BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE EDUCATION

DEPARTMENT OF SCIENCE AND MATHEMATICS EDUCATION

EXPLORING THE USE OF ICT IN THE TEACHING AND LEARNING OF BIOLOGY AT O LEVEL, A CASE OF MUNHEMBA CLUSTER IN MUTOKO DISTRICT.

BY

WUSHE BERITA

B1438501

A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF BACHELOR OF SCIENCE HONOURS DEGREE IN BIOLOGY EDUCATION
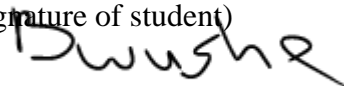
SUPERVISOR: DR MAKUVIRE

Release Form

Title of the dissertation: Exploring the use of ICT in the teaching and learning of Biology at "O" level, a case of Munhemba Cluster in Mutoko District.
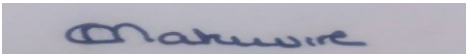
1. **To be completed by the student:**
   I certify that this dissertation is in conformity with the preparation guide lines as presented in the Faculty Guide and Instructions for Typing Dissertations

   _____   04/07/2024
                                              _____
   (Signature of student)   (Date)

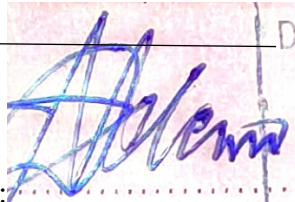2. **To be completed by the supervisor:**
   This dissertation is suitable for submission to the faculty. This dissertation should be checked for conformity with Faculty Guidelines.

   _____   04/07/2024

   (Signature of supervisor)   (Date)

3. **To be completed by the chairman of the department:**
   I certify, to the best of my knowledge that the required procedures have been followed and the preparation criteria have been met for this dissertation.

   Chairperson :   Date :14/10/24

Approval Form

Name of student: Wushe Berita

Registration Number: B1438501

Dissertation Title: Exploring the use of ICT in the teaching and learning of Biology at O level, a case of Munhemba cluster in Mutoko District.

Degree Title: Honours Bachelor of Science Education Degree in Biology

Year of Completion: 2024

Permission is hereby granted to Bindura University of Science Education to single copies of this dissertation and to lend or sale such copies to private, school scientific purposes only. The author reserves any publication rights and that the dissertation extensive extracts should not be reproduced without the author's written permission.

Signed……………………….   Date……04/07/2024…..……

Permanent Address: 4447, Rockview Park D, Harare

Declaration of Authorship

I declare that this research project herein is my original work and has not been copied or extracted from previous sources without due acknowledgement of the authors.

Name of Student: Wushe Berita

Signature...

Date...........04/07/2024...

Dedication

I would like to dedicate this dissertation to my husband Austin and children who supported me during the time of the study. It is through their commitment and encouragement that I completed this study. I also dedicate this study to my friends for all their unwavering support. They stood by me even when the going got tough.

Acknowledgements

I would like to acknowledge my academic supervisor Dr Makuvire for her efforts to mold the best out of me as far as this research study is concerned. She successfully shepherded me through this study with unwavering support from the start to the end of this educational episode. I also acknowledge my school head, teachers and learners for their cooperation and assistance they rendered during the data collection.

Abstract

The study was an exploration on the use of ICT in the teaching and learning of biology at O Level, a case of Munhemba cluster in Mutoko District. The aim of the study was to explore the use of ICT in the teaching and learning of Biology at O Level. The study's objectives were to assess the use of ICT tools to teach Biology, to determine challenges faced by teachers and learners and to evaluate the benefits of ICT in teaching biology at O Level. The interpretivism paradigm which relates to qualitative research informed the study. The study used the case study research design. The population for the study comprised twelve teachers and two hundred form four learners. The sample for the study were fourteen participants from two secondary schools. The study used open-ended-interviews, and questionnaires. The major findings for the study were that teacher centered mode of teaching is still important and being used in teaching Biology. Schools are still facing serious shortage of ICT tools, qualified ICT teachers, and technical support. The study concluded that the government is neglecting its schools hence serious structural problems that need urgent attendance. The study also concluded that shortage of qualified ICT teachers is crippling the use of ICT tools in rural schools. It was recommended that teachers improve their own ICT skills in order to keep up to date with the current ICT skills and knowledge necessary for their profession. School administrators were recommended to advocate for the construction of an ICT laboratory for use by the whole school and ensure that students may rotate the use of the lab with a minimum of fifty computers or laptops. The policymakers were recommended to provide internet services, alternative power such as solar systems at different rural schools, ICT tools such as laptops, projectors and computers. They were also recommended to train teachers in ICT skills and knowledge so that it go a long way in helping them in the advancement of ICT knowledge to students.

