from the final survey.

3.10.1 Reliability of the Research Instrument

To assess reliability, Cronbach's Alpha, an internal consistency measure, was utilized. Bain (2017) states that a Cronbach's Alpha value greater than 0.7 signifies a dependable instrument. Cohen (2007) endorsed the use of Cronbach's Alpha as a measurement scale for evaluating internal consistency in descriptive surveys. This coefficient was computed using the Statistical Package for Social Sciences (SPSS Version 24). Reliability refers to the ability of a tool to yield stable and consistent outcomes over repeated measurements. Instruments that generate inconsistent results are considered unreliable (Patten, 2020, Nov).

3.10.2 Validity of the Research Instrument

For this study, construct validity was evaluated by having the supervisor review the questionnaire to ensure that all relevant constructs were effectively addressed. Any questions deemed invalid were excluded from the survey. According to Kothari (2004), validity refers to the precision with which a tool evaluates what it is intended to measure. Validity represented the extent to which the instrument accurately captured the phenomena under examination (Myers, 2020). Validity can be categorized into various types, including face, construct, internal, and external validity

3.11 Data management

The data was reviewed to identify and correct any inaccuracies that could have arisen from the methods and tools used for data collection, errors introduced by research assistants, or respondent fatigue due to time constraints for completing the instruments. Prior to conducting statistical analyses and tests like multiple regression, the researchers ensured that the variables followed a normal distribution and that the selected samples were appropriate. To maintain the integrity of the analysis, multicollinearity and normality tests were performed to confirm that no underlying assumptions were breached.

3.11.1 Data Analysis and Presentation

The responses in the questionnaires were analyzed using a computer program called Statistical Package for Social Science (SPSS). The findings were presented as tables (Table 4.1), charts (Figure 4.2) , and graphs (Figure 4.3; Figure 4.5; Figure 4.6; Figure 4.7; Figure 4.8) for additional analysis and comparison. The results were analyzed using frequencies and descriptive statistics, followed by conclusions and recommendations based on the findings. The study examined completed questionnaires for completeness and consistency. The data was analyzed via descriptive statistics.

3.11.2 Empirical Model

A multiple linear regression model was employed. This method allowed for testing the study's independent variables to assess their influence on a single dependent variable. Regression analysis was applied wherever a relationship between the independent and dependent variables was identified. This analysis was essential for quantifying the extent to which independent variables impact the dependent variable. The analysis incorporated both descriptive and inferential statistical methods. Descriptive analysis utilized measures such as averages and standard deviations, while inferential techniques included regression analysis. Visual representations like tables, charts, and figures were employed to make the findings accessible and easy to interpret is the error term.

3.11.3 The Qualitative Analysis

The information was gathered through questionnaires (Appendix C), refined, and analyzed to determine response rates. The data was categorized into themes aligned with research variables and summarized using descriptive statistics, such as averages, standard deviations, and frequency distributions. These metrics, as explained by (Kothari, 2004), provided insights into clustering patterns and key characteristics of the collected data.

3.11.4 The Quantitative Analysis

Quantitative data underwent inferential statistical analysis, incorporating both parametric methods, such as the Chi-square test, and non-parametric approaches, including the Pearson correlation coefficient. The Chi-square test was applied to evaluate statistically significant discrepancies between large, unrelated parametric data sets, aiming to determine if there were variations in the means of two independent samples. The Pearson correlation test assessed the degree of significance between dependent and independent variables, with Pearson's correlation coefficient used to estimate the linear relationship between variables.

3.12 Data Collection Procedure

Data collection commenced after the proposal was successfully defended and approved. A letter was sent to the selected learners and teachers (Appendix E), seeking permission to collect information. To streamline the process, the researcher distributed the questionnaires online as a google form attachment via WhatsApp and some physically and interviews were conducted one on one.

3.13 Research Ethics

The researcher did not interfere with the learner's education environment and only the investigator had access to the data, and the participants willingly answered questions. The interview was solely for academic purposes, and all material were treated with strict confidentiality. Ethics, as noted by (Minja, 2009) referred to standards guiding human behavior with a substantial impact on human welfare. Confidentiality was an issue in this investigation because the information pertinent to the study was strategically important to the entity under study, Chasiyatende Secondary School. The respondents' names were not revealed.
The following ethical considerations were upheld:

- Informed consent.
- Voluntary participation.
- Right to zero harm to respondents.
- Confidentiality.
- Anonymity.
- Assessment of relevant components only.

The researcher employed the considerations to protect the rights of research participants, enhance research validity and to maintain scientific integrity.

3.14 Chapter Summary

This chapter detailed the methodological framework guiding the research. It began by outlining the descriptive research design, chosen for its suitability in addressing the research questions. The chapter proceeded to describe the participants comprising learners and teachers, with a target population of 14 participants and the census sampling technique used to select the sample. This ensured the sample is representative and relevant to the study's focus. Data collection methods employed were questionnaires. The method was justified in terms of its effectiveness in gathering the necessary data. The chapter emphasized the steps taken to ensure the reliability and validity of the data collected. Ethical considerations were also addressed, highlighting the importance of informed consent and participant confidentiality throughout the research process. Finally, the chapter acknowledged potential limitations, such as data accessibility and limited time, as well as resource constraints. The study was limited on data accessibility due to the secrecy and confidentiality policies and this may influence the findings. Despite these challenges, the chosen methodology is presented as robust and appropriately aligned with the research objectives, ensuring the study's credibility and relevance.

CHAPTER 4 RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the presents results, analyzes and discusses the findings of the study, which aimed to investigate the effects of implementing improvised chemistry experiments on students' understanding and performance at Chasiyatende Secondary School. The aims of this study were to assess the impact of improvised chemistry experiments on students' conceptual understanding of key chemistry topics at Chasiyatende Secondary School and to evaluate the effect of improvised experiments on students' academic performance by comparing test scores before and after their implementation as well as to identify challenges and opportunities in implementing improvised chemistry experiments in a resource-limited school environment.

4.2 Response rate

There is a 100% response rate obtained in the data collection process. The respondents managed to fill out their questionnaires and this served as reassurance that all their opinions were captured.

Table 4. 1: Questionnaire response rate

Description	Distributed	Returned	Percentage
Learners	12	12	100%
Teachers	2	2	100%
Average response rate	12	12	100%

Table 4.1 Above shows a 100% response rate obtained in the data collection process. The respondents managed to fill out their questionnaires, and this served as reassurance that all their opinions were captured. This result support the work of (Crompton & Tian-Cole, 1999) which suggests that 70% is an appropriate criterion for special-interest groups, although a 100% response rate would be ideal. The 100% response rate achieved ensures that all responses from the target population are reliable, allowing valid conclusions to be drawn from the findings. The researcher used a sample of twelve (14) respondents.

