BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE EDUCATION

DEPARTMENT OF SCIENCE AND MATHEMATICS EDUCATION

BACHELOR OF SCIENCE EDUCATION HONORS DEGREE IN BIOLOGY *Investigating the Impact of experimental methods on the teaching and learning of biology at ordinary level at Mashayamombe Secondary School in Chegutu District, Mashonaland West Province.*

By

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Submitted in Partial Fulfilment of the Requirements of the Bachelor of Science Education Honors Degree in Biology

Bindura University of Science Education, Bindura

FEBRUARY 2025

RELEASE FORM

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PROGRAMME FOR WHICH PROJECT WAS PRESENTED:	BACHELOR OF SCIENCE EDUCATION HONORS DEGREE IN BIOLOGY
YEAR GRANTED:	2025

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APPROVAL FORM

I, the undersigned certify that I have read and therefore recommend to Bindura University of Science Education for acceptance; a research project entitled: "**Investigating the Impact of Experimental methods on Biology Education: A Case Study of ordinary level students at Mashayamombe Secondary School in Chegutu District, Mashonaland West Province.**" submitted by Chakawarika Rutendo in partial fulfilment of the requirements of the Bachelor of Science Education Honors degree in Biology.

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EXTERNAL EXAMINER

DECLARATION

I, Chakawarika Rutendo do hereby declare that this research is a presentation of my own work except to the extend indicated in the Acknowledgement, References and by comments included in the body of the report and that it has not been submitted in part or in full to any other University or any other Institution of higher learning.

Student's Signature……  .....

Date……02 Feb 2025.....

ACKNOWLEDGEMENTS

First and foremost, I am grateful to God for allowing me to complete this research study.

I would like to thank some of the people who helped make this research possible. Mr L Muzamba whose precious time and constructive comments directed me throughout this research project, was the supervisor, mentor, and guide for this study. I would want to use this occasion to express my utmost gratitude to him for his unwavering support,

sharp interest, patience, and attention during this research.

My gratitude also extends to our respondents, who took the time out of their busy schedules to share their stories with us. I owe them a large debt of gratitude for their cooperation throughout this project, without which it would have been a colossal failure.

Once again, I want to express my thanks to my wife and children and friends, for their patience, time, and encouragement. You had to bear with me even though it was tough for you to be without me at a time you most needed me.

My sincere and unending gratitude to you all for your unwavering support, patience, and encouragement.

Thank You

DEDICATION

This research study is dedicated to my wife, children, parents, friends, and college classmates, all of whom provided me with the material and moral support I needed to keep going. You are all adored for encouraging me to work hard every day for a brighter tomorrow. It is your love and culture of hard work and devotion that you have instilled in me through the years that keeps fuelling me to try new things.

LIST OF ACRONYMS

ANCOVA	Analyses of Covariance
GST	General System Theory
IT	Information Technology
MoPSE	Ministry of Primary and Secondary Education
NECO	National Examination Council
SPSAT	Science Process Skills Acquisition Test
SSCE	Secondary Short end of Course Examination

STEM	Science, Technology, Engineering &Mathematics
UNESCO	United Nations Educational, Scientific and Cultural Organization
WAEC	West African Examinations Council
ZIMSEC	Zimbabwe School Examinations Council

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ABSTRACT

This study is found on the backdrop of Investigating the Impact of Experimental methods on the teaching and learning of Biology. Biology education holds a crucial position in secondary schools as it serves as the foundation for students' comprehension of living organisms and their interactions with the environment. Despite some researchers exploring the impact of experimental methods on teaching and learning of science subjects, including notable innovations and discoveries, there remains a research gap regarding the impact of experimental methods on teaching and learning of biology to ordinary level students. The study aims to investigate the current use of teaching methods including experimental methods in teaching biology, the impact of experimental methods in enhancing students' understanding of biology concepts, the challenges faced in implementing them, and strategies to improve their implementation. Biology has a special place in the curriculum of educational institutions. Numerous science-related courses, including those in biochemistry, medicine, pharmacy, agriculture, nursing, and other fields, heavily rely on biology. This research targets only a population of participants who happen to be ordinary level students at Mashayamombe Secondary School in Chegutu District, Mashonaland West Province. A sample of 70 participants was selected to ensure the inclusion of all members with required experiences related to the impact of Experimental methods on Biology Education. Summing up this research, the value of hands-on experimental methods towards students' learning process and academic improvement were shown in various data collected. The bulk of the data collected had shown positive results in most of the areas. As a result, this study has demonstrated that experimental methods promote students' knowledge and builds on their intrinsic impetus. The study found that when teachers use experimental methods in a constructive way, students

become more engaged, creative, critical thinkers, and first-hand skills are developed, and the teaching and learning process becomes more efficient. Based on the results of this study, the researcher suggests that Bruner's theory of teaching in science learning be investigated further using practical trials. Further study should involve other Ordinary level students within the district and other districts as well as their Provinces, with a view to comparing the results with this research which are only in Chegutu District.

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CHAPTER 1

1.0 INTRODUCTION

This chapter serves as an introduction to the research study, providing a comprehensive overview of the background, problem statement, purpose, objectives, research questions, basic assumptions, significance, limitations, delimitations, future research possibilities, key terms definitions, and a summary of the chapter. It sets the tone by presenting the background that led to the research and identifies the specific problems to be addressed. The purpose of the research is outlined, accompanied by research questions that will guide the investigation. The chapter takes into account the basic assumptions underlying the research and emphasises the significance of the study. The chapter also acknowledges the limitations and delimitations, while at the same time suggesting future research possibilities. Definitions of key terms are provided to ensure clarity and the chapter concludes with a summary, providing a brief overview of the chapter's contents.

1.1 BACKGROUND OF THE RESEACH

The teaching and learning of biology is key in the development of a nation. Biology is a fundamental subject as indicated by the Ministry of Primary and secondary education in 2016 through Science, Technology, engineering, and mathematics (STEM) education, which places significant emphasis on science education as it fosters the development, preservation, and dissemination of knowledge and skills that yields personal, economic, and social benefits .However the teaching and learning of biology as observed by this researcher is fraught with a number of challenges hence the poor performance by Ordinary level students at a chosen school, Mashayamombe Secondary School, Chegutu district, Mashonaland West Province.

The Ordinary level biology pass rate at the chosen school had remained at a very low level and the researcher also observed that the general motivation of students was at its lowest ebb. The students at the school exhibited a negative attitude towards biology and other science subject. The researcher also observed that science facilities were inadequate or poorly equipped. The teaching and learning of biology lacked hands-on approach and most of the learning were done using lecture method. As a result it became monotonous and the majority of the learners dropped science subjects including biology. The performance of the learners was deteriorating every day. These observations prompted this researcher embark on an investigation on the impacts experiment methods on students' performance in biology. This researcher therefore

suggested that the teaching methods have a great bearing on the participation of students during the lessons and active participation enhances understanding of the concepts being taught. These and other factors are the ingredients for better performance of students. Active participation encourages students to rely on evidence from observed data, promotes independent thinking, this reduces their reliance on authority.

This researcher also observed that there was a strong perception to the effect that biology and other science subjects are very difficult and that they can only be done in certain schools. This is one of the strongest push factors against biology and other science subject. The researcher noted that to address the issue of students' academic performance, a number of factors come into play. The researcher also observed that more male students take science subjects as compared to their female counterparts. This led to very low subscription of science subjects by females.

The focus of this research is to assess the effectiveness of experimental method in teaching biology to ordinary level students at Mashayamombe Secondary School in Chegutu District, Mashonaland West Province. This school situated in a rural setting, serves students from disadvantaged backgrounds, highlighting the importance of providing with practical and engaging learning experiences.

1.2 STATEMENT OF THE PROBLEM

The poor performance by candidates in biology is of serious national concern. In particular the concern of poor performance is glaring at the school under study. This study however, is going to zoom on biology performance at a chosen secondary school in Chegutu District of Mashonaland West Province. Despite the various factors that influence the poor pass rate in **biology, the researcher was prompted to investigate what actually are the impacts of** experimental method on students' academic performance in biology at a school in Chegutu District of Mashonaland West Province.

1.3 OBJECTIVES

1.3.1 Identify factors that contribute to poor performance in biology.

1.3.2 To find out which gender performs better in biology at ordinary level.

1.3.3 To assess the extent to which hands-on practical experiments influence the performance of students in biology.

1.3.4 To assess the impacts of experimental method on students' academic performance in biology at Ordinary level.

1.5.0 MAIN RESEARCH QUESTIONS

What are the impacts of experimental method on students' academic performance in biology at Ordinary level.

1.5.1 RESEARCH SUB-QUESTIONS

This study is guided by the following sub-questions:

1.5.2What are the factors that contribute to poor performance by students in biology?

1.5.3Which sex performs better in biology at ordinary level?

1.5.4To what extend do biology practical activities influence students' academic achievements in biology at ordinary level?

1.5.5 Which strategies can be used to improve ordinary level biology pass rate?

1.6.0 SIGNIFICANCE OF THE STUDY

1.6.1 TO BIOLOGY TEACHERS

This study's findings would assist biology teachers in developing ways and understanding how to teach this subject. The findings from this study might also be useful to biology teachers in the assessment and evaluation of teaching and learning of biology, thus enabling teachers to discover and perfect strategies aimed at improving teaching and learning of biology at a chosen secondary school.

This study's findings might be of use as it might contribute to discovery of new knowledge and might assist biology teachers to find solutions to the problems of learners who are facing challenges in the subject at the chosen school. Furthermore, educators might find this study to be of value to teaching and learning strategies and ensure inclusivity in the teaching and learning of biology.

1.6.2 TO SCHOOL ADMINISTRATORS

School administrators might get insight on how to conduct supervisions and improve on creating and managing an environment that is conducive for students and teachers to enhance performance in biology.

1.6.3 TO POLICY FORMULATORS

Policy formulators would gather useful information which would shed light on why the intervention so far implemented yielded required outcome. The study findings might as they would know the real impacts of experimental method on students' academic performance in biology at a Mashayamombe Secondary school in Chegutu District, Mashonaland West Province.

1.6.4TO STUDENTS/PUPILS OR LEARNERS

The students at the chosen school stand to benefit immensely from this study. The engagement of students in experimental methods in their learning of biology can make learning of biology more enjoyable and impactful. The experimental method affords students the opportunities to be active participants in the learning of biology. The research findings might provide learners with practical opportunities to explore and comprehend biological concepts, leading to a deeper understanding and the development of critical thinking skills.

1.6.5 TO THE RESEARCHER

The research findings will enable the researcher to have the basis for standardised future res2arch work. The researcher will gain skills and knowledge from the supervisor of this study. This will enable the researcher to be equipped with necessary skills to assist students in their areas of learning particularly biology.

1.7.0 DELIMITATIONS OF THE STUDY

For the purposes of clarity, this study will have certain delimitations which clarified below. The study was conducted at Mashayamombe Secondary School in Chegutu District in Mashonaland West Province. The study was carried out based on teachers and learners as these are active participants in the teaching and learning of biology. The criterion for the selection of the scfoFinaais based on geographical location and the socio-economic background of the catchment areas of this schIIICl.

The study examine the use of experiment method in teaching biology at ordinary level at Mashayamombe Secondary school, Chegutu District, Mashonaland West Province.

1.8.0 LIMITATIONS

This study acknowledges the power certain limitations that can have an impact on the research findings. The following were the limitations for the study :

Due to the requirements and schedule of events of Bindura University of Science Education, the study will be conducted within a specific time frame, which may limit the depth and scope of data collection analysis.

Considering practical constrains, the study focus on specific ordinary level class at the chosen school, Mashayamombe Secondary School. However, this might limit the

generalization of the findings to other schools with comparable features.

Fin ncial challenges were encountered during the cunduct of the study.