Table of Contents

CHAPTER ONE

THE PROBLEM AND ITS SETTING

1.0 Introduction

This chapter discusses the background to the study on challenges of using ICT in the teaching of biology in education. The chapter includes the statement of the problem, research objectives research questions, significant of the study, assumptions of the study, limitations and delimitations of the study. The chapter also defined key terms of the research and gave a chapter summary.

1.1 Background to the Study

The 21st century has seen the rapid adoption of different technologies in the education sector. The Information Communication Technology (ICT) has been the forerunner which has influenced the way the globe lives, socialize, communicate, educate or learn (Nikolić, Petković, Denić, Milovančević and Gavrilović 2019). The new global economy has been created since the introduction of ICT in every sector of society, fueled by information and driven by knowledge. Shah (2022) stated that, governments had been compelled by the advent of the global economic competition and knowledge economy to prioritize lifelong learning, quality education and the provision of educational opportunities for everyone. The access to ICT in education had been widely viewed as creating global competitive individuals who are well skilled and facilitate social mobility. According to the United Nations (2018), Zambia is striving to improve its education system for the knowledge era and improve the teaching of science subjects such as Biology. Biology is quite difficult to learn and teach because it includes complex relationships of unfamiliar and abstract concepts (Rana and Rana 2020). Learners try very much to learn biology through memorization because of lack of understanding it as they experience difficulty in understanding certain biological concepts. However, the use of ICT in the teaching and learning of Biology help learners understand the difficult subject easily.

In Mashonaland East Province, Mutoko district Munhemba cluster students have been failing their Ordinary Level Biology. Most learners in the cluster have been streamed according to their abilities hence learners in A class outshine the rest of the classes such as B, C and D classes (Sifelani 2022). The A class had proved that brilliant learners always outclass other learners or classes in the use of ICT in teaching and learning of Biology.

A survey conducted in South Africa by Aydin and Gürol (2019) revealed that learning become lively and interesting by using multimedia equipment in O Level classrooms as learners participate during the learning process. It was mainly important during Biology class as computers present all the necessary information virtually through well-prepared pictures, animations, three-dimensional models and interactive environments. Daudi and Nzilano (2019) argued that, the adoption and implementation of new technologies has to be embraced by teachers who are key to dissemination of information in classrooms.

Teachers' educational beliefs are closely linked to their actual use of ICT in classrooms hence their perceptions are an important aspect that influences their adoption of ICT in teaching and learning of Biology (Chinakidzwa and Chamba, 2023). The quality of teachers and their continuing professional education and training are central to the achievement of quality education. It is important that teachers are trained to be well versed with ICT to improve pass rates of Biology learners. It is against this background that the study aims to explore the use of ICT in the teaching and learning of Biology at O Level, Munhemba Cluster schools in Mutoko district.

In a study conducted by Makuru and Jita (2022) it was revealed that, ICT is important in providing learners with various facilities such as the ease of getting information by students which allow them to easily develop their potential. ICT is important in that it help learners and teachers to communicate online and learners themselves may communicate. However, schools in Munhemba Cluster faces serious shortages of ICT tools such as computers, laptops, projectors, smart phones, internet and computer laboratories. The education system should be aligned and prepared to equip learners for with ICT skills in order to prepare them for the digital economy (Mashoko and Dudu 2023). The use of ICT has been spreading even to education systems in some underdeveloped countries to address educational shortcomings and develop the 21st century competencies which include problem solving skills, critical thinking skills, life-long learning, global interaction,

inclusivity, collaborative teamwork and cooperative learning. Sifelani (2022) maintain that the use of ICT in Munhemba Cluster, was not restricted to the O Level classroom environment in the teaching and learning of Biology but orientated and introduced learners in the post-school technology-based information economy.

Despite the efforts by teachers and schools to provide the basic ICT infrastructure, the use of ICT in schools seems not to have been implemented according to the schools' initiatives. Maupa and Goronga (2023) refer to the availability of ICT for use in schools and its unsuccessful use in teaching and learning of Biology. Their research findings, Nunguye, Mugabo and Niyonzima (2021), indicated that teachers were enthusiastic about the use of ICTs in the teaching and learning of Biology. However, in reality, many teachers appear to drag their feet in using ICTs for teaching and learning of Biology. Learners lacked the necessary tools such as smart phones and alternative power for use in the teaching and learning. Chidzonga, Haruzivishe, Chikwasha and Rukweza (2022) concurred with these findings, stating that less than two percent of computer laboratories are well-resourced in most rural schools. These assertions indicate that there is a gap between the use and availability of ICT tools in schools due to factors that are particular to all public-school environments in the country.