4.3 Findings

The study's findings reveal that improvised chemistry experiments had a positive on learners at Chasiyatende Secondary School. Students reported that hands-on activities made lessons more engaging and facilitated better understanding of complex chemistry concepts. Although the use of improvised experiments was not consistent, mainly due to limited materials, time constraints and teacher preparedness when implemented, they significantly enhanced learner engagement and comprehension. Comparison of pre-test and post-test scores indicated noticeable improvements in academic performance showing that improvisation strengthened both knowledge retention and practical application. Topics such as acids and bases and chemical reactions were particularly clarified through these experiments. Improvised experiments also provide opportunities for creativity, problem-solving and active participation. However, challenges including material shortages, limited teacher training, safety concerns and occasional student disinterest hindered their application. Overall, the findings suggest that improvised experiments are valuable instructional approach in resource-limited settings capable of improving conceptual understanding and academic performance despite existing constraints. Therefore, more findings are discussed below.

4.3.1 Impact on students' understanding

This study aimed to assess the impact of improvised chemistry experiments on students' conceptual understanding of key chemistry topics at Chasiyatende Secondary School. Students often tend to see science as difficult to understand and its main ideas as abstract and remote from everyday life experiences (Valentina Osei-Himah, 2018). This means that more should be done to make science friendlier and more real. Through this investigation, we sought to determine how these innovative approaches can enhance student learning outcomes and contribute to a deeper comprehension of fundamental chemistry concepts.

4.3.2 Teachers' views on improvised experiments and understanding.

There was a 100% turn out on teachers' views on the effects of improvised materials on the study of science from the Likert-type items rated always, often, sometimes, rarely and never. This distribution suggested that the implementation of improvised chemistry experiments is quite frequent at this school; most students experienced hands-on practical work regularly. This agrees with (Holdhus, 2017) who stated that improvisation in teaching and learning Mathematics and science is of paramount importance as it fosters a dynamic and engaging educational environment as it allows educators to adapt their teaching methods to the specific needs and learning styles of their students. This high frequency is likely to have a positive impact on students' understanding and performance, as regular exposure to experiments helps reinforce theoretical concepts, encourages active participation, and makes learning more engaging and memorable.

4.3.3 Frequency of improvised experiments use

The frequency of improvised experiments in chemistry classes was found to be limited, often influenced by resource availability and teacher preparedness. More detail to follow on the findings below;

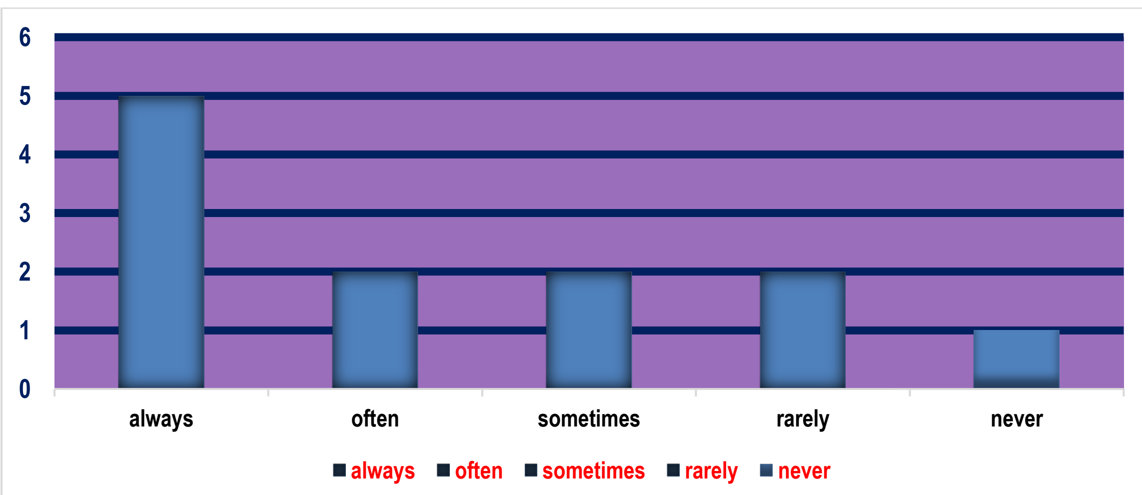

Figure 4.1 Frequency of carrying out improvised experiments

At Chasiyatende Secondary School were used inconsistently, largely due to limited resources, teacher preparedness and time constraints. Classroom observations and teacher interviews revealed that only about 42% of lessons conducted when essential concepts required practical demonstration or when locally available materials could be used. Teachers noted that experiments requiring specific chemicals or glassware were frequently skipped, reflecting the challenges reported in rural Zimbabwean schools (Chikasha et al. ,2014). Similarly, Mwangi & Mwinzi (2020) observed that improvised experiments are often supplementary rather than a regular part of instruction in under-resourced. Despite this, teachers reported that when improvisation was implemented, learners showed increased engagement, understanding and motivation underscoring the potential benefits of incorporating improvised experiments more frequently into the chemistry curriculum.

4.3.4 Learners' views on improvised experiments.

Learners expressed positive views towards improvised experiments noting that they made lessons more engaging, practical and easier to understand. Findings are presented below;