Money was required to meet transport costs, internet acces, typing,

printing and photocopying. The researcher used some savings.

The reliability of the research study could be exaggerated by respondent-based biases. Some respondents might not be truthful in their responses due to reasons of trying to impress the researcher and hiding certain information from the researcher. Some respondents might respond in a manner that enures that they protected their school.

1.9 ASSUMPTIONS

This study is based on the following assumptions:

a) Experimental method has a positive impact on students' understanding of biological concepts.

b) Experimental method promotes the development of critical thinking skills problem-solving skills

c) Experimental method fosters positive attitude in students learning experience.

1.10 DEFINITION OF TERMS

BIOLOGY

Biology is the scientific study of life and living organisms, including their structure, function, growth, evolution, distribution, and taxonomy (Campbell and Reece, 2008)

Biology is the scientific study of life and living organisms, including their structure, function, growth, evolution, distribution, and taxonomy (Campbell & Reece, 2008; Johnson & Raven, 2004; Purves et al., 2004).

As defined by the American Institute of Biological Sciences (AIBS), biology is "the scientific study of the living world and its many interactions" (AIBS, 2020)

EXPERIMENT

An experiment is a research method in which a researcher manipulates one or more independent variables and measures their effect on one or more dependent variables, while controlling for extraneous variables (Cozby, 2009; Kerlinger & Lee, 2000; Myers & Hansen, 2006).

According to the American Psychological Association (APA), an experiment is a "research strategy in which the researcher manipulates one or more independent variables and measures their effect on one or more dependent variables" (APA, 2020, p. 27).

Experiment refers to a research method whereby a hypothesis is formulated and is tested through manipulation of variables and observation of outcomes leading to a reasoned conclusion based on available facts.

1.11 SUMMARY

In conclusion, this chapter served as an introduction for the research study highlighting the background, problem statement, purpose, objectives, research questions, basic assumptions, significance of the study, limitations, delimitations, and key terms definitions. The chapter provided a comprehensive overview of the research study foundation and set the stage for the subsequent chapters. The next chapter will focus on literature review.

CHAPTER 2

LITERATURE REVIEW

2.0 INTRODUCTION

Literature review is a search and evaluation of the available literature in a certain subject or topic area according to Harvey (2018). The chapter focuses on theories behind practical experiments which are general systems theory, Piaget's theory, constructivism theory, experimental learning theory, cognitive load theory, self-efficacy and social learning theory. In this chapter Biology as a branch of science, teaching and learning and also practical activities were examined. Also included in the chapter are issues to do with laboratory facilities and student performance in Biology, merits and demerits of laboratory-based instruction, practical and academic performance, problem associated with biology practical related empirical studies and concluded with a summary.

2.1.0 Theoretical Framework

In the field of education, hands-on experiments have been recognized as a valuable tool for enhancing student learning experiences, particularly in science subjects like biology. The theoretical framework explored by the researcher is one which is engaging, learner-centred and based on constructivism approach.

2.1.1 The experiential approach

Due to the birth of positive psychology in the process of education, classroom engagement has been flourished and got a remarkable role in the academic field. The other significant determining factor of success in education is motivation which is in line with classroom engagement. Moreover, based on the constructivist approach, experiential learning (EL) as a new method in education and a learner-centric pedagogy is at the center of attention, as a result of its contributions to improving the value of education which centers on developing abilities, and experiences. The current review makes effort to consider the role of EL on students' classroom engagement and motivation by inspecting its backgrounds and values. Subsequently, the efficacy of findings for academic experts in educational contexts is discussed.

It is stated that a basic causative factor in the general achievement of learners studying in higher education is learners' engagement (Xerri et al., 2018; Derakhshan, 2021). It is extensively approved that learners who are actively participating in the learning progression and take interest in their academic education are more likely to achieve higher levels of learning (Wang et al., 2021). Therefore, higher education institutions encourage learners to use their capabilities,

as well as learning opportunities and facilities that enable them to be actively engaged (Broido, 2014; Xie and Derakhshan, 2021). Moreover, students' dissatisfaction, boredom, negative experiences, and dropping out of school are in part due to the low engagement in academic activities (Derakhshan et al., 2021). It has been demonstrated that engagement is, directly and indirectly, related to intelligence, interest, motivation, and pleasure with learning outcomes within many academic fields (Yin, 2018). Likewise, engagement is a construct that is shaped from the multifaceted relations of perceptions, feelings, and motivation which is corresponding to the progress of self-determination theory in the motivation realm (Mercer and Dörnyei, 2020). Besides, the student's motivation is a significant factor in cultivating learning and consequently increasing the value of higher education because the more the learners are motivated, the more likely they can be successful in their activities (Derakhshan et al., 2020; Halif et al., 2020).

From a psychological point of view, motivating learners and engaging them in the classroom are closely related (Han and Wang, 2021); nevertheless, motivation consists of factors that are psychological and difficult to observe, while engagement involves behaviors that can be observed by others that it is not simple to notice and estimate learners' motivation (Reeve, 2012). In other words, educators cannot concretely understand the fulfillment of their learners' basic mental necessities and enthusiasm for learning (Reeve, 2012). Nonetheless, Reeve asserted that in contrast to motivation, learners' engagement by all accounts is a phenomenon that is distinctive and can nearly be noticed. Generally, educators can impartially consider whether or not a specific learner is engaged in the class exercises, such as problem solving.

As a reaction to the traditional teaching approach that is teacher-centric (Che et al., 2021) and following the inclination to expanding interest in a more unique, participative learning atmosphere, educational organizations are orienting toward learning approaches that cultivate students' involvement, interest, and dynamic participation. EL is a successful teaching method facilitating active learning through providing real-world experiences in which learners interact and critically evaluate course material and become involved with a topic being taught (Boggu and Sundarsingh, 2019). Based on the teaching theory of Socrates, this model relies on research -based strategies which allow learners to apply their classroom knowledge to real-life situations to foster active learning, which consequently brings about a better retrieval (Bradberry and De Maio, 2019). Indeed, engaging in daily activities, such as going to classes, completing schoolwork, and paying attention to the educator, is all indicators of classroom engagement (Woods et al., 2019). Moreover, by participating in an EL class paired with relevant academic activities, learners improve their level of inherent motivation for learning (Helle et al., 2007) and they have the opportunity to choose multiple paths to solve problems throughout the learning process by having choices and being autonomous (Svinicki and McKeachie, 2014). EL is regarded as learning by action whereby information is built by the student during the renovation of changes (Afida et al., 2012). Within EL, people become remarkably more liable for their learning which regulates a stronger connection between the learning involvement, practices, and reality (Salas et al., 2009) that are key roles in learning motivation.

To make sure that the learners gain the required knowledge and get the factual training, it is equally important to give them time to develop their ability to use their knowledge and apply those skills in real-world situations to resolve problems that are relevant to their careers (Huang and Jiang, 2020). So, it seems that they would like more hands-on training and skills development, but awkwardly, in reality, they generally just receive theoretical and academic education (Green et al., 2017). In addition, as in today's modern world, where shrewd and high-performing people are required, motivation and engagement should be prioritized in educational institutions as they are required features in the learning setting while they are often overlooked in classrooms (Afzali and Izadpanah, 2021). Even though studies on motivation, engagement, and EL have been conducted so far; however, based on the researcher's knowledge, just some have currently carried out systematic reviews about the issue and these studies have not been all taken together to date; therefore, concerning this gap, the current mini-review tries to take their roles into account in education.

2.1.2 Classroom Engagement and Motivation

As a three-dimensional construct, classroom engagement can be classified into three types: physical, emotional, and psychological (Rangvid, 2018). However, it is not always easy to tell whether a learner is engaged because observable indicators are not always accurate. Even those who display signs of curiosity or interest in a subject or who seem engaged may not acquire knowledge about it. Others may also be learning despite not displaying any signs of physical engagement (Winsett et al., 2016).

As an important component of success and wellbeing, motivation encourages self-awareness in individuals by inspiring them (Gelona, 2011). Besides, it is a power that manages, encourages, and promotes goal-oriented behavior, which is not only crucial to the process of learning but also essential to educational achievement (Kosgeroglu et al., 2009). It appears that classroom motivation is influenced by at least five factors: the learner, the educator, the course content, the teaching method, and the learning environment (D'Souza and Maheshwari, 2010).

2.1.3 Experiential method

EL, developed by Kolb in 1984, is a paradigm for resolving the contradiction between how information is gathered and how it is used. It is focused on learning through experience and evaluating learners in line with their previous experiences (Sternberg and Zhang, 2014). The paradigm highlights the importance of learners' participation in all learning processes and tackles the idea of how experience contributes to learning (Zhai et al., 2017). EL is a method of teaching that allows learners to learn while "Do, Reflect, and Think and Apply" (Butler et al., 2019, p. 12). Students take part in a tangible experience (Do), replicate that experience and other evidence (Reflect), cultivate theories in line with experiences and information (Think), and articulate an assumption or elucidate a problem (Apply). It is a strong instrument for bringing

about positive modifications in academic education which allow learners to apply what they have learned in school to real-world problems (Guo et al., 2016). This way of learning entails giving learners more authority and responsibility, as well as involving them directly in their learning process within the learning atmosphere. Furthermore, it encourages learners to be flexible learners, incorporate all possible ways of learning into full-cycle learning, and bring about effective skills and meta-learning abilities (Kolb and Kolb, 2017).

2.1.4 Implications and Future Directions

This review focused on the importance of EL and its contributions to classroom engagement and motivation. Since experiential education tends to engage a wider range of participants who can have an impact on the organization, employees, educators, leaders, and future colleagues, it is critical to maintain its positive, welcoming atmosphere. The importance of EL lies in its ability to facilitate connections between undergraduate education and professional experience (Earnest et al., 2016), so improving the connection between the university and the world of work (Friedman and Goldbaum, 2016).

The positive effect of EL has actual implications for teachers who are thinking of implementing this method in their classes; indeed, they can guarantee their learners' success by providing them with the knowledge required in performing the task as following the experiential theory, knowledge is built through converting practice into understanding. Based on the literature review, the conventional role of the teacher shifts from knowledge provider to a mediator of experience through well-known systematic processes. Likewise, teachers should encourage learners by providing information, suggestion, and also relevant experiences for learning to build a learning milieu where they can be engaged in positive but challenging learning activities that facilitate learners' interaction with learning materials (Anwar and Qadir, 2017) and illustrates their interest and motivation toward being a member of the learning progression. By learners' dynamic participation in experiential activities, the teacher can trigger their ability to retain knowledge that leads to their intrinsic motivation and interest in the course material (Zelechoski et al., 2017).

The present review is significant for the learners as it allows them to model the appropriate behavior and procedures in real-life situations by putting the theory into practice. Indeed, this method helps learners think further than memorization to evaluate and use knowledge, reflecting on how learning can be best applied to real-world situations (Zelechoski et al., 2017). In the context of EL, students often find activities challenging and time-consuming which necessitates working in a group, performing work outside of the classroom, learning and integrating subject content to make decisions, adapt procedures, compare, and contrast various resources of information to detect a difficulty at one hand and implement that information on the other hand to form a product that aims to solve the issue. Participation, interaction, and application are fundamental characteristics of EL. During the process, it is possible to be in touch with the environment and to be exposed to extremely flexible processes. In this way, education takes place on all dimensions which cover not only the cognitive but also the affective and behavioral dimensions to encompass the whole person. Learners enthusiastically

participate in mental, emotional, and social interactions during the learning procedure within EL (Voukelatou, 2019). In addition, learners are encouraged to think logically, find solutions, and take appropriate action in relevant situations. This kind of instruction not only provides opportunities for discussion and clarification of concepts and knowledge, but also provides feedback, review, and transfer of knowledge and abilities to new contexts.