1.2 Statement of the Problem

The use of ICT in teaching and learning of Biology help to improve to prioritize lifelong learning, quality education and the provision of educational opportunities for everyone. The quality of teachers and their continuing professional education and training is central to the achievement of quality education. However, schools in Munhemba Cluster faces serious shortages of ICT tools such as computers, laptops, projectors, smart phones, internet and computer laboratories and this limit the use of ICT in the teaching and learning of Biology. The teachers are also reluctant to embrace use of ICT in the teaching of O Level Biology. The research seeks to explore the use of ICT in the teaching and learning of Biology at O Level, case of Munhemba Cluster in Mutoko District.

1.3 Research Aim

The research explored the use of ICT in the teaching and learning of Biology at O Level, in Munhemba Cluster of Mutoko District.

1.4 Research Objectives

The research is guided by three research objectives.

1. To assess the access of ICT tools to teach biology at O Level
2. To determine challenges faced by teachers and learners at O Level
3. To evaluate the benefits of ICT in teaching biology at O Level

1.5 Research Questions

1. Which are the ICT tools used to teach biology at O Level?
2. What are the challenges faced by teachers and learners in teaching and learning Biology using ICT?
3. What are the benefits of using ICT in teaching and learning biology at O Level?

1.6 Significance of the Study

The study identified four crucial stakeholders who benefited from the study. The first group comprises of teachers. The study is important to teachers as it exposes that they must improve their computer skills, knowledge and applications. This would make it easier for teachers to impart ICT knowledge during the teaching of different subjects especially Biology. If teachers learn the skills, they would not feel embarrassed in front of learners during the teaching and learning of Biology. The second stakeholders were the learners. The study is significant to them in that they would be able to learn ICT skills and knowledge for use in the global knowledge-based economy

driven by ICT. Learners would acquire different competitive skills such as problem-solving skills, critical thinking skills, life-long learning, global interaction, inclusivity, collaborative teamwork and cooperative learning third are the school administrators. School administrators are key to the study because they provide important teaching and learning materials for the school. The plan the whole school programs so that it becomes successful in the teaching and learning of Biology. Lastly is MOPSE as policy makers, they are key to the success of any policy especially on its formulation. Policy makers derive their policies from what is on the ground in schools hence the teaching and learning of Biology needs policy makers support for its continuous improvement.

1.7 Limitations of the Study

The study's limitation was lack of financial resources to finish the study on time. The researcher, instead of travelling to meet participants and the supervisor physically, most of the work was done virtually or distributed research instruments online. The study's duration was short to finish the research as well. These potentially impact the study's validity, generalization or reliability of the research findings. The researcher employed a holistic approach towards finishing the project in time by writing chapters ahead whilst the supervisor is marking and correcting the current chapter. Mostly, if the sample size not representative or small of the whole population of schools in Munhemba Cluster, the findings may not be able to precisely reflect the use of ICT in the teaching and learning of Biology at O Level, Mutoko district. However, if certain stakeholders or schools in the district are overrepresented or underrepresented in the sample, the study's results could lead to bias of findings. The researcher ensured that all participants were evenly represented in the study especially on the sample and during data collection.

1.8 Delimitations of the Study

This study was limited only to the geographical area of Munhemba Cluster, Mutoko District in Mashonaland East Province. Munhemba Cluster are rural schools in Mutoko district with each school with an average number of 550 learners per each school. The study did not include any other school in the Munhemba cluster, Mutoko district.

1.9 Assumptions of the Study

The study's assumption was that participants or respondents were open and gave honest answers during data collection on the use of ICT in the teaching and learning of Biology. The study assumed that, the research was carried out within the stipulated timeframe. The study also assumed that the MPOSE would allow the researcher permission to use schools in collecting data in Munhemba Cluster.

1.10 Definition of Key Terms

1. **Forerunner**

One that goes before or announces the coming of another (Rana and Rana 2020). Forerunner is applicable to anything that serves as a sign or presage (Jandrić 2021).

2. **Exploration**

An active learning approach which helps students learn through curiosity and inquiry (Gandolfi, Ferdig and Kratcoski 2021). Hart, Da Costa, D'Souza, Kimpton and Ljbusic (2021) state that, learning through exploration as a process changes the way learners approaches a particular situation. During the exploration phase, students actively explore the new concept through concrete learning experiences.

3. **Biology**

The study of structure, function, heredity, and evolution of all living organisms (Jandrić 2021). is defined biology as the science of life and living organisms. Biologists try to understand the natural world and the things that live in it. These things include plants, animals, fungi, protozoa, algae, bacteria, and viruses (Christopoulos, Mystakidis, Cachafeiro and Laakso 2023).