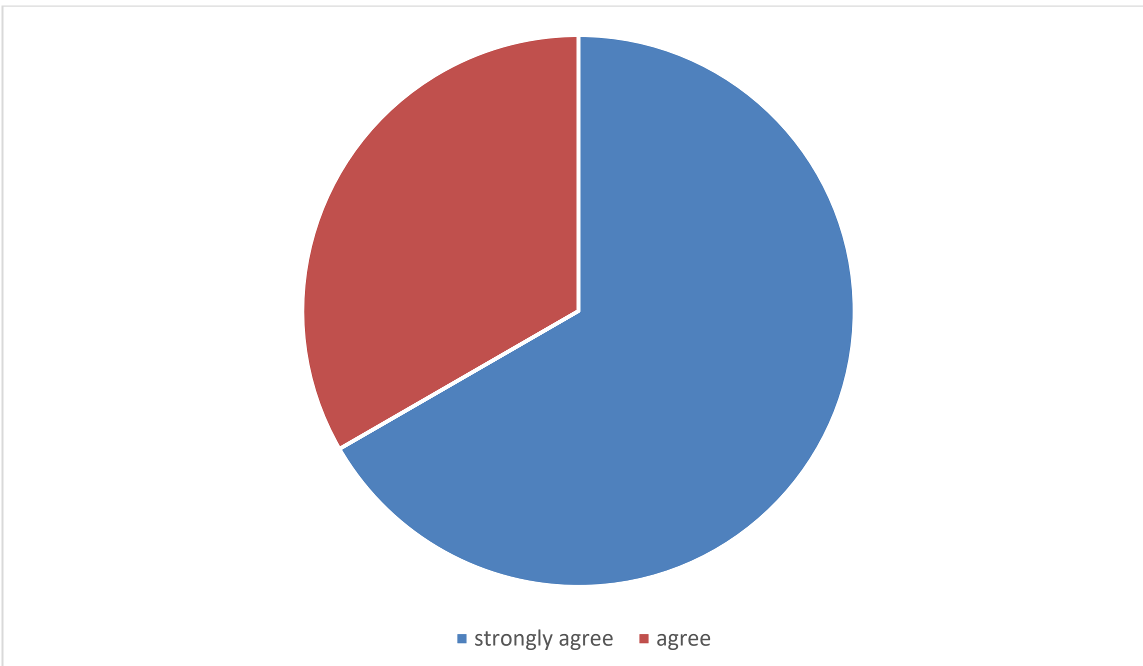

Figure 4.2 Learners' view on chemistry concepts

The data indicates a strong positive reception among students towards the use of improvised chemistry experiments. Specifically, 8 learners (66.7%) strongly agreed and 4 learners (33,3%) agreed that such experiments enhance their understanding and engagement in Chemistry lessons. This suggests that the majority of students perceive improvised experiments as an effective and engaging learning strategy. Supporting this, a study by Ngendabanga et.al. (2025) found that the use of improvised chemicals significantly enhanced student understanding and engagement in learning about chemical reactions. For instance, one participant noted,' using improvised chemicals significantly enhanced student understanding and engagement in learning about chemical reactions. This aligns with the positive feedback observed in the current study.

Therefore, the findings from both the current study and the recent literature underscore the effectiveness of improvised experiments on enhancing students' conceptual understanding and engagement in Chemistry.

4.3.5 Effects of improvised experiments on chemistry concepts.

This overwhelmingly positive response indicates that the implementation of improvised chemistry experiments has had a substantial effect on enhancing students' grasp of key scientific ideas. Effective use of instructional materials enhances the understanding of students in teaching and learning processes. It was discovered that improvised instructional materials convey the same meaning as compared to the originally produced instructional materials. It is evident from the analysis that there is no significant difference between improvised instructional materials and originally produced instructional materials when used in the teaching and learning of science. When students are able to interact with practical, hands-on activities, even with improvised materials, they are more likely to develop a deeper and more meaningful understanding of abstract chemistry concepts(Valentina Osei-Himah, 2018).

4.3.6 Impact of improvised experiments on lesson engagement.

All the teachers indicated that they "Strongly Agreed" that improvised experiments have positively impacted chemistry lessons and made them more engaging. In support of the above fact, (Salami, 2014) maintained that teachers should employ instructional materials in their teaching to make sure that teaching is more permanent in the minds of the learners. The strong positive responses imply that hands-on, practical activities, using locally available or improvised materials make lessons more interactive and help clarify complex concepts. This likely leads to improved academic performance and greater enthusiasm for the subject.

4.3.7 Topics clarified best by improvisation.

Improvised experiments proved most effective in clarifying abstract and challenging chemistry topics, enabling learners to grasp complex concepts with greater ease and confidence. Findings are presented below;

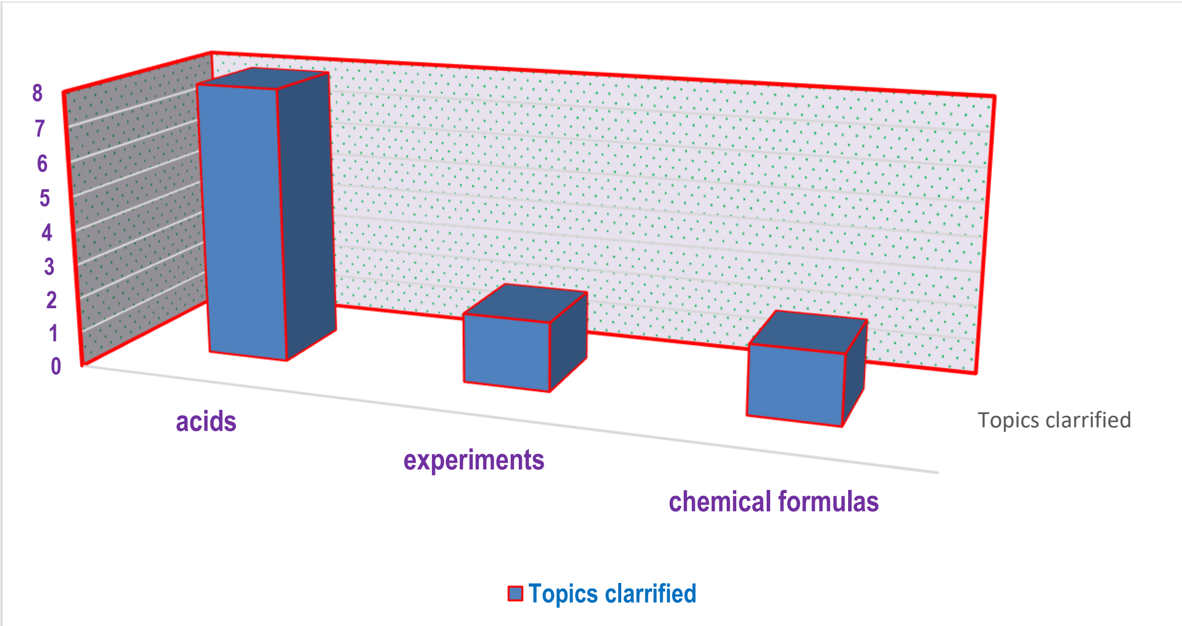

Figure 4.3 Chemistry topics

This distribution suggests that improvised chemistry experiments are particularly effective in demystifying the concept of acids, likely because acids can be demonstrated with simple, safe household materials, making the lessons more tangible and relatable. By improvisation, teachers can tailor their lessons to address individual learning gaps and stimulate interest in these subjects. This personalized approach can lead to increased comprehension, better retention of knowledge, and a deeper appreciation for the topics which was supported by the work of (Ndihokubwayo K. &., 2020). The hands-on approach seems to bridge the gap between theory and practice, enhancing students' conceptual understanding and retention. While the impact on topics like experiments and chemical formulas is less pronounced, the chart still indicates that improvised methods have some positive effect on these areas. This may point to the need for more targeted or varied improvisation strategies to address topics that are inherently more abstract or complex.