Moreover, for materials developers and syllabus designers to truly start addressing the learners' motivation and engagement, they could embrace some interesting and challenging activities because when they can find themselves successful in comprehending the issue and being able to apply their information to solve it; they are not only more interested to engage in the mental processes required for obtaining knowledge but also more motivated and eager to learn. More studies can be conducted to investigate the effect of EL within different fields of the study courses with a control group design to carry out between-group comparisons. Besides, qualitative research is recommended to scrutinize the kinds of EL activities which make a more considerable effect on the EFL learners' motivation and success and even their achievement.

2.1.5 Self-Efficacy Theory

According to Bandura's Self –Efficacy Theory, students' motivation and academic performance are influenced by their self-perceptions. By giving students, the chance to succeed in real-world problems, practical experiments can raise their self-efficacy and confidence in their biological knowledge (Bandura 1997).

2.1.6 Social Learning Theory

Bandura's Social Learning Theory emphasises the importance of modelling and observation in the learning process. Students can witness phenomena first-hand and engage with classmates through hands-on activities, which create collaborative learning environments that support the sharing of knowledge and the development of skills (Bandura 1977).

The above-described theoretical framework offers a thorough grasp of the ways in which practical experiments might influence biology teaching for students at the average level. Teachers can create efficient teaching strategies that use practical experiences to improve student learning outcomes by referencing constructivism, experiential learning, cognitive load, self-efficacy, and social learning theories.

2.1.7 Conceptual Framework

According to its definition, science is the study of natural phenomena. Additionally, science is an impartial, logical, and repeatable endeavour to comprehend the principles and forces at work in the natural world.

2.1. 8 What are the factors that contribute to poor performance by students in biology?

Research has shown that several factors contribute to poor performance by students in biology. Anderson (2007) concurs with Tsui (2007) that inadequate prior knowledge contributes to poor performance by students in biology. Anderson (2007) emphasise that limited understanding of fundamental concepts and insufficient background knowledge in chemistry and physics can lead to poor performance by students in biology.

Ineffective teaching methods have also been pointed out as possible causes of poor performance by students in biology. Hostein and Lunetta (2004) confirms that lecture-based instruction dominating practical activities makes a big contribution in the poor performance by students in biology. Abd-El-Khalic et al (2004) also concurs that lack of hands-on experiences and experiments have a negative effect on students' performance in biology. According to Mayer (2009) inadequate use of visual aids and multimedia resources is a big contributor to poor performance by students in biology.

Zimmerman (2002) asserts that students who study biology performs poorly due to inadequate time management and study habits. Bornwell and Elson (1991) add another dimension of poor learning strategy in limited use of active learning strategies as another contributor to poor performance by students in biology. Inefficient note-taking and review technics also causes poor performance in biology by students.

Assessment and feedback have been mentioned in previous studies as having an impact on student performance. Harlen (2007) shows confirms that overemphasis on summative assessment has a negative impact on student performance. Black and William (1998) identified limited formative feedback assessment as a factor that contribute to poor performance by students in biology.

Student motivation and engagement have according to study effects on student performance. Koballa (1988) posits that low motivation and interest in biology

contribute to poor performance by students. Limited opportunities for student autonomy and choice causes students to perform poorly (Deci et al (1990). Wentzel (1998) weighs in by stating that inadequate teacher support and encouragement impacts negatively on students' performance.

Akombo (2017) argues that limited resources and infrastructure causes poor performance by students in biology. According to Brotman and Moore (2008) societal and cultural factors influencing student attitudes have an impact on student performance. Parental involvement and support play an important role on the student's performance.

Several studies have investigated the factors contributing to poor performance in biology among South African students. The study carried out in South Africa showed that lack of prior knowledge and experience has a negative effect on student's performance in biology. Education or acquisition of knowledge depends on prior knowledge. According to Marbach (2015), student's prior knowledge and experience in biology can significantly impact their performance in biology, with those having a weaker foundation in the subject performing poorer. Language barrier was also picked up as another factor that contribute to poor performance in biology. The study further reviewed that insufficient hands-on laboratory experience can also hinder students' ability to develop essential scientific skills and understand complex biology concepts (Banilower et al, 2013). The study also highlighted on the socio-economic factors such as the fact that students from low-income background may face challenges that impact their academic performance, including limited access to resources, lack of parental support and poor health. This may also further impact on students as their self-esteem is also brought to its lowest ebb.

These factors highlight the need for a comprehensive approach to improve student performance in biology, including enhancing teacher preparation, increasing hands-on laboratory experience, and addressing socio-economic and language barriers.

2.1.9 Which sex performs better in biology at ordinary level?

Research suggests that there is no significant difference in biology performance between males and females at the Ordinary level. However, some studies have reported varying results. A study in Zimbabwe found no significant difference in biology performance between males and females at the Ordinary level (Moyo and Moyo,2015). A study carried out in Nigeria reported that females outperformed their male counterparts in biology at Ordinary level (Okebukola ,2002). In a study that was carried out in South Africa it was found that males performed better than females in biology at

the Ordinary level (Reddy,2005).

There are however, different factors influencing performance in biology by students. Sociocultural factors such as possibility of females facing more societal pressure to pursue non-STEM fields has an effect on student performance (Brotman and Moore,2008). The other factor is that males and females may have different learning styles, which can influence performance (Wintzel,1998)

Unfortunately, I couldn't find any specific studies on the performance of students in biology by sex carried out in Malawi. However, research has shown that various factors can influence student performance in biology, including socio-economic status, access to resources, teacher qualifications, and language barriers.

It's essential to note that studies on sex differences in biology performance have yielded mixed results globally. Some studies suggest that girls may perform better in biology, while others indicate that boys may have an advantage. However, these findings can be influenced by various factors, including cultural context, educational system, and research methodology.

2.10.0 To what extend do biology practical activities in academic achievements in biology at ordinary level

Research suggests that biology practical activities have a positive influence on students' academic achievements in biology at the Ordinary level. Practical improves understanding and retention of biological concepts (Hofstein and Lunetta, (2004). Hands-on experiences enhance students' critical thinking and problem-solving skills (Abd-El-Khalick et al,2004). Practical activities promote student engagement and motivation in biology (Koballa, 1998). Laboratory experiences improve students' scientific literacy and understanding of the scientific method (Lunetta, 1998)

A study in Zimbabwe found that students who participated in practical activities showed a significant improvement in their biology grades at the Ordinary level (Moyo and Moyo, 2015). A study in Nigeria reported that practical activities accounted for 30% of the variance in students' biology achievements

At the Ordinary level (Okebukola, 2002). In a study that was carried out in South Africa it was found that practical activities had a moderate to strong positive corer relation with student's biology achievement at the Ordinary level (Reddy, 2005).

2.10.1 Which strategy can be used to improve Ordinary level biology pass rate?

Several strategies can be employed to improve Ordinary level pass rate. Research has indicated that Inquiry-Based Learning as a strategy to improve Ordinary level biology pass rate. The strategy is to encourage students to explore biological concepts through hands-on investigations (Hofstein and Lunetta, 2004). The strategy involves the use of inquiry-based learning to promote critical thinking, problem-solving, and scientific literacy (Abd-El-Khalick et al,2004)

Research also suggests the use of differentiated instruction as a viable strategy. Facilitators are encouraged to cater to diverse learning needs by using various teaching methods, such as visual, auditory, and kinaesthetic approaches (Tomlinson, 2001). There is also need to use differentiated instruction to promote student engagement, motivation and understanding 9Koballa, 1998).

According to Black and William (1998), regular administration of formative assessment to monitor student progress and identifying areas for improvement is a strategy to be used to improve biology pass rate. Wiggins (1998) pointed out that it is important to use formative assessments to provide constructive feedback and adjust instruction to meet students' needs.

Practical activities are mentioned by research as key strategies in improving students' biology pass rate. Facilitators should incorporate practical activities to enhance student understanding and retention of biological concepts (Hofstein and Lunetta, 2004). There is also need to use practical activities to promote student engagement, motivation, and scientific literacy (Abd-El-Khalick et al, 2004).

Research has found out that technology has a big role to play in improving students' biology pass rate. Facilitators should incorporate technology such as simulations, games, and multimedia resources. To enhance student engagement and understanding (Mayer, 2009). To improve students' biology pass rate facilitators should use technology to provide personalised feedback, promote self-directed learning, and facilitate collaboration (Spector 2015). In addition, the education system should provide teacher support and guidance to help overcome difficulties and build confidence (Wintzel, 1998). The strategy I also to use teacher support and guidance to promote student motivation, engagement, and academic achievement (Koballa, 1998).

A study carried out in Tanzania identified several strategies to improve Ordinary Level biology pass rates (Mwamwenda, 2015). Here are some of the strategies recommended:

2.10 Strategies to Improve Ordinary Level Biology Pass Rates

Teacher professional development can be key factor in improving Ordinary level biology pass rate. Teacher professional development provides teachers with regular training and workshops to improve their content knowledge, pedagogical skills, and assessment techniques.

Facilitators who regularly undergo training keep abreast with modern approaches, thereby assisting students to acquire skills that are relevant to the current needs of individuals and community around.

The facilitator plays a significant role in ensuring that students get actively involved. It is the role of the facilitator to identify methods of instruction that are student-centered. Student-centered learning approaches, such as problem-solving, group work, and discussion promote active learning and engagement. Practical based learning including laboratory experiments and fieldwork help students develop essential scientific literacy and understanding. Peer Tutoring can be used where high achieving students provide support and guidance to the other students. According to Mavhunga (2 015) collaborative learning promote active learning and engagement.

The provision of resources such as textbooks, infrastructure such as laboratories and manpower development have a potential of increasing the pass rate in biology. Technology provision and use can be important in ensuring that effective learning takes place.

The improvement of assessment tools, execution and its quality are effective in providing feedback to the educational stakeholders. Both formative and summative assessment and evaluation provide critical insights in teaching and learning process. Assessment and evaluation insights informs the school of the importance of involving parents in the learning of their children. Therefore, regular progress reports will provide essential feedback to the parents and this provide the platform for meaningful engagement. Through parent conferences teachers and parents engage each other for the benefit of student.

By implementing these strategies, educators in Tanzania can work towards improving Ordinary Level biology pass rates and promoting student success.

A study carried out in Zimbabwe identified several strategies to improve Ordinary Level biology pass rates (Moyo, 2017). According to this study content knowledge enhancement is important in providing teachers with regular training to improve their content knowledge in biology. The study also identified practical-based learning as very critical in developing scientific skills.

Setting specific, measurable, and achievable goals enables students to track their progress and adjust their study strategies accordingly. This approach helps students feel more in control and

reduces anxiety during exams. Also, the use of a wide variety of learning resources such as textbooks, online courses, podcasts, and revision cards can provide students with various contexts and perspectives, making learning more engaging and effective

Regular practice exams can help students become familiar with the exam format, identify areas of improvement, and develop effective time management skills. Practice and experience enable the students to develop confidence in what they do.

Attracting and retaining high-quality teachers is crucial in improving educational outcomes. This can be achieved by offering competitive salaries, providing opportunities for professional development, and creating a supportive teaching environment. This is very important especially in our Zimbabwean set up where brain drain has taken its toll in science subject area.

Socio-economic factors, such as poverty and lack of access to resources, can significantly impact student performance. Addressing these factors through initiatives like free meals, uniforms, and learning materials can help level the playing field. The ongoing school feeding program is one of the initiatives by the government which has gone a long way to improving nutrition and consequently attendance of school by students.

2.11 Challenges and limitations

Despite the benefits of experimental methods, several challenges and limitations exist. According to Hofstein and Lunetta (2004), limited resources and equipment work against the provision of quality education whereby students are actively engaged. The equipment and other resources help students grasp concepts in the context of teaching materials and interaction with the environment.

Lack of qualified teachers in the areas of science and biology in particular has affect the teaching and learning of the subject. Teachers who are qualified in the area provide quality expertise that will be a strong base for grooming young scientists.