4. **Information and Communication Technology (ICT)**

The mode of education that use information and communications technology to support, enhance, and optimize the delivery of information in and outside classrooms (Kozlova and Pikhart 2021). According to Zafar, Zaidi, Mansoor, Sinha and Qin (2022), ICT is a set of integrated technological resources that provide, through hardware, software, and telecommunications functions, the automation and communication of teaching and learning and scientific research among others.

1.10 Chapter Summary

The chapter focused on the background to the study, statement of the problem, research aims, research objectives, research questions, significance of the study delimitations and limitations of the study, assumptions of the study and definition of key research terms.

CHAPTER 2

REVIEW OF RELATED LITERATURE

2.0 Introduction

The previous chapter discussed the background to the study on challenges of using ICT in the teaching of biology in education. This chapter focused on the review of literature related to the study. The chapter will commence with the theoretical framework.

2.1 Theoretical Framework

The theory for the study shall be the systems theory which was modelled by Ludwing Vin Betsalanffy (1928) and advocated by Kate & Kahn (1966). The theory state that, a system is a collection of some interrelated parts which then form some whole (Forrest, Forrest & Strauss, 2018). The researcher preferred this theory over the neo-classical organizations theory which was felt that it cannot not serve the desired purpose because they emphasized schools as closed and fragmented social units which are independent of external force. According to the systems theory, there are two types of systems, which are open and closed systems. Closed systems do not interact with the environment and are self-supporting systems. On the other hand, open systems interact with the environment which they rely on to get essential inputs and discharging of outputs (Markovsky & Dörfler, 2021). According to a proponent of the systems theory, Cole (1993) asserted that there is a boundless interdependence the environment and the system and further stated that whenever something goes wrong in the environment or any of the sub systems, the other systems would be affected and this would affect the output as well. Schools are managed as systems in which there are innovated educational programs where they are re-innovated in order to realize the importance of each part which makes the whole and the elimination of parts that contribute negatively towards the system (Wolfram, 2018). In a school system, Biological Science Department can be considered as a subsystem. The other school system is the administration, which support the teaching and learning of ICT by purchasing ICT tools needed and lay infrastructure, procurement and finance, discipline, guidance and counselling and many other duties. The improvement in pedagogical teaching and resultant good performance in Biology is part of the output measured through formative and summative evaluations respectively (Becvar,

Becvar & Reif, 2023). The other departments such as finance, procurement and discipline that are concerned with availing and effective use of the resources are also affected what goes on in the biology classroom such as instructional methods. The schools, due to these facts, they are studied as a whole than in parts. Schools are open systems which interacts with their environments by engaging in various modes of exchanges (Pesurnay, 2018). The school environments include communities where the school draw its learners and where it is located. This entails the social, physical, cultural, climatic, economic and sometimes political aspects such as educational policies.

2.2 The use of ICT in Teaching and Learning

ICT infrastructure refers to the software and hardware used to enhance the teaching and learning of biology. The ICT hardware includes computers, mobiles phones, scanners, projectors, printers, cameras, radios, television sets, while software include some application such as data logging as well as simulations (Mulimani & Naikar, 2022). Internet connection and electricity connection are also necessary infrastructure for the teaching and learning of Biology. According to Kilag, Segarra, Del Socorro, & Mahasol, (2023), ICT infrastructure must be easily accessed and used by all in the teaching and learning. The use of ICT tools in the teaching and learning of biology created a conducive learning environment whereby students actively participate constructively. However, the use of ICT should not be taken as a way of replacing the current teaching methods but should be used to support existing teaching and learning processes (Zagouras, Egarchou, Skiniotis & Fountana, 2022). In this way, ICT is used to develop student skills in terms of communication, cooperation, lifelong learning and problem-solving skills. ICT teaching and learning should be applied in almost all subjects instead of teaching it as an isolated topic or course. Student centred learning can enhance the innovative use of ICT. Teachers must use ICT in every subject in order to improve student learning skills in every subject. This would help students to develop critical thinking skills, problem-solving and decision-making behaviours (Jadhav, Gaikwad & Patil, 2022).

When using ICT in teaching and learning biology, it created a good learning environment for students and it becomes motivating, enjoyable and attractive to learners as they increase their attention to the subject thereby increasing the effective teaching and learning of the subject. Most

biology teachers were still using the teacher centered approach to teaching where they use textbooks as the main and only source of content for teaching (Hailegebreal, Sedi, Belete, Shibiru & Mengiste, 2022). Biology as a subject had been found and viewed as a difficult subject taught using traditional teaching methods and biology teachers have to find means and ways of simplifying the teaching using ICT. The use of ICT in teaching and learning biology allowed teachers opportunities of bringing nature into classrooms. It had been recognized that ICT increases students' motivation through facilitating the exchange of information between groups of students and their teachers.