4.4 Pre-test and Post-test analysis of improvised experiments.

The comparison of pre-test and post-test results provides critical insights into the impact of improvised experiments on students' academic performance highlighting measurable shifts in in understanding and achievements. The findings are presented and analysed below;

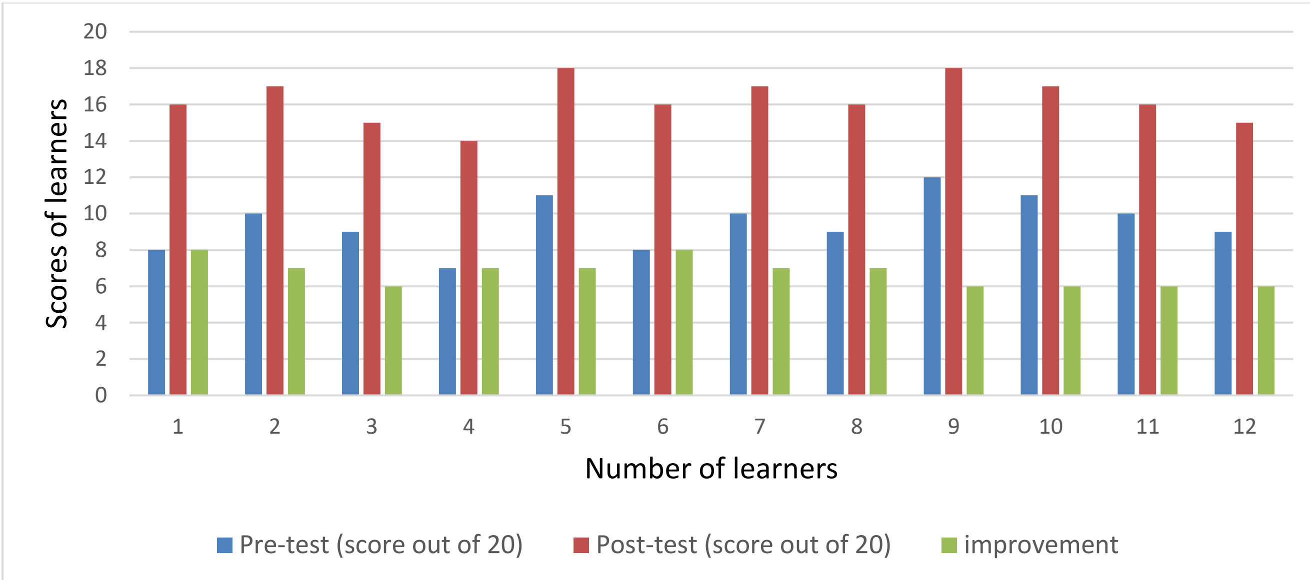

Figure 4.4 student performance pre- and post- improvised experiments

The pre-test and post-test results indicate a marked improvement in student' academic performance following the implementation of improvised chemistry experiments. Before the introduction of improvised experiments, many students demonstrated limited understanding of abstract Chemistry concepts reflected in lower pre-test scores. After engaging in hands-on, locally improvised practical activities, post-test scores showed significant improvement suggesting that experiential learning enhanced comprehension and knowledge retention.

Observation and student feedback revealed that the practical, interactive nature of improvised experiments made abstract concepts such as chemical reactions, acids and bases, separation techniques more tangible and relatable. Most students reported that working with familiar, low-cost materials increased their interest, motivation and engagement in lessons. Specifically, data showed that 8 students strongly agreed and 4 students agreed that improvisation positively impacted their understanding, highlighting widespread acceptance and favorability among students.

The present findings concur with the observations of Mushimiyamana et al. (2022) who found that improvised instructional materials significantly improved post-test performance compared to traditional teaching methods. Similarly, Ngendabanga et al. (2025) also supports the present research by reporting that improvisation in chemistry education enhances student motivation, practical skills and conceptual understanding particularly in resource limited contexts.

In conclusion, the pre-test and post-test analysis demonstrates that improvised experiments are an effective strategy for improving students' academic performance, conceptual understanding and engagement in chemistry lessons especially in schools with limited laboratory resources.

4.4.1 Teachers' view on improvements.

Teachers observed that students show notable improvements in both engagement and academic performance after participating in improvised Chemistry experiments. This observation aligns with the pre-test and post-test data, which revealed an average of pre-test score of 9.5 out of 20 and an average of post-test score of 16.3 out of 20, indicating an average improvement of 6.8 points. Teachers reported that students who initially scored low on the pretest were able to grasp complex concepts such as chemical reactions and separation techniques more effectively after hands-on, improvised experiments.

Teachers agreed that the introduction of improvised experiments led to measurable improvements in student performance. Teachers highlighted that students become more attentive, asked more questions, and were better able to apply theoretical concepts during practical activities. One teacher noted that, students who struggled during pre-test demonstrated considerable improvements in post-test, reflecting better conceptual understanding by hands-on experimentation.

In support of the findings, Udogu (2017) observed that the use of improvised instructional materials significantly enhanced students' academic achievement in Chemistry leading to improved understanding. The study emphasized that such materials offer cost effective alternative to standard laboratory equipment, making practical science education more accessible in resource-constrained settings.

Overall, teachers' views supported by pre-test and post-test data, strongly suggest that improvised Chemistry experiments positively affect students' learning outcomes.

4.5 Challenges in implementing improvised chemistry experiments.

While improvised experiments offer valuable learning opportunities, their implementation at Chasiyatende Secondary School is constrained by a number of challenges that affect both teaching and learning processes. The include shortages of materials, limited teacher preparedness, disinterest of learners and time constraints all of which warrant critical examination to fully understand their implication on learner understanding and conceptual development. The findings are presented and analyzed below;