According to Taraban et al (2 007), limited time given to practical activities is another challenge posed in the teaching and learning of biology. Most of the schools commit

themselves to attaining very good results at the examinations. These pressures force teachers to encourage their students to learn by rote.

Safety concerns and risk assessment are challenges that are weighing down on effective teaching and learning of biology. Science teaching and learning involves the use of dangerous chemicals and it is imperative that safety issues be addressed so that the laboratories are learner friendly.

2.12 Summary

The chapter looked at the theoretical frameworks behind practical experiments which include the theory approach, social efficacy theory and the social learning. The chapter made attempt to review literature based on the sub- questions of the research what are the factors that contribute to poor performance by students in biology? Which sex performs better in biology at ordinary level? To what extend do biology practical activities assist in academic achievements in biology at ordinary level and which strategy c can be used to improve Ordinary level biology pass rate. Finally, the chapter looked into the challenges and limitations of the experimental methods. The following chapter will explore research methodology.

CHAPTER 3

RESEARCH METHODOLOGY

3.0. Introduction

This chapter outlined the research methodology that was used in this study. It explains the importance of qualitative methods and procedures that were used in this research. The development of qualitative research is strongly influenced by ideas about the importance of understanding human behaviors in their social and material contexts ; and meanings that people attach to their own experiences(Ritchie 2003).Thus, 'Interpretivism', which is integral to the qualitative research tradition, is seen to overcome some of the perceived limitations associated with 'positivism', the tradition most commonly associated with statistical social enquiry (Ritchie,ibid).This study sounds to investigate the impact of hands-on experiments on biology education at ordinary level using face to face interviews, focus group discussions, observations to solicit data based on their practical experiences. The different theories formed the basis of this study focusing on biology as a science as used in both developed and developing countries. It is at this stage worth mentioning that the idea of interpretative research corresponds with how designers undertake to learn and understand behavior, and analyze findings in order to produce theories about the nature's problems and potential solutions.

3.1 Research Design

Research design refers to the overall strategy and plan for conducting a research study, including the methods and procedures used to collect and analyze data. According to Creswell (2014), a research design is plan for collecting and analyzing data to answer research questions or test hypothesis. In the same vein, Dawson (2012) mentioned that a research design may include observational research, case studies and surveys. This study involves quantitative research. Quantitative research, according to Creswell (2014), is an approach for testing objective theories by examining the relationship among variables. These variables can be measured typically in instruments, so that numbered data can be analyzed using statistical procedures.

In addition, this design describes what all participants have in common as they experience the practicality of hands-on experiments in the teaching of biology at

ordinary level. Phenomenology is not only a description, but it is also seen an interpretive process in which a researcher makes an interpretation thus, the researcher mediates between different meanings of the hands-on experiments, according to Van Manen (1990). Therefore, the phenomenal paradigm reduces individual experiences to a description of universal experience, which in this case, the impact of hands-on experiments on biology teaching and learning. The researcher is therefore a learning to collect data from people who have experienced this phenomenon. On the other hand, Morrison (2005) argues that through in-depth investigation of complex phenomena, qualitative research offers valuable insights into the underlying causes, motives, and behaviors of individuals or groups. Conversely, quantitative research facilitates the quantification of correlations between variables and the extrapolation of findings to a broader population. Researchers can have a thorough grasp of the study subject from several angles by integrating the two methodologies. Consequently, Douglas and Moustakas (1984) posited that integrating quantitative and qualitative research designs has several advantages, one of which is triangulation, which is the use of several approaches to investigate the same topic. While quantitative data can confirm conclusions drawn from qualitative investigation, qualitative data can assist in understanding the outcomes of quantitative analysis. This cross validation increases the reliability and trustworthiness of the research findings.

This design begins by acknowledging that there is a gap in our understanding and that clarification will be of benefit. This therefore justifies the main scope of this study of investigating the impact of experiments in the teaching of biology at ordinary level. In summary, there are several advantages to using both qualitative and quantitative research approaches in a study, including thorough comprehension, validation through triangulation, improved research validity, complementary data collecting, and deeper insights for decision-making.

3.2.0. Research approach

The research approach which was employed in this study is quantitative approach. Bryman (2 016) defines quantitative approach as a research that allows for objective measurement and analysis, minimizing research bias. Creswell (2 014) asserts that quantitative methods provide reliable results, as data collection and analysis are standardized.

3.2.1 Methodological Limitations

The methodology used in a research study has its strengths and weaknesses. The quantitative method has the potential of being oversimplified as a result of overemphasis on quantification. The tendency of quantitative of data massively tends to reduce complex phenomena to numerical data, potentially oversimplifying reality. The quantitative method is based on a restrictive research design. It risks relying on predetermined hypothesis, limiting exploration of unexpected findings.

Sampling limitations arise as a result of sample sizes and selection methods not accurately representing the population (Field, 2018)

3.2.2 Data-Related Limitations

The carrying out of research studies involve a variety of approaches as well as activities which may be part of error creation. Data collection pose challenges of accuracy. Errors in data collection, entry, or analysis can compromise findings (Bryman, 2016). Numbers can be used to illustrate size or quantity but if a wrong number is used the message is totally distorted.

Numbers can be used to summarize a lot of data but the same data cannot reveal the details and contextual information, making it difficult to interpret data. Quantitative data often assume linear relationships which may not accurately represent complex phenomena.

Overreliance on statistical significance may lead to overlooking practical significance or real-world implications (Bryman, 2016). Findings from research studies may not be generalizable to other contexts or populations (Creswell, 2014). This is so because each environment is better understood contextually since the characteristics differ from one environment to another. The other challenge is that quantitative method may treat participants as mere objects simply data sources.

Quantitative research may overlook important qualitative aspects, such as participants' experiences or meanings (Field 2018)

3.3.0 Research design

Research design refers to the overall plan and structure for conducting a research study, including the methods and procedures used to collect and analyze data (Creswell, 2014). It involves identifying the research question, selecting the research methodology, and determining the sampling strategy, data collection methods, and data analysis techniques (Bryman, 2016).

3.3.1 Key Elements of Research Design

The key elements of research design are research question, research methodology, sampling strategy, data collection methods, and data analysis techniques. Research question is a clear and concise statement of the research problem or question. Research methodology is the overall approach and strategy used to conduct the research, including the research paradigm, methods, and procedures (Bryman, (2016). Sampling strategy is the method used to select participants or cases for study, including probability and non-probability sampling techniques. The techniques for collecting data, including surveys, interviews, observations, and experiments.

Bryman (2016) defines data analysis techniques as the methods used to analyze and interpret the data, including statistical analysis and qualitative data analysis.

3.3.2. Types of Research Designs

There are different types of research designs which include experimental design, quasi-experimental design, survey research design, case study research design and phenomenological design. Experimental design is a type of research design that involves manipulating an independent variable to observe its effect on a dependent variable. Quasi-experimental design is a design that involves comparing groups that are similar but not identical, often due to lack of random assignment (Bryman, 2016). On the other hand, the survey research design is a design that involves collecting data through self-report measures, such as questionnaires or interviews. The case study is a design that involves in-depth examination of a single case or a small number of cases. The phenomenological design is a design that involves exploring participants' subjective experiences and meanings (Bryman, 2016)

3.3.3 Research paradigm

Descriptive Research Paradigm

Descriptive research is a research paradigm that aims to accurately and systematically describe a phenomenon, situation, or population (Creswell, 2014). This approach focuses on providing a detailed and objective account of the research topic, without attempting to explain or interpret the findings (Bryman, 2016).

3.3.4 Characteristics of descriptive research

Descriptive methods of data collection are distinct in the way they operate. These methods have a quality of being objective, that is, they seek to provide a research that aims to give an unbiased research topic. According to Creswell (2014), descriptive research strives for objectivity, aiming to provide an unbiased and accurate description of the research topic. Besides being objective, the descriptive research involves systematic observation and data collection, using methods such as surveys, observations, and content analysis. The main focus of descriptive research is on providing detailed description of the research topic, without attempting to explain or interpret the findings. The other characteristic of descriptive research is that it uses quantitative methods such as statistical analysis and data visualization, to summarize and describe the data.

3.3.5 Types of Descriptive Research

The types of descriptive research are survey research, content analysis, and observational studies. The survey research involves collecting data through self-report measures, such as questionnaires or interviews (Creswell, 2014). The content analysis involves analyzing text, images, or other media to identify patterns and themes. The third type of descriptive research is the observational studies. This one involves collecting data through the systematic observation of participants or phenomena.

3.3.6. Advantages

There are a handful advantages of using descriptive research. Descriptive research provides an accurate and detailed description of the research topic (Creswell, 2014). In descriptive research the topic should clearly say what it says. The use of graphs and other media enables the identification of patterns and trends. According to Bryman(2016), descriptive research can identify patterns and trends in the data, providing valuable insights. Descriptive research is very crucial in informing future research by providing a foundation for further investigation.

3.3.7 Limitations

Descriptive research is widely used in research studies because of some reasons. Despite it being used widely, it has its shortcomings. Descriptive research does not attempt to explain or interpret the findings, which can limit its usefulness (Creswell, 2014).

Descriptive research may have limited generalizability to other contexts or populations (Bryman, 2016). This means what may apply in one area may not apply in another.

Collection of data is a very important aspect of descriptive research. However, descriptive research is dependent on the quality of the data, which can impact the accuracy and reliability of the findings (Field, 2018).

3.3.8 Population of the study

The identification of the population is very critical including its geographical distribution. This means that group composition based on commonality between people in their relationship to the research topic or in the social demographic characteristics which are most relevant to it are central, (Ritchie ,2003:56). The emphasis therefore is that significant differences in status between participants in the same group should be by all means be avoided. Hence, the definition of population by Frankel and Wallen (1996) as the entire group of persons having the same characteristics that are of interest to the researcher clearly elaborate on the characteristics of the population to be used by the researcher. Based on the understanding of the significance of fundamental characteristics of a population, the researcher confined the population to be composed of participants who are ordinary level students at Mashayamombe Secondary School in Chegutu District, Mashonaland West Province. This research sought to target form three and form four students of Mashayamombe Secondary School. Thus, the selection sought to cater for the differences in experiences these categories of people had. The research was based on the topic an investigation on the impact of experiments in the teaching and learning of biology at ordinary level.

3.4 Sample size

The researcher took a sample from form three and four students, who represented the target population. A sample size of a total of thirty students from both form three and form four classes. The sample size was regarded to be convenient in terms of time and cost limitations. McLeod (2014), defines a sample as a group of people who take part in an investigation. The individual who take part in the research are referred to as respondents or participants. A sample is intended to represent the population the population under study (Ibid 2014).According to Tull and Hawkins (1993), a sample may not give a true picture of the entire population because it is only a representative of the

total population. However, sampling was used because it poses a lot of challenges to treat the whole population in this research study. By sampling, the researcher was able to collect data more quickly and to analyze it faster than when the whole population was used. The use of the whole population poses challenges including accessibility of the whole population, time and financial constraints as well as the amount of data that need to be handled and analyzed.

3.5 Sampling Procedure and Technique

Sampling technique, according to Foley (2018) is the way the sample units are to be selected. In this research, the researcher both probability and non-probability sampling techniques for the two groups of respondents in the study. The technique ensured that the population were represented in the sample. Therefore, the cost of implementing the procedure was also minimal. Saunders,Lewis and Thomhill(2009) contend that,with probability sampling, the chance of each case being selected from the population is known and is usually equal for all cases.

From the form four students thirty-four were selected using purposive sampling, which is a non-probability sampling technique. Thus, a total of seventy students were selected. With purposive sampling, the researcher used judgement based on the knowledge of the people from which the required information could be acquired according to Lavraskas (2011). With the purposive sampling technique, the researcher was able to extract a lot of information out of the data collected. This technique, according to Foley (2018), is time and cost effective when compared to other sampling methods.