The research conducted by UGWU & Nnaekwe (2019), described the use of multimedia strategy in teaching and learning process as one of the best modes of teaching that can be adopted for making teaching biology more meaningful. Regardless to the importance of ICT in the teaching and learning process, its use was found to depend on different factors ranging from the simple to complex ones. Some of these factors are based on teachers' perception about its usefulness, professional development, technical supports, teachers' age, ICT infrastructure and teaching experience (Shava, 2022).

2.3 Accessing of ICT tools to teach biology

Hardware and software are needed when using ICT for teaching and learning in education in schools. Studies by Mahdum, Hadriana & Safriyanti (2019) had identified the shortage of computers in most rural schools as one of the obstacles in the use of ICT in teaching and learning of biology. On the other hand, in a study conducted by Makuru, & Jita (2022) indicated the shortage or lack of hardware and software as one of the main reasons why teachers do not use ICT in classrooms. The availability of internet and electricity facilities is also needed during the teaching and learning of ICT because it can be difficult to use computers without electricity. Internet, in addition is needed by teachers in order to enrich themselves of content from different sources (Johnson, 2022). In many developing countries like Zimbabwe, internet and electricity connectivity remains a serious challenge which continues to haunt African countries. According to different studies conducted and discussed above, it had been found that the use of ICT in effective

teaching and learning requires and influenced by different factors (Sayfullayeva, Tosheva, Nematova & Inoyatov, 2021).

2.3.1 Technical and Administrative Support

The use of ICT in classrooms, according to research conducted by Aristovnik, Kovač, Murko, & Tomaževič (2021) had been enhanced by the availability of the technical and administrative support team. This is done through the provision of training on teachers equipping them with necessary skills in using ICT and motivating the use ICT in daily classroom activities. Technical ICT related support had been found to be useful because its unavailability had affected the willingness of teachers to adopt and integrate ICT in teaching and learning of biology (Jacob, Dahir & Jegede 2021). The use of technical support is a necessity in troubleshooting issues. In this regard, teachers may be taught or trained on how to resolve some simple ICT technical issues. In this regard, teachers' anxiety would be greatly reduced in the use of ICT in teaching and learning of biology. In this context, school leaders should adopt strategies that will facilitate teachers to use ICT as the basic tool in their daily teaching practices (Shemshack, 2021).

Teachers and school authorities are the ones who discuss the school vision and ICT policies at the school and how to ensure equal sharing of resources appropriately. It is important for administrative staff of schools to make follow up on the implementation of ICT in the teaching and learning to ensure challenges are identified early and find out possible solutions to help teachers. Motivation on using ICT in education should be more effective if it starts from school leaders. School administrators play a key role in integrating ICT in education through acquisition and coordination of all resources required for ICT use in teaching and learning process (Khtere, Ramadan, & Mohamed, 2021).

2.4 The challenges faced by teachers and learners in teaching and learning Biology

The major responsibilities of educational authorities to achieve the desired results is to recognise the demands of the time and defining educational goals and objectives for the implementation of ICT in teaching and learning of biology (Alkhawaldeh & Khasawneh, 2022). The key barrier that

prohibits teachers from effectively implementing ICT in teaching and learning is the absence of a clearly defined educational policies. In order to integrate ICT into their teaching practices effectively, teachers must have enough time to finish their teaching responsibilities (Hafeez, Ajmal & Kazmi, 2021).

According to studies on the other hand, it revealed that teachers could not have enough time to finish all their pedagogical duties such as note-taking, lesson planning and lecturing required to use ICT in the teaching and learning of biology. Lukas & Yunus (2021) also identified similar challenges that as a result of their negative perception of the use of ICT in teaching and learning, teachers lacked the time to successfully use ICT to increase the efficacy of their teaching strategies. It is important for educational authorities to support teachers by providing professional development and time management programs in order to overcome these barriers (Bhuana & Apriliyanti, 2021).

The second challenge is the shortage of qualified ICT teachers especially in rural schools. The number of qualified teachers to teach ICT cannot meet the demand for ICT teaching and learning on the rise tremendously. There are few teachers who are ready to transfer ICT skills and knowledge to more students who willing to be taught computing skills (Izhar, Al-dheleai & Na, 2021). In addition to the above, there are still shortages of computers in schools across the country maybe because that they are expensive. Some government agencies, corporate organizations, individuals and NGOs donated computers to different rural schools but there still remains a huge number of rural schools which are unable to buy computers for use by their students. Schools in rural areas are not yet connected to electricity because the government is yet to connect all parts of the country to the national grid (Gurung, 2021).