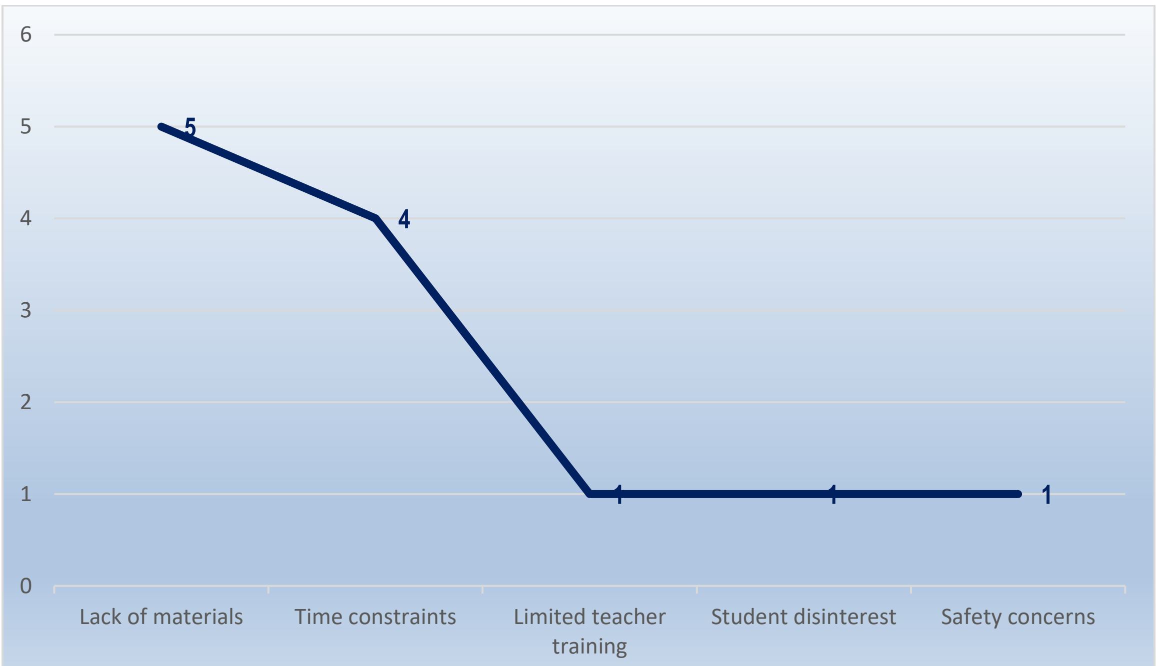

Figure 4.5 Challenges faced in implementing improvised experiments

Chasiyatende Secondary School, a rural school in Masvingo Province faces several challenges in implementing improvised chemistry experiments. One of the most pressing issues is the lack of resources and materials needed to conduct meaningful practical sessions. Teachers at school often struggle to access even basic laboratory equipment such as beakers, test tubes and chemicals forcing them to rely heavily on improvisation. While improvisation offers a partial solution, the scarcity of suitable local substitutes and limited financial resources mean that experiments are often incomplete or conducted in a theoretical manner. This finding is consistence with Chikasha et al.(2014) who reported that rural schools in Zimbabwe face chronic shortages of science teaching materials resulting in an overreliance on lecture methods.

Similarly, Muringani (2019) corroborates that underfunding in rural schools severely limits the availability of science resources, thereby constraining effective hands-on learning.

Another major challenge is time constraints, as teachers are burdened with tight syllabi and administrative responsibilities. At Chasiyatende, science teachers indicated that practical sessions are sometimes skipped or shortened due to pressure to cover theoretical content before national examinations. This aligns with the observations of the National Math and Science Initiative (2023), which found that inadequate instructional time restricts teachers from properly designing and implementing laboratory–based activities improvised ones.

The issue of limited teacher training also hampers effective use of improvisation. May teachers have not received adequate professional development on how to creatively adapt local materials for scientific experiments. Dave et al (2024) supports that without targeted training in improvisation, teachers often lack the confidence and expertise to design safe and pedagogically sound experiments. This resonates with the researcher’s findings that improvisation sometimes fails to meet circular standards.

In addition, student disinterest presents another obstacle. While some learners find improvisation engaging, others perceive improvised materials as inferior as or less scientific than conventional laboratory apparatus. This discourages participation and reduces enthusiasm during practical lessons. Pratap (2024) highlights similar findings, observing that Chemistry is often viewed as abstract and difficult, which contributes to low learner motivation during experimental tasks. At Chasiyatende, teachers confirmed that disengagement is especially common when students cannot easily connect improvised activities to examination-style question.

Finally, safety concerns remain a key challenge. Improvised materials, if not carefully tested may introduce hazardous such as breakages, chemical spills or injuries. Teachers at Chasiyatende acknowledge fears of accidents when using locally sourced substitutes which sometimes deters them from conducting certain experiments altogether. The National Science Board emphasizes that safety protocol is essential in science education, yet many schools lack adequate training and protective equipment to guarantee safe practice.

Overall, the findings reveal that while improvisation is a valuable strategy in resource constrained schools like Chasiyatende, its implementation is hindered by lack of materials, insufficient time, limited training, student disinterest and safety challenges. Addressing these issues through better resourcing, professional development and safety support would greatly enhance the effectiveness of improvised chemistry experiments in rural schools.

4.6 Opportunities in resource limited environment.

In resource limited settings, improvised experiments offer significant opportunities to strengthen the teaching and learning of Chemistry. By utilizing readily available local materials in place conventional laboratory equipment, teachers are able to simplify abstract concepts. The graph findings are therefore presented below.

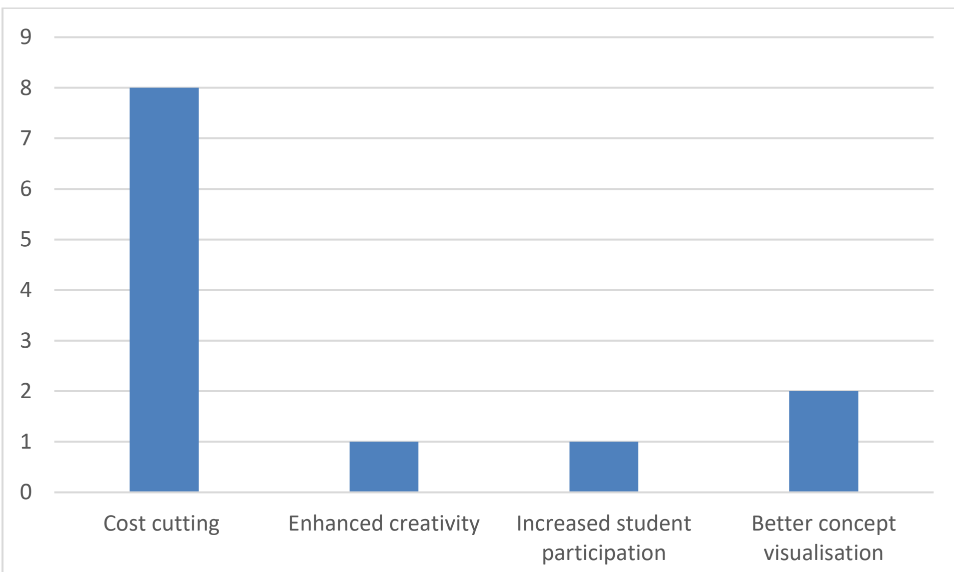

Figure 4.6 Challenges faced in implementing improvised experiments

Despite the challenges faced in implementing improvised chemistry experiments, they present numerous opportunities that can significantly enhance teaching and learning in resource-constrained schools such as Chasiyatende Secondary School. Improvisation allows teachers to creatively replace unavailable laboratory apparatus and chemicals with locally available materials, ensuring that students still gain hands-on experience. This opportunity helps bridge the resource gap and ensures that learners are not disadvantaged compared to their peers in better equipped schools. In support of the findings Olagunju (2019), confirmed that improvisation encourages innovation and problem-solving as teachers and students adapt resources to meet experimental needs.

Another important opportunity lies in improving conceptual understanding. Chemistry is often regarded as abstract, but improvised experiments make the subject more relatable by linking classroom learning with students' everyday experiences. For example, household materials such as vinegar and baking soda can be used to demonstrate acid-base reactions, enabling learners to visualize scientific principles. Research by Mwangi & Mwinzi (2020) affirms that learners in rural schools develop deeper comprehension when experiments are contextualized using familiar local resources.

Improvisation also fosters inclusivity and engagement in learning. Students in rural environments often feel detached from laboratory science due to the lack of exposure to real experiments. By integrating locally available materials, students actively participate and take ownership of the learning process. In support of the findings, a study by Sibanda (2021) in Zimbabwean rural schools found that learners showed higher enthusiasm and confidence when exposed to improvised experiments compared to purely theoretical lessons.