3.6.0 Data Collection Instruments

This section sought to highlight a number of qualitative instruments used such as interviews, group discussions, questionnaires and observations. The use of a variety of instruments necessitated error reduction or biases of data collection and analysis that ma accrue as a result of over relying on one set of research instrument over another. Creswell (2017), contends that evidence from multiple sources could be cross-checked and searched for consistence, regularities and irregularities.

3.6.1 Questionnaires

Questionnaires were used in this study to obtain primary data from students. The

survey questions on the research instruments were both open-ended and closed. Some closed-ended questions were designed in the form of Likert-Scale options. Griffin (2013), defines a questionnaire as a set of questions to a targeted sample of the study population with an aim of getting relevant answers. A questionnaire is a research instrument that consists of a set of questions, or other types of prompts, for the purpose of gathering information from respondents through survey or statistical study. A questionnaire may include open-ended and closed ended questions. Both closed-ended and open-ended questions were used in this study in order to get information from the participants and they helped in confirming the research findings. A lot of care and diligence were applied in the expression and arrangement of the questions so as to create simple, direct and non-biased questions.

3.6.2 Closed-ended Questions

Spiller (2014) stated that closed-ended questions have limited choices of responses and these were used in this study due to limited time which was available. The respondent opinions in this case were expressed without confusion. This system is directly linked to the usage of a likert scale.

Table 3.1 Rating of Likert Scale

Strongly agree	**5**
Agree	**4**
Uncertain (neither agree nor disagree)	**3**
Disagree	**2**
Strongly disagree	**1**

In this research a Likert scale was used to have direct and dependable evaluation of attitudes from the respondents. Students from Mashayamombe Secondary school were able to express their views and feelings by marking in the boxes provided and quantitative data was extracted from the use of Likert Scale. However, the Likert scale has a weakness in limiting the choice and type of responses.

3.6.3 In-depth face to face interviews

In general terms, interviews are optimal for collecting data on individuals' personal experiences, history and perspectives particularly when very sensitive topics are being investigated. The interview may be unstructured and or semi-structured, characterized by open-ended questions. According to Sim,(ibid), the researcher needs an interview guide or set of questions to keep the interview in line with issues under study. Face to face interviews are qualitative tools used to solicit data. They provide an interface between the researcher and the respondents, thus allowing interaction that clearly amounts to convenience in this research. Face to face interviews has an advantage that they maximize chances of clarifying questions, issues and answers between the interviewer and interviewee ,Pooley (2005).In this study teachers were interviewed in relation to issues concerning the study question. Also, this study utilized unstructured interviews which are also recommended for their ability to unravel and explore a phenomenon from the actor's point of view Dooley,(ibid). Hence, interviewing selected students enabled the researcher to have a detailed and meaningful information with regards to the impacts of hands-on experimental methods in the teaching and learning of biology at ordinary level.

3.7.0 Data Collection Procedures

3.7.1 Permission and Access

The researcher obtained permission from the Ministry of Primary and Secondary Education to conduct the research study. After the permission was granted, the researcher contacted Mashayamombe Secondary School authorities, briefed them on the research topic, scheduled interviews, focus group discussions and questionnaires.

3.7.2 Data Collection Methods

The researcher personally administered the following data collection methods: In-depth interviews, Focus group discussions and questionnaires.

3.7.3 Data Recording and Management

All data collected during the interviews and focus group discussions were accurately recorded using audio recorders and note taking. The recorded data was the transcribed verbatim and stored securely to maintain confidentiality and integrity.

3.7.4 Data Quality Control

To ensure data quality, the researcher verified the accuracy of the transcribed data, checked with participants to validate the data. The data was then stored in a secure location, accessible only to the researcher.

By strictly following these data collection procedures, the researcher ensured the collection of high- quality data that addressed the research questions and objectives while maintaining ethical standards.

3.7.5 Data Presentation and Analysis Procedures

Due to the nature of the research methodologies which are qualitative research and quantitative research themes and sub themes were generated from the data as well as objectives and study questions. Discussion of findings was linked to the literature review. In this regard information was created, discovered and emphasized which satisfied objectives and study questions from different respondents in response to the study topic.

3.7.6 Ethical considerations

Cosenza (2020) defines ethics as moral obligations and principles that researchers should adhere to in carrying out and reporting their findings. Macolm (2020) defines ethics as observations of what is good or bad. Ethics are very important in a study as they enable the researcher to develop meaningful acceptable research protocols that are worth the participant's time and have a reasonable chance of yielding meaningful findings, protect the rights of participants and report results accurately (Wosenga,2020). The researcher made sure that participants were informed of all aspects of the study.

The researcher sought permission from the Ministry of Primary and Secondary Education and Mashayamombe Secondary School to carry out the study at the station Respondents were confidentially in order to uphold and maintain integrity of the research study, and no data was falsified. Respondents were assured that no disclosure of their personal details would be made or communicated to anyone except to the University. All the participants were treated with respect and dignity.

3.7.7 Validity and reliability

Doodley, (2018) says reliability is the accuracy of the actual measuring instrument or procedure. Validity is the appropriateness, meaningfulness and usefulness of specific inferences made from the answers. Therefore, validity refers to which data is accurately reflecting the phenomenon under study. In regard to this study, the researcher uses a qualitative research method and was reliable in conducting face to face deliberation. The researcher used triangulation method on research on research tools. Multiple research tools were employed in order for one tool to compensate for the other's weaknesses. Interviews, questionnaires and focus group discussions were all blended in order to come up with s good and reliable study outcomes in as far as investigating the impacts experimental methods on teaching biology at ordinary level is concerned.

3.8 Summary.

The chapter's thrust was on research methodology used in this research study to investigate the impact of experimental methods on the teaching of biology at ordinary level. It outlined the research design, population, sample and sampling procedure. Research instruments uses included interviews, focus group discussions and questionnaires were used to gain valid and reliable insight of the study. The procedure for collecting data, validity and reliability, data presentation and analysis procedures together with ethical considerations were discussed in detail. In the next chapter, data presentation, analysis and discussions follow.

CHAPTER 4

DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.0 Introduction

Chapter three focused on the research methodology which was used in this study. Chapter four dwells on data presentation, analysis and interpretation. The chapter presents data using pie charts, graphs and tables. These brought out comparisons and trends which numerical data might not have revealed if data remained in a very raw form.

4.1 Response rate

Questionnaires distributed	Questionnaires returned	Response Rate
70	70	100%

Table 4.1

Questionnaire response rate

The researcher administered 70 questionnaires, and all Questionnaires were returned fully completed. Thus, the response rate was 100%.

Response rate refers to the percentage of participants who complete and return a survey, questionnaire, or other research instruments out of the total number of participants invited or sampled (Krosnich, 1999; Lynn,2008).

According to American Association for Public Opinion Research (AAPOR), Response rate is calculated as the number of complete and partial interviews, divided by the number of eligible respondents in the sample (AAPOR,2016).

Bryman (2016) asserts that a Response rate of 100%is overwhelming, hence it is taken to be acceptable deeper statistical data analysis. Severance and Bouge (2013) echoed the same sentiments by mentioning that for deeper statistics any Response rate above 50% is considered to be of great value. The 100% response rate was mainly due to the fact that the researcher personally administered the questionnaires and collected them.

A saturation point was reached when the researcher 9 interviewees. The tenth respondent mentioned the content that had been said by prior respondents.

4.2 Demographic Data

4.2.1 Gender Distribution

Table 4.2 Gender Distribution

Gender	**Frequency**	**Percentage**	**Valid Percentage**	**Cumulative Percentage**
Boys	**32**	**45.7**	**45.7**	**45.7**
Girls	**48**	**54.3**	**54.3**	**100**
Total	**70**	**100**	**100**	

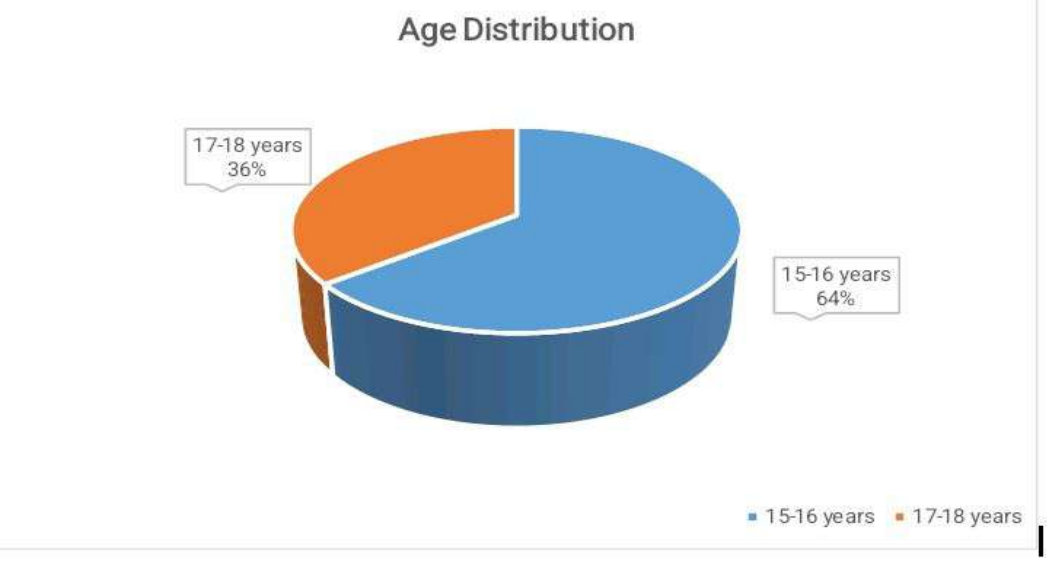
Source: Field Data

Table 4.2 Gender Distribution

The first section of this research survey questions was requesting that the respondents indicate their gender. The survey results were as indicated in Table 4.3 below. As indicated by the table, 54.3% of the sample were girls while 45.7% of the respondents were boys. The gender distribution as indicated in the table shows that gender stereotyping is losing ground and the population is increasingly getting aware of gender equality. According to Hove (2013), this is an indication of remarkable increase in women empowerment in Zimbabwe.

Figure 4.1 Age

Below is a diagrammatic presentation of how the age was distributed among the respondents who participated during this survey. The pie chart below shows the age Distribution of respondents.



Source : Field data

Figure 4.1

The large number of those who participated in the survey was in the range of 15 to 16 years which had 64% followed by 17-18 years with 36%. This research shows how the school is accepting the younger generation and how in Zimbabwe it is not easy for the

older generation to stay in school especially the 17 - 18 years and above age range.

4.4 Current Grade Level

The respondents' background is very critical, and hence the researcher tasked the respondents to indicate their current grade. The current level of the study participants is shown in figure 4.2 below.

Figure 4.2 Current Form Level

Figure 4.2 depicts that form three students represented 51.43% whereas 48.57 of the participants were from form four students. The statistics here may indicate the retention rate for biology. Biology's retention rate as a science may decline as students move from Form three to Form four.

4.5 Responses

The research questions that directed the study are addressed by the data presentation and analysis below. The scale used is thus: Strongly disagree (1) Disagree (2) Neither agree (3) Agree (4) Strongly Agree (5).