As a result, those schools had been left handicapped because they may not be able to offer computer studies worse still use ICT in teaching biology. Most schools had obsolete computers which contributed to lower morale for both school teachers and students. Old computers were still available in most rural schools running on win98 or win2000. It is common knowledge that technology keeps evolving and advancing at a high rate with new programs which are made every time. Most teachers do not want to embrace and implement the use of ICT tools because they "feel" that they remain an authority and a 'know it all' in class is something they cherish and anything

that makes them look or become otherwise becomes an enemy of the teacher centred approach in classroom (Erlangga, 2022).

2.4.1. Teachers' perception towards use of ICT in teaching and learning of Biology

Teachers had a positive perception that integrating and implementing ICT in the teaching and learning of biology help learners to achieve their learning goals and it aids teachers in aligning their teaching practices with world-wide standards. Pakistan, Bangladesh, India and Indonesia acknowledged the value use of ICT in education and their governments are interested in implementing ICT tools for teaching and learning to meet the global demands of their citizens on national educational policies (Daar, & Nasar, 2021). However, there are a number of developing countries such as Malawi, Kenya, Uganda, Zambia and Zimbabwe with a detrimental impact on how to use ICT in classrooms. These countries lack the following: technological knowledge and expertise (Mohd & Shahbodin, 2021), ICT infrastructure (Inganah, Darmayanti & Rizki (2023), electricity and internet (Varas, Santana, Nussbaum, Claro & Imbarack (2023), and teachers' perceptions of implementing ICT in teaching and learning and a lack of teacher preparedness in educational institutions. According to Mohd & Shahbodin (2021) the teachers' beliefs and attitudes heavily depends on the successful implementation of ICT for teaching and learning in addition to other technologically related factors. The teachers' ideas and views shape the academic decisions they make with regards to how technology is implemented into their teaching practices in a way that serves the needs of teaching and learning in the twenty-first century.

2.4.2 Teachers' Attitudes in implementing ICT in teaching and learning

Teachers of today are required to be innovative in their pedagogical approaches. In doing so, Katemba (2020) argued that, technological use in education plays a significant role in introducing innovation to the way teachers teach and it aids students in achieving their academic objectives when it is done successfully. Abel, Tondeur & Sang (2022) argued that, since teachers favour technical tools that match their academic beliefs and pre-existing views about effective teaching and learning methods, their attitudes about using ICT in teaching and learning have a substantial

impact on teachers' teaching practices. In this regard, in a study by Guillén-Gámez & Mayorga-Fernández (2020) in 2018 in Santiago, Chile, where ICT teachers, students and HODs from six different secondary schools where each school contributed a sample of two ICT teachers, five students, and six HODs. The total sample was forty-eight from all six secondary schools. The research revealed that, a comprehensive grasp of teachers' willingness to implement ICT in their teaching and learning, impressions of the advantages, as well as their attitudes toward the difficulties they face in classroom (Khan & Kuddus, 2020).

Many developing countries had not yet achieved the deployment of technologically integrated teaching and learning in their schools. The research results under examination, despite the positive results over teachers' attitudes demonstrated a number of advantages of using ICT in teaching and learning (Rahayu & Wirza, 2020) The student academic improvement was consistently mentioned as a huge positive factor which is related to the motivating environment that kept them engaged in active learning. Furthermore, students can easily get useful learning resources which boosts academic performance and explains impending ideas, thanks to teachers' attitudes in implementing ICT in teaching and learning of biology. These results support those of Varas, Santana, Nussbaum, Claro & Imbarack (2023) who revealed that participants in urban high schools stated high levels of cognitive knowledge and learning accomplishments compared to rural schools.

2.5 Ways of using ICT in teaching and learning of Biology

Both the teacher and the students can use ICT in different ways in the teaching and learning of Biology.

2.5.1. Online Lessons

The most effective way of teaching online is through the use of trained and experienced teachers in the subject matter. The use of interested and qualified teachers is the best way to ensure the connection between the value of traditional and online education in teaching online (Daar, & Nasar, 2021). There are two emerged online approaches which are synchronous and asynchronous learning. The synchronous learning approach uses instruction and collaboration in real time using the internet. The tools involved include audio and video conferencing, live chat, shared whiteboard

and data and application sharing among others. While asynchronous learning methods uses the time-delayed capabilities of the internet (Erlangga, 2022). It normally involves these tools emails, newsgroups and bulletin boards and file attachments. The following are the advantages of online lessons.