Furthermore, improvised experiments cultivate critical thinking and creativity. Students are encouraged to reflect on how simple local materials can substitute for standard laboratory resources, which promotes inquiry-based learning. This aligns with Bruner's constructivist learning theory, which emphasizes discovery learning and active involvement in knowledge construction. This outcome is in support of Adeyemi (2022), who confirms that improvisation prepares learners with problem-solving skills that are transferable beyond the science classroom.

4.7 Summary

This chapter examined the findings on the impact of improvised chemistry experiments at Chasiyatende Secondary School. Results indicated that most learners favored improvisation with majority strongly agreeing that it improved their understanding of abstract concepts and engagement in lessons.

The pre-test and post-test analysis revealed notable improvements in academic performance, with post-test scores significantly higher. Teachers supported these results, observing that learners become more confident, active and better able to apply theoretical knowledge in practical contexts.

Despite the positive outcomes, challenges such as lack of materials, time limitations, insufficient teacher training, student disinterest and safety concerns were highlighted. However, opportunities also emerged including greater learner motivation, creativity, inclusivity, and problem-solving skills.

In conclusion, improvised experiments proved to be an effective strategy for enhancing both understanding and performance in chemistry, particularly in resource limited settings like Chasiyatende Secondary School. The following chapter will comprise the conclusions, interpretation of findings and the recommendations of the research.

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the conclusion and recommendation drawn from the study on the impacts of improvised chemistry experiments on students' understanding and performance at Chasiyatende Secondary School. The conclusions provide a synthesis of the key findings discussed in the previous chapters, highlighting how improvisation influenced learners' conceptual understanding, engagement, and overall academic performance in Chemistry. Furthermore, the chapter outlines practical recommendations directed towards teachers, school administrators, policy makers and curriculum planners to strengthen the use of improvised experiments in resource-limited environments. These recommendations are informed by the challenges, opportunities and evidence identified in the study, ensuring that they are both context specific and actionable.

5.2 Summary of findings.

The findings of the study reveal that improvised chemistry experiments provide a valuable opportunity for enhancing teaching and learning, particularly in resource-constrained environments. In line with the aim of the project, which was to explore the viability and effectiveness of improvisation as a strategy to address shortages of conventional laboratory equipment, the results show that teachers and learners alike benefit significantly from such approaches. Evidence gathered indicates that improvised materials not only ensure continuity of practical work but also stimulate creativity, problem-solving skills, and contextual understanding among learners. For instance, in experiments on acids and bases, substances such as red cabbage extract were effectively used as natural indicators in place of laboratory litmus paper. Learners were able to test household substances like vinegar, lemon juice, soap solution, and baking soda, thereby achieving the same conceptual understanding of neutralization and pH variation as they would with standard apparatus. This demonstrated that improvisation can maintain both the integrity and outcomes of experiments while making them more relatable to students' daily experiences.

The pretest and post-test results provided strong evidence of the effectiveness of improvised experiments. In the pretest, the majority of learners (with an average score of about 45%) struggled to correctly identify acidic and basic substances, and their explanations showed limited conceptual clarity. However, after participating in improvised practical sessions, the post-test revealed a marked improvement, with average scores rising to around 78%. Most students were able to accurately classify substances and give clear scientific explanations of the observed changes in indicators. The contrast between pretest and post-test scores confirmed that the hands-on experience of using improvised materials not only improved knowledge retention but also deepened understanding of theoretical concepts. These findings strongly suggest that improvisation is not only a solution to resource shortages but also a catalyst for meaningful and long-lasting learning.

Furthermore, analysis highlighted that improvised experiments encourage learner participation and collaboration, since most of the materials are familiar and easily accessible, reducing the sense of intimidation often associated with laboratory work. Teachers also reported that the use of improvisation increased their confidence and adaptability in lesson delivery, demonstrating that lack of standard apparatus should not be a barrier to effective science teaching. However, the findings also noted challenges such as lack of technical guidance for teachers and inconsistency in quality of improvised materials, which could limit precision in certain experiments. Despite these limitations, the evidence supports the conclusion that improvisation is not merely a stop-gap measure but a sustainable strategy for broadening access to experimental science. Overall, the study confirms that improvised experiments directly contribute to achieving the project's aim of promoting inclusive, innovative, and practical science education in contexts where resources are scarce.

5.3 INTEPRETATION OF FINDINGS BASED ON THE OBJECTIVES OF THE STUDY.

The 100% response rate is a significant strength of this study, indicating thorough participation and reliable data for analysis. While the sample size is limited, the findings offer valuable insights into the impact of improvised chemistry experiments at Chasiyatende Secondary School and can serve as a strong foundation for further research or implementation in similar educational settings. The willingness of all learners and teachers to participate suggests a strong interest and motivation in the study's objectives. This level of engagement may be reflective of the perceived importance of the intervention and its potential benefits for chemistry

5.3.1 Impact of Improvised Experiments on conceptual understanding.

The majority of students reported that improvised experiments were always conducted at Chasiyatende Secondary School. This suggested that practical improvised experiments were a regular part of the curriculum. The high frequency of experiments likely enhanced students' conceptual understanding of key chemistry topics because regular engagement with hands-on activities facilitates deeper learning and retention of concepts. The research data reflected a strong consensus among students that improvised experiments significantly enhanced their comprehension of challenging chemistry concepts, highlighting the importance of practical engagement in science education. It can therefore be concluded that improvised experiments could bridge the gap between theoretical knowledge and practical application, making abstract concepts more tangible and relatable for students. This hands-on approach aided in visualising and understanding complex topics(Ndihokubwayo K. , 2021).

A significant number of students agreed that improvised experiments enhanced their comprehension of abstract chemistry concepts, such as chemical bonding and reaction rates. This indicated a strong belief in the effectiveness of hands-on learning. Given the overwhelmingly positive feedback, it would be beneficial to continue incorporating improvised experiments into the curriculum. This could further enhance student engagement and understanding of chemistry and agrees with the social constructivism theory.

The strong agreement among students that improvised experiments made lessons more engaging suggested that improvised experiments significantly enhanced student interest and participation. The findings highlight the importance of incorporating practical experiments into the curriculum to foster an engaging classroom atmosphere. Engaged students are more likely to retain information and develop a deeper understanding of complex concepts. The data indicated that improvised experiments significantly enhanced the engagement of chemistry lessons, making them a vital component of effective teaching practices in science education. This data proved that improvised chemistry experiments were particularly effective in demystifying the concept of acids, likely because acids can be demonstrated with simple, safe household materials, making the lessons more tangible and relatable. By improvisation, teachers can tailor make their lessons to address individual learning gaps and stimulate interest in these subjects. The strong clarity shown for acids suggests that educators should consider focusing more on practical applications related to this topic when designing lessons. Incorporating more experimental activities could further enhance comprehension.