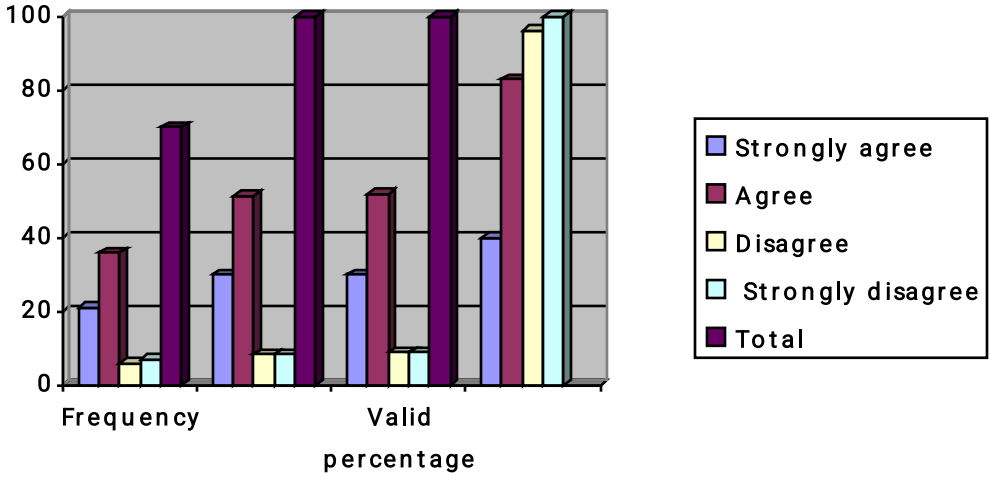


Figure 4.3

Figure 4.8:1

Participation in hands-on experiments

Source: Field Data (2024)

Figure 4.3

According to Table 4.8 From the results of table 4.8, 83% agreed that they had participated in hands-on biology experiments while 17% disagreed.

	Frequency	Percentage	Valid percentage	Cumulative percentage
Strongly agree	21	30	30	30
Agree	35	50	50	80
Disagree	11	15.7	16	**96**
Strongly disagree	**3**	**4.2**	**4**	**100**
Total	**70**	99.9	**100**	

Source: Field Data (2022)

Table 4.4

From the results of table 4.9, from the results of table 4.9.2, 80% 0f the respondents agreed that experiments Increase interest in biology.

4.9.2 On assistance of hands-on experiments in understanding biological concepts

Table 4.9.2: Hands-On experiments assist in understanding biological concepts

Source: Field Data (2024)

Figure 4.4

From the results of table 4.9, 94% of the respondents agreed that hands-on experiments assist in understanding biological concepts better when using traditional methods, 6% disagreed.

Figure 4.5 On beFigunefits of hands-on experiments

	Frequency	Percentage	Valid percentage	Cumulative percentage
Strongly agree	25	35.7	36	36
Agree	**35**	**50**	50	**86**
Disagree	10	14.2	14	100
Strongly disagree				**100**

Source: Field Data (2024)

Table 4.5

From the results of table 4.9, 86% of the respondents agreed that hands-on experiments are beneficial to the learners and 14% diagreed.

Barriers hindering the use of ICT to facilitate teaching process in secondary schools.

4.9.4 Benefits of hands-on experiments

Table 4.11: Hands-on experiments bring benefits to learning experience

	Frequency	Percentage	Valid percentage	Cumulative percentage

Strongly agree	32	45.7	46	46
Agree	35	50	50	96
Disagree	2	2.9	3	99
Strongly disagree	1	1.4	1	**100**
Total	**70**	**100**	**100**	

Source: Field data (2

Table 4.6: Benefits of hands-on experiments

Source: Field Data (2024)

From the results of table 4.10, 96% of the respondents agreed that hands-on experiments bring benefits to learning experience ,4% disagreed.

4.9.5 Challenges faced while conducting hands-on experiments in biology

Table 4.12: Challenges faced in conducting experiments

	Frequency	Percentage	Valid percentage	Cumulative percentage
Strongly agree	40	57.1	57	57
Agree	29	41.4	42	99
Disagree	1	1.4	1	100
Strongly disagree	0	**0**	**0**	**100**
Total	**70**	99.9	**100**	

Table 4.7: Challenges faced in conducting experiments

Source: Field Data (2024)

From the results of table 4.11, 99% of the respondents agreed that challenges are faced when conducting experiments, 1% disagreed.

4.9.6 Incorporation of hands-on experiments into biology curriculum

Table 4.13: Hands-On in biology curriculum

	Frequency	Percentage	Valid percentage	Cumulative percentage
Strongly agree	28	**40**	**40**	40
Agree	40	57.1	57	97
Disagree	2	2.9	3	100
Strongly disagree	0	0	0	100
Total	**70**	**100**	**100**	

Source: Field Data (2022)

Table 4.8

From the results of table 4.12, 97% of respondents agreed that there is need for frequent incorporation of hands-on experiments,3% disagreed.

4.9.7 Influence of hands-on experiments on academic performance

Table 4.14: On hands-on influence on academic performance

Source: Field Data (2024)

Figure 4.6: Influence of hands-on experiments on academic performance

From the results of table 4.1, 99% of the respondents agreed that hands-on experiments influence academic performance in biology, 1% of the population disagreed.

4.9.8 Engagement and motivation

Source: Field Data (2024)

Figure 4.7

From the results of table 4.18, 88% of respondents agreed that they are more engaged and motivated when participating in experimental methods, 12% disagreed.

4.9.9 Career and the teaching of biology

Table 4.16: On relationship between teaching method and the choice of career

	Frequency	Percentage	Valid percentage	Cumulative percentage
Strongly agree	**20**	28.6	29	29
Agree	40	57.1	57	86
Disagree	5	7.1	7	93
Strongly disagree	5	7.1	7	**100**
Total	**70**	99.9	**100**	

Source: Field Data (2022)

Table 4.9

From the results of table 4.19, 86% of the respondents agreed the choice of career is influenced by the way the teacher teaches biology, 14% said they do not agree.

4.11 Presentation of open- ended interview questionnaires

The data obtained through face to face interview with respondents are presented according to the order of the objective of the study.

Question 1: Can you describe the experimental methods you use in your ordinary level class?

Majority of the respondents responded by identifying and describing several experimental methods. There are various experimental methods used in the teaching and learning of biology at ordinary level. These were identified as microscopy, dissections, ecological studies, conservation biology, plant growth studies, and science funfair.

T1 respondent said the following:

In the teaching and learning of biology I use experimental methods such as microscopy in which students observe and study microorganisms, cells, and tissues using light and electronic microscopy. These methods enable the students to manipulate materials and ensure active participation of the students.

In response to the same question the respondent T2 said that:

Teaching can be done using any method but certain methods such as dissections, ecological studies, field observations and conservation biology. We use these methods to help students understand science concepts. Sometimes these methods consume much time so we avoid them because we may fail to cover the subject content within a stipulated time.

Another respondent T3 had this to say

Science teaching involves many methods which include field studies, dissections and ecological studies, Science funfair and microscopy. These methods are vital in the teaching and learning of biology. These teaching approaches are learner centered as learners are actively engaged. The use of hands-on activities enables them to use their senses as they manipulate and observe in the learning processes.

The other respondent described the experimental methods and this is what she said:

In science teaching and learning we use a variety of teaching methods. We use field observations, microscopy and dissections and not forgetting conservation biology and ecological studies. The use depends on the topic to be covered and the time available in relation to the examinations. For the sake of examination we, teachers, are forced to use rote learning to enable learners to write examinations.

Question 2. How often do you conduct practical experiments in your class?

The respondents aired out their different views as to the frequency of conduct of experimental methods in their classes. They gave varied responses as to the number of times experiments are held per week.

T1 respondent gave the following comments:

Science is a practical subject and as such more practical work is a must. I make sure that the lessons are done practically and experiments form the basis of teaching and learning of biology as a science subject. I make sure that practical experiments are done often. Almost every week we conduct experiments or other practical activities that enable learners to get engaged and participate actively.

T2 respondent said:

Very often, practical experiments are carried out in the classes. Most of the learning in science has to be done through practical activities because of the nature of the subject. However, in some cases lecture method are sometimes carried out but that is done when the teacher lacks preparation of the lessons.

Question 3. What type of experiments do you typically conduct?

In the interviews held between the respondents and the interviewer, the majority of the respondents identified a number of experiments that they normally use in conducting biology lessons. These experiments include dissections, lab experiments, and field study.

T4 respondent responded to the question by saying:

In teaching we use a variety of teaching approaches which enable learners to be engaged and to collaborate as they interact in the learning process. Field study, laboratory experiments and dissections are among the teaching methods that we normally use.

T5 respondent has this to say:

Teaching methods that we use depends on the knowledge, availability of teaching and learning equipment. Many methods are used but I prefer methods that are engaging and that sustain learner motivation to learn. Dissections, field studies, lab experiments and surveys are some of the diseases that I use.

Section 3 Impacts of experimental methods on academic performance of students

Question 4 In your opinion, how do experimental methods impact the academic performance of ordinary level biology students?

The majority of respondents during face to face interviews were able to give their assessments on the impact of experimental methods in the teaching and learning of biology at ordinary level. Different opinions were given on the use of experimental methods which include the promotion of active participation of students, enhancement of motivation and improved understanding of biological concepts.

T6 respondent said that:

Hands-on experimental methods play a very critical role in the teaching and learning process of students. The impact of hand-on experiments is multifaceted, affecting students in many ways. Experimental methods help in improved understanding. The learners develop a deeper understanding of biological concepts, as they observe and experience phenomena first-hand. Students are more likely to remember concepts learned through hands-on experiments, so they associate the learning experience with tangible activities. Hands-on experiments encourage students to think criticality, analyze data, and draw conclusions bases on evidence.

T 7 gave this response:

Hands-on experiments are really of great positive effect in the teaching and learning of biology at ordinary level. There is improved understanding of biological concepts. The memory retention is enhanced by active participation of students during experiments. Hands-on experiments have a tendency of arousing students' interest in learning and also it sustains the interest throughout the lesson. Hands-on experiments can be used to build confidence in students. Students develop confidence in their ability to conduct experiments, collect data, and analyze results. This results in students taking ownership of their learning.

The use of experimental methods is key in developing and enhancing the psychomotor domain. How do they develop? Through working in experiments, students develop manipulative skills such as handling equipment, measuring and observing. It is very critical in helping students to improve dexterity and hand-eye coordination through hands-on experiments.

The impact of hands-on experiments in the teaching and learning of biology is of great magnitude. Hands-on experiments contribute to enhanced scientific literacy. Students develop scientific literacy which can help them to critically evaluate scientific information and make informed decisions.

Question 5 Can you provide specific examples how experimental methods have improved students understanding and retention of biological concepts.

The respondents provided quite varying narratives on impact of experimental methods and specific examples of how experimental methods have improved students' understanding and retention of biological concepts. From the respondents' experiences with experiments and their interactions with students it was clear that experimental methods play a very critical role in assisting students to understand concepts.

T8 respondent said that:

The teaching of science or biology using hands-on experiments improved students understanding and retention of biology concepts. This is evidenced by the students' responses to questions in reference to experiments that were done previously. Some students could even put their answers in drawings to indicate that they have concrete evidence of what they learnt. This is supported by the Chinese proverb which says, I hear I forget, I see I remember, I do I understand. This explains why hands-on experiments are very crucial in the teaching and learning of biology. The involvement of all the senses ensured that the students can tell what they have learned. I have witnessed collaboration in students as they do different activities. During experiments students remind each other of different steps or apparatus to be used.

Hands-on experiments and other methods provide an engaging environment and students participate actively. Pupil-centered methods such as hands-on experimental methods make learning as live as possible. The written work or practical assignments given to students show higher academic performance compared to work written when lecture method is done.

T9 respondent had this to say:

From my experience I have realized that there are certain topics that as teacher you know your students have done so well that given the chance that questions are drawn from such topics you expect your students to do very well. The reason being that the topic was taught using hands-on experimental methods. Therefore, understanding of

concepts has a bearing on the method used.

Question 6 Have you noticed any differences in student motivation or engagement when using experimental methods

T 10 respondent said that

The response from respondents indicated that motivation and engagement in students is great when hands-on experiments are used in the teaching of biology. Many instances showed that there is an increase in motivation when methods used are student- centered. The students show engagement and interest by showing enthusiasm in handling science apparatus and the zeal they show when carrying out experiments,

Question 7 What challenges or limitations do you face when implementing experimental methods in the Ordinary level biology class?