1. **Student-centred learning-** Students become more versatile learners by using a variety of online tools drawing from individual learning styles (Forrest, Forrest & Strauss, 2018).
2. **Collaborative learning-** Students becomes more active by using online group work in the learning process. Students must comprehend what would be discussed in order for them to contribute their input by organising their thinking coherently and expressing the same thinking with careful constructed language (Martínez, Ortega Martin, Marin Marin, & Gomez Garcia, 2020).

2.5.3 Power Point Presentation

Information can be presented in different ways by using PowerPoint by projecting colours, videos and images, text and writing prompts for reading, sound and music for auditory mode as well as interactive slides that ask students to do something (Guillén-Gámez & Mayorga-Fernández, 2020). The main purpose of PowerPoint presentations in classrooms is to help direct lectures or lessons although they have different purposes at the same time giving students an opportunity to follow along and better understand the material being taught. Clip art must be avoided with a PowerPoint teacher for effective teaching. The slides must be used to focus on students' attention and then leave the details to textbooks and lectures (Gurung, 2021). When new more information needs to be put forward, there is need to make a new slide.

Advantages of PowerPoint

PowerPoint are quick and easy to use as the basic features are easy to master which makes the students to appear more organised. It is easy to create an attractive and colourful design using the standard themes and templates (Hafeez, Ajmal & Kazmi, 2021).

Disadvantages of PowerPoint

The design power pointless because it gives an illusion of some content and coherent when there is no substance between different points raised on the slides. Some speakers use PowerPoint so that they create their presentations instead of organising, outlining and focusing on the message (Daar, & Nasar, 2021). PowerPoint presentation replaces planning and preparation as it is a convenient tool for poor speakers because it reduces complicated messages into simple bullet points and elevate style over substance (Erlangga, 2022).

2.5.4 Research

Online research involves the collection of information by the researcher from the internet. The advent of internet has driven the pen-and-paper research techniques to the backseat and created room for online research design (Erlangga, 2022). Online polls, surveys, focus groups, and questionnaires are some of the tools used with online research that are important in collecting important information for market research. Students and teachers have used internet to create impressive avenues to conduct research at zero or minimum investments. This form of research is often called internet research or web-based research. Researchers use online focus groups and online interviews for students as data collection instruments (Forrest, Forrest & Strauss, 2018).

2.5.4 Online Assignment Submission and Marking

Assignments maybe submitted using several submission types to the supervisor. It is up to lecturers to choose the type of online submissions to be used by the students (Martínez, Ortega Martin, Marin & Gomez Garcia, 2020). Any attachments added as part of a graded assignment submission are also copied to the student's user files but are not counted against the user quota. However, once the file has been uploaded as a submission, the file cannot delete. The students have advantages for using online assignment submission. Students do not print their assignments to submit, students do not queue at the school office to submit their assignments, and students submit their assignments wherever they are (Gurung, 2021). Online marking is becoming an integral part of institutions as lecturers mark large cohorts especially when dealing with online and distance

learning. However, online marking may sometimes become a serious struggle to set it up but the use of a rubric to mark them make things easier and quicker for the lecturer or teacher (Hafeez, Ajmal & Kazmi, 2021). Online marking's disadvantage is that it lacks the drawing tools that annotate scripts online.

2.6 The benefits of using ICT in teaching Biology

Traditional teaching and learning are different from online teaching in many ways which makes it difficult and challenging for it to provide effectiveness to students when they lack necessary knowledge and skills. According to Hong, Hwang, Tsai, Liu, & Lee, (2022) the effective use of ICT in teaching and learning of biology plays a critical role by using teachers' professional expertise in determining their teaching techniques. However, according to a study by Guillén-Gámez, & Mayorga-Fernández (2020) in Yemen city of Saana in 2018 where eight secondary schools in the capital city were examined. Three ICT teachers, four students, ICT HODs and school heads were examined. The total number of the sample was seventy-two. The study's findings were that teachers were generally positive to the implementation of ICT in teaching and learning although lack of resources and expertise made it impossible for them to incorporate ICT in teaching and learning (Alvarado, Aragón, & Bretones, 2020).

Teachers' attitudes towards the introduction of ICT in Ecuadorian public schools. Teachers should constantly improvise their teaching techniques. In order for teachers to advance their technological and professional competencies, teachers be provided with the required assistance from the concerned educational authorities. In developing nations, even at secondary school level, technology use is still in its infancy (Pongsakdi, Kortelainen & Veermans, 2021). Teaching and learning at both primary and secondary school levels, during COVID-19 phase, technological use had not been fully implemented which negatively affected teachers' skills and technological knowledge of ICT in students. Lack of proper infrastructure and trained teachers, according to Raygan & Moradkhani (2022) found that during CIVID-19 period, the most advantaged were students from urban areas compared with students in rural public schools when it comes to grasping online teaching and learning.