5.3.2 Pre-test and post-test analysis.

The results showed that there was a registered improvement in various areas since the implementation of improvised experiments in the chemistry curriculum, specifically focusing on problem-solving skills, retention of concepts, participation in class, and exam performance. The data indicated a notable improvement in problem-solving skills. This suggested that improvised experiments helped students develop critical thinking and analytical abilities, which are vital in chemistry. There was a significant improvement in the retention of concepts, though not as pronounced as in problem-solving skills. This indicated that improvised experiments aided in long-term understanding and memory of key chemistry topics, enhancing students' ability to recall information. The report showed that nine out of ten students reported significant improvement in their performance. This strong response indicates that the use of improvised experiments has had a positive and impactful effect on students' understanding and application of chemistry concepts in a formal testing setting. The findings underscore the effectiveness of using practical experiments in enhancing student performance in standardised assessments. This could encourage educators to continue or expand the use of such methods in their teaching strategies.

Notable change in student performance was realised in standardised tests and assignments since the introduction of improvised experiments. The data distribution highlighted that all students benefited academically from the implementation of improvised chemistry experiments, with the majority showing marked gains. The absence of any negative or neutral responses further underscored the effectiveness of this teaching approach. The data strongly suggests that improvised chemistry experiments not only enhance students' understanding but also translate directly into improved performance in standardised tests and assignments. These findings support the continued use and possible expansion of improvised practical activities as a strategy to boost both engagement and achievement in chemistry at Chasiyatende Secondary School.

Science improvisation is a better way of learning by doing, where students are allowed to work hands-on and cope with the cheap, wasted materials around their environment.

5.3.3 Challenges and opportunities in Chemistry improvisation.

Challenges faced in implementing improvised experiments in the chemistry curriculum were investigated and the most significant challenge identified was the lack of materials**,** with a score of 5**.** This indicated that access to necessary resources was a major barrier to successfully conducting improvised experiments, highlighting the need for better resource allocation or alternative sourcing strategies. The second highest challenge was time constraints**,** indicated by a score of 4**.** This suggested that educators struggle to fit hands-on improvised experiments into an already packed curriculum, emphasizing the need for careful planning and potential adjustments to lesson pacing. while challenges exist, particularly concerning materials and time, there are also opportunities to improve the implementation of improvised experiments in the chemistry curriculum.

The most significant opportunity identified in improvised experiments in a resource-limited environment was cost savings. This suggested that improvised experiments can be a budget-friendly alternative to traditional lab activities, making chemistry education more accessible. The data highlighted several key opportunities that could be leveraged to enhance the educational experience. In support of the findings, STAN 40th anniversary conference proceedings (1997), confirms that some of influences that improvised materials would have on chemistry teaching and learning were mainly provision of a cognitive bridge between abstraction and reality to students. Cost saving and the teacher student positive effort towards effective instruction. Thus, improvisation undertaken by the teachers enabled them to think and research for cheaper, better and faster methods of making the teaching and learning process easier for students. By focusing on cost-effective methods and fostering creativity, educators can create a more engaging and resourceful learning environment. To maximise these opportunities, it may be beneficial to develop workshops or training sessions that focus on creative experiment design and visualisation techniques, ensuring that educators are equipped to fully utilise the potential of improvised experiments.

5.4 Conclusion

The purpose of this project was to assess the impact of improvised chemistry experiments on students' conceptual understanding of core topics, as well as to evaluate their effect on academic performance and identify both challenges and opportunities in resource-limited school settings. The findings revealed that improvised experiments significantly improved students' ability to visualize and internalize abstract chemical principles, thereby bridging the gap between theoretical instruction and practical application. Test score analysis provided further evidence of this improvement, with post-experiment results showing a marked increase in comprehension, accuracy, and retention compared to pre-experiment assessments. Beyond academic performance, the study found that improvised experiments cultivated greater learner engagement, fostered collaborative problem-solving, and stimulated creativity, attributes that are crucial for long-term scientific literacy. Nonetheless, the project also exposed barriers to effective implementation, including shortages of locally available materials, insufficient teacher preparation, and limited institutional support. These findings highlight that while improvised experiments are highly effective in enhancing learning outcomes, their success depends on deliberate investment in teacher training, structured resource mobilization, and sustained curriculum integration. Overall, the study confirms that improvised experiments can serve as a transformative pedagogical tool, capable of elevating science education in under-resourced schools by making chemistry both accessible and meaningful to learners. By addressing the identified challenges, this approach has the potential to move from a temporary coping strategy to a sustainable, innovative practice that directly supports the aim of improving conceptual understanding and academic performance in chemistry.

5.5 Recommendations

Based on the study's conclusion, the following recommendations are proposed:

- Train teachers on the effective use of improvised experiments to enhance learners' understanding of abstract chemistry concepts through continuous professional development workshops
- Integrate improvisation techniques into lesson planning to promote active knowledge construction, engagement and practical application by students.

- Regularly incorporate pre- and post-test evaluations to monitor the impact of improvised experiments on academic performance, to monitor students' academic progress and inform teaching strategies.
- Encourage teachers to design experiments that align with examination topics to improve performance outcomes.
- Provide guidance on locally available, safe materials that can substitute standard laboratory equipment and ensure safe practices.
- Advocate for the formal inclusion of improvised experiments in the national science curriculum to support resource limited schools.
- Encourage collaborative, hands-on experiments to boost student participation, motivation and problem-solving skills.
- Encourage group-based improvisation activities to foster collaboration and active participation.
- Offer continuous professional development workshops focused on improvisation and low-cost practical teaching strategies.
- Develop safety protocols and guidelines for using improvised materials in practical lessons.
- Promote the adoption of improvisation strategies as a standard practice in chemistry classrooms to enhance learning outcomes.
- Conduct further research on the long-term impact of improvised experiments and explore innovative materials and methods for future use in under-resourced schools.

5.6 Suggestions for future use.

- Investigate the long-term impact of improvised chemistry experiments on students' academic performance and retention of knowledge.
- Explore the effectiveness of improvised experiments across different science subjects, such as physics and biology, in resource-limited schools.
- Examine the influence of teacher training programs on the quality and effectiveness of improvised experiments.

- Study the relationship between student engagement, motivation, and learning outcomes when using improvised teaching methods.
- Analyze the safety and risk management strategies associated with using improvised materials in practical science lessons.
- Assess the role of community and parental support in facilitating the availability of resources for improvised experiments.
- Investigate the comparative effectiveness of improvised experiments versus conventional laboratory experiments in improving conceptual understanding.
- Explore innovative, low-cost materials and techniques that can be used for science practicals in rural and under-resourced schools.

5.7 Areas for further research

Although this study established that improvised chemistry experiments positively impact learners' understanding and performance at Chasiyatende Secondary School, several areas warrant further investigation to strengthen the evidence base and guide future practice. One area is the long-term effects of improvised experiments on students' academic performance and retention of chemistry concepts. While this study focused on short-term improvements observed through pre- and post-tests, longitudinal studies could determine whether the benefits are sustained over time.