The majority of respondents identified a number of challenges faced in conducting experiments in biology. These challenges range from lack or inadequate laboratory facilities to crowded curricula. Some mentioned lack of qualifications teachers.

T11 respondent said that

The teaching and learning of biology present some challenges which may hinder the smooth teaching and learning of biology at ordinary level. The challenges that are faced when implementing experimental methods. The first challenge is that of limited resources which are caused by insufficient funding. Inadequate equipment and materials can hinder

the teaching and learning of biology. Non payment of fees by students contribute to schools failing to buy necessary equipment and learning resources.

The other Institutional challenge is inadequate laboratory facilities which may limit the scope of experiments..Some of the facilities are outdated or poorly maintained. Students face challenges when using such facilities because they fail to conduct experiments in a conducive environment of teaching and learning of science and

biology in particular.

The other challenge is caused by the fact that ordinary level class is a public examination class.and crowded curriculum can leave little time for experimental work, making it very difficult to use hands-on activities.

T12 respondent said :

Students with varying learning style, abilities and prior knowledge pose a big challenge in the teaching and learning process. The other challenge is that experimentsal methods or any hands-on activities can be time consuming in terms of preparation, setting up apparatus, calibration and trouble shooting among other activities. Also, equipment malfunctioning can be another challenge to the teaching and learning of biology.

We also face curriculum challenges in that the curriculum may not provide sufficient flexibility to incorporate practical experiments. Expectations from the administration and the parents is on pass rate which they want to be always higher than neighbouring schools or anything higher than previous pass rate. We find ourselves trapped in a dilemma of wanting to do the correct thing and safeguarding the pride of the school.

The other challenge is on assessment requirements. The emphasis on certain stipulated number of written assessments can lead to a focus on theoretical knowledge over practical skills. The need to cover a broad range of topics can leave little time for in -depth experimentation. The large size of classes also pose a great vhsllenge to the teaching and learning of biology. Large clas sizes can make it challenging to provide individualised attention and ensure student participation in experiments.

T13 respondent has this to say :

There are so many challenges faced in the teaching and learning of biology at ordinary level. Experiments have a potential of posing risks to to students such as chemical spills, electrical shocks, or biological hazards. The challenge of scheduling and coordinating experiments with other subjects can be difficult.

4.11.4 Drawing and Labelling.

In practical classes, biologists place great emphasis on creating diagrams that accurately name the specimens being studied. According to Tan (2018), and 46.8% of the respondents, biological diagrams differ from fine art diagrams, which call for colorful, beautiful diagrams from artists. The following factors are taken into account while drawing and labelling biological specimens: size, proportionality, title, and view or viewpoint.

4.11.5 Observation.

78.9% of the study participants believed that observation is a crucial component of practical biology. It is impossible to overstate the value of closely observing the specimen during a practical biology examination. It is expected of candidates to examine the specimen closely and critically, as this is necessary for accurate specimen identification, complete drawing representation, and realistic comparative analysis.

Various explanations have been offered for the issues surrounding laboratory work, Tan (2018). Benze and Hodan (2015) claim that when students only obey their lecturers' instructions without question, issues with laboratory work occur. On the other hand, 28.3% of the respondents agree with some academics' assert that the laboratory has evolved from a location for science experiments and practical to one where students complete assignments assigned by their teachers. During laboratory work, just the assigned tasks are completed; technique or purpose are ignored, Hurtegal (2012). The issue with laboratory work has been linked by Jimenz Alexander (2014), Wikinson and Wand (2007) to an inadequate assessment of the goals of the tasks performed in the laboratory.

The multiple purpose of the laboratory work has been subject of discussion worldwide for many years. Multiple lists of these purpose have been prepared for different levels of education. Many of these list focus on carrying out experiments through scientific methods and technical skills while some strongly emphasize effective objectives others

have dwelled on other purpose, Johnstone and Al-Shuali, (2011), Reid and Shah (2007). When university biology laboratory is considered the general purpose of laboratory work may be:

Supporting or strengthening theoretical knowledge

Experiencing the pleasure of discovering and developing of the psychomotor skills

Teaching how scientific knowledge may be used in daily life.

Increasing creative thinking skills

Gains in scientific working methods and high thinking skills

Developing communication skills

Developing manual dexterity by using tools and equipment

Allowing students to apply skills instead of memorizing (Bayraktar 2014).

4.11 Chapter Summary

This chapter deals with the presentation and analysis of data for the study. The findings of the study are presented as per objectives of the study in the following sections. The findings are presented according to the sections of the questionnaire. The next chapter will present the discussion of the findings of the study as guided by the research questions. The chapter also presented on the discussion of the findings of the study. The research questions led the discussion which is organized under the following broad themes, Participation and interest in hands-on experiments, benefits of hands-on experimental methods, challenges faced in conducting experiments and influence of hands-on experiments on academic performance. The next chapter provides the last part of the research and it

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.0 Introduction

This chapter provides a synopsis of the major findings in relation to the major themes developed from the research questions. The chapter extricates the conclusions and key recommendations derived from the findings.

5.1 Summary

This particular section extricates a summation of the various chapters for this research.

The first chapter of this research was based on the background of the study and it uncovered the fact that hands-on experiments involve students actively participating in the learning process by manipulating materials and equipment to observe and explain phenomena. This then gave rise to the need to investigate the current status of hands-on experiments in teaching biology, their effectiveness in enhancing students' understanding of biology concepts, the challenges faced in implementing them, and strategies to improve their implementation at Mutsonzowa Secondary School. Research objectives formulated were to determine the impact of hands-on experiments on students' understanding of biological concepts in the ordinary level class at Mutsonzowa Secondary School, to assess the development of critical thinking skills among students through hands-on experimental activities and to determine the impact of biology practical on the students’ academic performance in biology.

Chapter two was based on literature review and this was gathered from different authors and scholars who have done an in-depth review and gave well synthesized knowledge in line with the impact of hands-on experiments in Secondary Schools in

various settings of different countries in practical science subjects. Literature looked at biology hands on experiments, the impact of biology practical on students' academic performance, the advantages and disadvantages of hands-on experiments, the contributions of biology practical to effective teaching, the impact of hands on experiments on students understanding and the contributions of biology practical towards students critical thinking. Problems associated with biology practical and related empirical studies were also covered However, the different thoughts in different journals leave a number of debates in the way hands on experiments are conducted.

In chapter three the researcher explained both the qualitative and the quantitative research methods as they helped in giving a clear and detailed comprehension of how the how the hands-on experiments contribute to teaching biology to the ordinary level students at Mutsonzowa Secondary School. The research population was from the form three and four biology class. To select a sample, the researcher used non probability sampling and the researcher relied on the primary data gathered so as to enhance quality and data validity.

In Chapter four, the data was gathered from 70/70 respondents and was analyzed and presented in the form of tables, graphs and pie charts. This data was used in making recommendations, suggestions and conclusions. The study reveals that students are more likely to interact with assignments meaningfully and receive higher evaluation grades when given academically stimulating practical laboratory courses. The study also found that when teachers use hands-on activities in a constructive way, students become more engaged, creative, critical thinkers, and first-hand skills are developed, and the teaching and learning process becomes more efficient. An active, encouraging community of educators may make a big difference. The findings show that in as much as biology practical has obvious benefits, it also has challenges attached to it. Respondents opined that one issue with biology education and learning in secondary schools has been the lack of suitable laboratory space.

5.1.1 Main Findings

- The results indicate that Biologists are in high demand across a number of

industries, including education, research institutes, and pharmaceuticals. Many students are encouraged to enrol in biology programs for the first time and also retaking the course because of the bright employment possibilities.

- The findings reveal that some students have experience with hands on experiments whereas others do not. It is nevertheless, a clear indication that most students are interested in the practical aspect of the subject.

- The study revealed that practical activities have a significant impact on students' academic achievement in biology.

- The researcher observed that students can engage in meaningful learning in the lab if they are provided with opportunities to work with tools and materials in a setting that allows them to build their understanding of phenomena and associated scientific ideas.

- A number of the study participants believe that a laboratory is a suitable learning setting that fosters meaningful learning and improves students' comprehension of scientific concepts and the nature of science. In a laboratory, students engage with materials and/or models to observe and comprehend the natural world.

- It was acknowledged that many teachers who intuitively included the essential learning within their teaching recognized the need of knowledge skills at a particular subject.

- The research observed from the literature at hand that effective teaching of biology can be sub-divided such as qualification of teachers teaching method effective use of laboratory and mastery of the subjects.

- The researcher is of the opinion that the teaching methods employed during science classes contribute a lot to effective teaching of biology. However, laboratory method is the method used in effective teaching and learning of science subjects especially biology.

- The study population observed that most teachers resort to the use of lecture method not minding the lecture modification, the concept of education while maintaining that the best learning is that which result from purposeful practical activity.

- The researcher suggested that teachers should use as many techniques as possible to gain the attention and interest of the students. The teacher should apply any method of motivation, so as to heighten the spirit of the students.

- Some of the respondents indicated that another factor that affects effective teaching of biology is mastery of the subject matter.

- Many students expressed their interest and enthusiasm in practical exercise. It is well known that students who enjoy science practical do well in science.

- The study reveals that students are more likely to interact with assignments meaningfully and receive higher evaluation grades when given academically stimulating practical laboratory courses.

- The study found that when teachers use hands-on activities in a constructive way, students become more engaged, creative, critical thinkers, and first-hand skills are developed, and the teaching and learning process becomes more efficient. An active, encouraging community of educators may make a big difference.

- The findings show that in as much as biology practical has obvious benefits, it also has challenges attached to it.

- Respondents opined that one issue with biology education and learning in secondary schools has been the lack of suitable laboratory space.

- The study participants mentioned that time management has an adverse effect on students, since many applicants have examination fever due to anxiety and stress.

- A crucial issue with biological approaches in science studies is comparing and contrasting the qualities of different specimens. 88.7% of the study participants were of the view that pupils typically do badly on these assignments because they lack the necessary technical knowledge or skills.
- The respondents believed that observation is a crucial component of practical biology. It is impossible to overstate the value of closely observing the specimen during a practical biology examination.

Summing up this research, the value of hands-on experiments towards students' learning process and academic improvement were shown in various data collected. The bulk of the data collected had shown positive results in most of the areas. As a result, this study has demonstrated that hands-on experiments promote students' knowledge and builds on their intrinsic impetus.

5.2 Conclusion

It is clear from the context of the aforementioned findings that the activity-oriented method has introduced teachers and students to different assessment performance tasks.

Students were given the chance to demonstrate their expertise and skill.

Teachers also acknowledged that the exercise was very beneficial to them, and this has inspired them to investigate different approaches to meaningfully assess students' development of scientific and mathematical knowledge.

By emphasizing the experience and process of researching, developing, and implementing solutions, hands-on activities encourage problem-based approaches to learning.

Through practical investigations, students acquire knowledge of the subject topic as well as critical thinking techniques.

In order for science concepts to be fully understood by pupils, teachers and students

alike must have real-world application chances. Teachers and students alike need to be given real-world opportunities to apply their knowledge, as well as assistance in integrating or transferring that knowledge, in order for pupils to genuinely acquire science topics.

It is impossible to overestimate the value of students researching fundamental scientific concepts.

The study found that when teachers use hands-on activities in a constructive way, students become more engaged, creative, critical thinkers, and first-hand skills are developed, and the teaching and learning process becomes more efficient.

An active, encouraging community of educators may make a big difference.

The findings further confirm that the students who were instructed through a hands-on approach outperformed those who received instruction through a typical lecture style, indicating that including experimental activities into biology lessons could enhance student performance. Also, both boys and girls can improve together.

Therefore, compared to traditional teaching methods like lecturing, which are inefficient in producing better results, experimental teaching strategies have a favourable impact on biology learners' successes.

The study's findings indicate that most scientific students' academic achievement and their practical work are positively correlated. The results are consistent with earlier research, including a study by Abdi (2014), which found that the experimental groups understood the material far better, particularly when it came to questions that needed to be interpreted. Instructors were urged to think about how to set up and then deliver to students learning environments that encourage greater student participation.

Indeed, comparable findings have been obtained by other studies. For instance, laboratory activity is crucial to science education and aids in learning the distinction between data presentation and observation, according to Hofstein and Lunetta (2014) and Hofstein and Mamlok-Naaman (2007). According to Musharrat (2020), students

might become more motivated and interested in learning through practical practice.

However, it has been suggested by Boyuk et al. (2010) and Kambaila (2019) that some educators are hesitant to assign laboratory work. They stated that while laboratory work is essential for learning the sciences, there are some issues that arise. These include a lack of supplies for the necessary experiment, inadequate knowledge for conducting the experiment, the procedures used, the glassware and chemicals required for the experiment, safety regulations, what to do in the event of an accident during the experiment, and what to do after one occurs.

The current study's researcher recognizes the significance of these constraints and advise educators and school officials to investigate and resolve them in order to enable the value of practical work to assist students in meeting more rigorous academic standard.

Lab exercises have a major effect on students' academic performance in biology.

Factors related to the biology teachers have a major impact on the academic success of the pupils.

Students' academic performance in biology is impacted by how school administration strategies affect the biology practical.

5.3 Recommendations of the study

This study is found on the backdrop of investigating the impact of hands-on experiments on biology education: A case study of ordinary level students at Mashayamombe Secondary School in Chegutu District, Mashonaland West Province. The following recommendations are made in relation to the findings generated from the study.

The researcher recommends that most concepts in biology be taught through practical exercises. Certain concepts are incomprehensible if not used in real-world situations.

The researcher recommends that school administrators to provide all required tools,

glassware, and chemicals to enable practical work on the majority of biology topics in order to guarantee the success of such projects.

In order to ensure that students do more than just follow teachers' guidelines, the researcher believes it is critical to provide students the opportunity to design some of their own experiments (student-centred activities).

5.4 Suggestions for Further Studies

Based on the results of this study, the researcher suggests that Bruner's theory of teaching in science learning be investigated further using practical trials. Four main components of a theory of teaching are learning disposition, knowledge structure, representational modalities, and efficient sequencing, according to Bruner (1960). In order to help students, become independent learners who can make new discoveries, build new knowledge, analyse what they have learned, and conduct experiments to test their theories, teachers must use theory as a foundation and source of support. This research was mainly focused on investigating the impact of hands-on experiments on biology education. It was limited to responses from ordinary level students at Mashayamombe Secondary School in Chegutu District. Further study should involve other Ordinary level students within the district and other districts as well as their Provinces, with a view to comparing the results with this research which are only in Chegutu District.

5.5 Conclusion of the Chapter

This chapter presented summaries, conclusions and recommendations of study.

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APPENDIX I: CONFIRMATION LETTER

SAMED

P Bag 1020
BINDURA
ZIMBABWE

Tel: 0271 - 7531 ext 1038
Fax: 263 - 71 - 7616

BINDURA UNIVERSITY OF SCIENCE EDUCATION

Date: .....

TO WHOM IT MAY CONCERN

NAME: CHAKAWARIKA RUTENDO REGISTRATION NUMBER: B1234520

PROGRAMME: HBScEdBz PART: 2.2

This memo serves to confirm that the above is a bona fide student at Bindura University of Science Education in the Faculty of Science Education.

The student has to undertake research and thereafter present a Research Project in partial fulfillment of the HBScEdBz programme. The research topic is:

In this regard, the department kindly requests your permission to allow the student to carry out his/her research in your institutions.

Your co-operation and assistance is greatly appreciated.

Thank you

BINDURA UNIVERSITY OF SCIENCE EDUCATION
DEPARTMENT OF EDUCATIONAL FOUNDATIONS
OCT 2023
P. BAG 1020
BINDURA

Z/Ndemo (Dr.)
CHAIRPERSON - SAMED

THE HEAD
MASHAYAMOMBE SEC SCHOOL
P.O. BOX 117, MUBAIRA
MHONDORO

APPENDIX II: PERMISSION LETTER

Mashayamombe Primary School

Post Office Box 54

Mubaira

20 September 2024

The Provincial Education Director

Ministry of Primary and secondary Education

Mashonaland West Province

Post Office Box

Chinhoyi

Zimbabwe

Dear Sir/Madam

REF :REQUEST FOR A PERMISSION TO CARRY OUT A RESEARCH IN CEGUTU DISTRICT SECONDARY SCHOOLS

The above reference matter.My name is Rutendo Chakawarika a final year student studying with Bindura University of Science Education specialising in Honours Bachelor of Science Education in biology.I do hereby request for a permission to carry out a research in Chegutu District Secondary school.I am currently working on a research entitled, an investigation on the impacts of experiment methods in the teaching and learning of biology at ordinary level.

Your usual cooperation will be greatly appreciated.

Yours faithfully

Rutendo Chakawarika (B1234520)

MASHAYAMOMBE PRY SCHOOL
THE HEAD
BOX 54 MUBAIRA
DATE 21/10/24
SIGN

addressed to
"The Provincial Education Director"
Telephone: 067-2123043/25655
Tele Fax: 067-2123320
Email edumashwest@gmail.com

ZIMBABWE

Ref :C/246/1/MW

Ministry of Primary & Secondary Education
Mashonaland West Province
P.O Box 328
Chinhoyi

21/10/2024

The District Schools Inspector
..CHEGUTU.....District

AUTHORITY TO CARRY OUT EDUCATIONAL RESEARCH: SCHOOLS IN
..CHEGUTU..... **DISTRICT: MR/~~MRS/MS~~:** CHIKWARIKA RUTENDO
EC.NO/IDNO.....01111855C.....**STATION** MASHAYAMOMBE PRY
DISTRICT..CHEGUTU.....**INSTITUITION** BINDURA UNIVERSITY
REG.NO.B1234520.....**PROGRAMME** B.SC. Ed 52

The above named student has been granted authority by the Provincial Education Director to carry out a research in.....District. The student has been advised to visit your office before entering the schools.

Research Topic AN INVESTIGATION INTO THE IMPACT OF EXPERIMEN METHODS ON THE TEACHING OF BIOLOGY AT ORDINARY LEVEL AT MASHAYAMOMBE SECONDARY SCHOOL

Period of research..21 OCTOBER TO 30 DECEMBER 2024

Targeted school/s ..MASHAYAMOMBE SECONDARY SCHOOL

Method of research...QUESTIONNARES, INTERVIEWS

Please ensure that the learning and teaching programmes at the targeted schools are not interrupted in any way; the student strictly adheres to the activities and topics specified in his/her letter of request and that the research should be conducted according to the given time frame.

The District Schools Inspector is requested to liaise with the researcher on the specific schools where the research will be conducted and advise the Provincial Office of the chosen schools. Furthermore, the District Schools Inspector should ensure that a copy of the research findings is submitted to the Provincial Education Director once the research is completed.

FOR: ACTING PROVINCIAL EDUCATION DIRECTOR
MASHONALAND WEST PROVINCE

MIN OF PRY & SEC EDUCATION
MASHONALAND WEST PROVINCE
HUMAN RESOURCES (DISCIPLI...
21 OCT 2024
P.O. BOX 328, CHINHOYI
ZIMBABWE

APPENDIX IV: COVER LETTER TO RESPONDENTS

Dear Respondent

RE: QUESTIONNAIRE TO OBTAIN INFORMATION FROM RESPONDENTS

Chakawarika Rutendo is a student of Bachelor of Science Education Honors degree in Biology at Bindura University of Science Education. I am carrying out a study entitled; **Investigating the Impact of experimental methods on teaching and learning of Biology.A Case Study of ordinary level students at Mashayamombe Secondary School in Chegutu District, Mashonaland West Province.**

All information obtained here in will be used by the researchers to complete the research in partial fulfillment of the requirements of the degree programme. The research is purely for academic purposes and any information provided will be treated with strict confidentiality.

Your cooperation in completing this questionnaire will be greatly appreciated.

Yours sincerely

_____

CHAKAWARIKA RUTENDO. B1234520

APPENDIX V : QUESTIONNAIRE TO RESPONDENTS

Instructions

Answer the questions that follow as truthfully and honestly as possible

Do not write your name on this questionnaire

May you please attempt all the questions

Please place a tick (√) in the box of your preferred answer

Section A Demographics and general information

Gender

Male ☐

Female ☐

Age

15-16 years ☐

17-18 years ☐

Current Grade Level (please tick in the appropriate box)

Form Three (3)

Form Four (4) ☐

☐

Type of Student

Conventional

Repeater ☐

☐

Section B: What is your experience with hands-on experiments?

The following statements seek to solicit views/perceptions on the experience with hands-on experiments. Please indicate the extent to which you agree with each of the statements (Please tick the appropriate number). **Scale:** Strongly disagree (1) Disagree (2) Neither agree nor disagree (3) Agree (4) Strongly Agree (5)						
Code	**Description**	**1**	**2**	**3**	**4**	**5**
PDTITP1	You have participated in hands-on biology experiments before attending Secondary School.					

PDTITP2	You are interested in biology experiments.					
PDTITP3	Hands-on experiments help you understand biological concepts better than traditional methods.					
PDTITP4	You have a choice in the assignments you do.					

Section C: How do hands-on experimental activities contribute to the development of critical thinking skills among students?

The following statements seek to solicit views/perceptions on the level of perceived benefits and challenges faced by the students on hands-on experiments. Please indicate the extent to which you agree with each of the statements (Please tick the appropriate number).

Scale: Strongly disagree (1) Disagree (2) Neither agree nor disagree (3) Agree (4) Strongly Agree (5)

Code	Description	1	2	3	4	5
PCSITP1	Hands-on experiments bring benefits to your learning experience.					
PCSITP2	You have faced challenges while conducting hands-on experiments in biology class.					
PCSITP3	Hands-on experiments should be incorporated more frequently into the biology curriculum.					

Section D: What does the impact of biology practical pose on the students' academic performance in biology?

The following statements seek to solicit views/perceptions on the impact, the biology practical pose on students' academic performance and engagement. Please indicate the extent to which you agree with each of the statements (Please tick the appropriate number). **Scale:** Strongly disagree (1) Disagree (2) Neither agree nor disagree (3) Agree (4) Strongly Agree (5)						
Code	**Description**	**1**	**2**	**3**	**4**	**5**
MTGITP1	How well do you feel hands-on experiments have influenced your academic performance in biology?					
MTGITP2	Do you feel more engaged and motivated when participating in hands-on experiments compared to traditional lectures?					
MTGITP3	Has your interest in pursuing a career related to biology increased due to engaging in hands-on experiments?					

Section E: What are the challenges faced when implementing hands-on experiments in the classroom?

……

……

……

Section F

How often do you engage in hands-on experiments in your biology classes?

……

……

Section G

How would you describe your overall academic performance in biology?

……

……

APPENDIX VI : INTERVIEW GUIDE FOR INVESTIGATING THE IMPACT OF HANDS-ON EXPERIMENTS ON BIOLOGY EDUCATION.

What is your experience with incorporating hands-on experiments in biology education?

Did you use any specific examples of hands-on activities used and your perceived impact on your learning?

What are the perceived benefits of using hands-on experiments in teaching biology?

Discuss any challenges faced when implementing hands-on experiments in the classroom.

How have hands-on experiments influenced your engagement in biology classes?

Discuss any observed changes in your learning outcomes as a result of incorporating hands-on activities.

Compare the effectiveness of traditional teaching methods versus hands-on experiments in biology education.

Discuss any differences in your understanding between these two approaches.