Another key area is the application of improvisation across other science subjects. Research could explore how improvised experiments influence learning in physics, biology, and integrated science, particularly in rural and resource-limited schools. Understanding cross-disciplinary impacts may help educators develop more holistic approaches to science instruction in under-resourced contexts.

The role of teacher training also requires further investigation. Studies could examine the effectiveness of professional development programs in equipping teachers with the skills to design, implement, and assess improvised experiments safely and effectively. Linked to this is the need to explore student engagement, motivation, and attitudes, assessing how these factors interact with learning outcomes when using improvised materials.

Finally, research could focus on innovative, low-cost materials and techniques that can be used for practical science lessons, as well as evaluating community and parental support mechanisms in facilitating access to resources. Such studies would provide practical strategies for scaling up the use of improvisation in resource-limited schools.

5.8 Summary

The research attempted to determine the effects of implementing improvised chemistry experiments on students' understanding and performance at Chasiyatende Secondary School. The study's findings led to the conclusion that improvised experiments significantly enhance learners' comprehension of challenging chemistry concepts, highlighting the importance of practical engagement in science education. The results conclude that improvised experiments can bridge the gap between theoretical knowledge and practical application, making abstract concepts more tangible and relatable for students. This confirms the hypothesis **H_0:** implementing improvised chemistry experiments has an impact on students' understanding and performance.

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APPENDIX

Appendix A: Sample Pre-Test Questions (Before Improvisation)

1. Define an acid and give two examples.
2. State two methods used to separate mixtures.
3. Explain the term “neutralization reaction.”
4. Identify common laboratory equipment used for measuring liquids.
5. Name two indicators used to determine the pH of a solution.

Appendix B: Sample Post-Test Questions (After Improvisation)

1. Using an example, explain how improvised materials can be used to demonstrate an acid-base reaction.
2. Describe how you can separate sand from salt using materials found at home.
3. What observable changes occur during a neutralization reaction?
4. List any two improvised materials you used during the chemistry practical lessons.
5. Explain how the practical activities helped you understand the topic better.

Appendix C: Questionnaire: Effects of Improvised Experiments on Learner Performance

School: Chasiyatende Secondary School
Confidentiality: Responses are anonymous and for research purposes only.

Section A: Demographic Information

1. Respondent type:
   - ☐ Student
   - ☐ Teacher
   - ☐ Laboratory Technician
2. If a student:
   - Grade/Class: ________
   - Gender: [ ] Male [ ] Female [ ] Other
3. If a teacher:
   - Years of teaching experience: ________
   - Subjects taught: ________

Section B: Conceptual Understanding

(Objective 1: Assess impact on conceptual understanding)

4. How often are improvised experiments used in your chemistry classes?
   - ☐ Always
   - ☐ Often
   - ☐ Sometimes
   - ☐ Rarely
   - ☐ Never
5. Rate your agreement with the following statements **(1 = Strongly Disagree, 5 = Strongly Agree)**:

Statement	1	2	3	4	5
Improvised experiments helped me understand abstract chemistry concepts (e.g., chemical bonding, reaction rates).					
Improvised experiments made lessons more engaging.					
I can relate improvised experiments to real-life applications.					

6. Which topics did improvised experiments clarify most? (e.g., acids/bases, stoichiometry):

Section C: Academic Performance

(Objective 2: Evaluate effect on test scores)

7. Compare your test scores in chemistry before and after using improvised experiments:
   - Average score before: [ ] 0–40% [ ] 41–60% [ ] 61–80% [ ] 81–100%
   - Average score after: [ ] 0–40% [ ] 41–60% [ ] 61–80% [ ] 81–100%
8. Have you noticed improvements in the following areas since using improvised experiments?
   - ☐ Problem-solving skills
   - ☐ Retention of concepts
   - ☐ Participation in class
   - ☐ Exam performance

(For teachers)
9. How has student performance in standardized tests or assignments changed since introducing improvised experiments?

- ☐ Significant improvement
- ☐ Moderate improvement
- ☐ No change

- ☐ Decline

Section D: Challenges and Opportunities

(Objective 3: Identify challenges and opportunities)

10. What challenges do you face in implementing improvised experiments? (Select all)
    - ☐ Lack of materials
    - ☐ Time constraints
    - ☐ Limited teacher training
    - ☐ Student disinterest
    - ☐ Safety concerns
11. What opportunities do improvised experiments offer in a resource-limited environment?
    - ☐ Cost savings
    - ☐ Enhanced creativity
    - ☐ Increased student participation
    - ☐ Better concept visualization
12. Suggest ways to improve the use of improvised experiments:

Section E: Additional Feedback

13. Other comments on the use of improvised experiments:

Thank you for your participation!

Appendix D: Teacher Interview Guide

1. What challenges do you face in conducting chemistry practical lessons at Chasiyatende Secondary School?
2. Have you ever used improvised materials in teaching chemistry? If yes, which materials?
3. In your experience, how do improvised experiments affect students' understanding of key chemistry concepts?
4. What safety measures do you consider when using improvised materials?
5. What support do you think is necessary to improve practical chemistry teaching in resource-limited schools?

Appendix E: Consent form

Research Title: The impact of improvised chemistry experiments on students' understanding and academic performance.

Researcher: Mhlanga Rowan Simangele Tariro

Institution: Bindura University of Science Education

Supervisor: Mr Manyeredzi

Purpose of study

You are invited to take part in a study that seeks to investigate the impact of improvisation on students' key concepts and their academic performance. Your participation will help generate knowledge that may improve the teaching and learning of chemistry, especially in resource-limited environments.

Procedures

If you agree to participate, you may be asked to:

- Complete questionnaires or participate in short interviews.
- Take part in improvised chemistry experiments or lessons.
- Provide feedback on your experiences with improvised experiments.
- For students, complete pre-test and poet-test assessment to evaluate learning outcomes.

Participation will take approximately 5-10 minutes per session and all activities will be carried within normal school settings.

Voluntary participation

Your participation in this study is entirely voluntary. You may withdraw at any time without any penalty or negative consequences.

Confidentiality

All information collected will be kept strictly confidential and used only for academic purposes. No names or personal identifiers will appear in the final report, data will be presented in aggregate form.

Risks and benefits

There are no anticipated risks in participated in this study. However, the findings may benefit both teachers and learners by improving teaching and learning experiences in chemistry.

Consent statement

I have read and understand the information provided above. I voluntarily agree to participate in this study and understand that I can withdraw at any stage without penalty.

Participant's Name:………………………………………………………………………………

Signature:…………………………………………………………………………………...

Date:………………………………………………………………………………………...

For participants under 18 years (learners):

I give permission for my child/ward to participate in this study.

Parent/Guardian's Name:……………………………………………………………………….

Signature:……………………………………………………………………………………….

Date:……………………………………………………………………………………….

Researcher's signature:…………………………………………………………………………...

Date:………………………………………………………………………………………...