2.7   Disadvantages of using ICT in teaching and Learning of Biology

As technologies brings so many benefits to the education sector, it is not perfect because it has its own disadvantages to be taken into account. ICT is full of destruction and lack of attention (Jadhav, Gaikwad, & Patil 2022) There is so much multiple access to unlimited sources of information brought about by digitalisation such as social chats or networks, web pages and as a result taking away attention of learners from the important subject matter. Technology has inappropriate and excessive impact which may lead to students creating a compulsive relationship with it. This may lead to uncontrolled consumption and as a result, have negative effects on students' health on academic, family and social life. The development of other skills may be reduced due to overuse or reliance on technology (Johnson, 2022). The widespread adoption of technology in academic institutions may lead to the nullification of other practices such as public speaking, academic writing and reasoning. In research conducted by Khan & Kuddus, (2020) at the University of California, revealed that, social skills of the new generations are based more on the use of technologies which therefore affect negatively direct personal communication.

Information available on the internet tend to be incomplete and false hence consumption of false information by students. Most students are not yet able to detect false information and have a direct influence on students' media literacy (Liesa-Orús, Latorre-Cosculluela, Vázquez-Toledo & Sierra-Sánchez, 2020). Students' data maybe stolen because of lack of dangers of cybercrime which sometimes expose students' data for instance by sharing personal photos with strangers. The use of technologies in the teaching and learning had reduced the human contact and the learning process had become distant decreased the physical relationships between teachers and classmates (Lukas & Yunus, 2021). As a result, the appearance of isolation by reducing human contact becomes an obstacle to students' development personally.

2.8 Conclusion

The chapter discussed the literature review focusing on the study's theoretical framework systems theory which was developed by Ludwing Vin Bestalantly (1928) and advocated by Kate & Khan

(1966). The chapter discussed the use of ICT tools used in teaching Biology, challenges faced by teachers and learners in the teaching and learning of Biology and the benefits if using ICT in the teaching of Biology. The next chapter shall discuss about the research methodology.

CHAPTER 3

RESEARCH METHODOLOGY

3.0 Introduction

According to Voss and Kunter (2020), literature review is one of the most important areas that are used by researchers to explore the problem under investigation and the ability to identify knowledge gaps in line with different scholars and theorists in relation to the identified problem. Literature review was able to assist the researcher to identify theories related to the research problem. Research methodology shall comprise of the research paradigm, design, research population, research sample and sampling procedures, data collection procedures, data analysis procedures, instruments, ethical considerations, and quality assurance procedures are the hallmark of research methodology.

3.1 Research Paradigm

The research plan clearly fit the framework of theories and practices of the discipline of study. The areas of the research plan such as the research questions, data collection instruments, aims of the study and methods of analyzing are all guided by research design (Park, Konge, & Artino, 2020). This qualitative research used an interpretivists paradigm. It is the belief of interpretivists that because human behavior is complex so there is no single reality but multiple realities in existence. Interpretivists is the popular research paradigm that is mostly used by the majority of qualitative researchers in social sciences. Research bias is the main problem when using the interpretivists framework. Interpretivist paradigm can only be used in reality within the framework of those participants under study not in an environment of laboratory (Brown, & Dueñas, 2020). The results of interpretivist studies, their nature is that, they can only be valid when they were collected within a particular circumstance of the study and cannot be generalized. The quality of teachers and their continuing professional education and training is central to the achievement of quality education. However, schools in Munhemba Cluster faces serious shortages of ICT tools such as computers, laptops, projectors, smart phones, internet and computer laboratories and this limit the use of ICT in the teaching and learning of Biology. The research paradigm is used as a

research plan or guide including the aims of the study, research questions, instruments and data analysis methods. The interpretivist research paradigm was used by the researcher. The paradigms were aligned with the purpose of the study. In line with the interpretivism the researcher employed the qualitative research approach.

3.2 Research Strategy

A case study research design will be utilized for this study as it seeks to extract purely descriptive and in-depth data such as structured interviews, closed ended questionnaires will be utilized in order to allow for structured responses. Hennink & Kaiser (2022) defines a case study as an in-depth investigation of two or more phenomena in natural settings considering perspectives of the participants involved in the phenomenon. Khatri (2020) states that a case study, is a qualitative approach in which the researcher explores a case or cases over time, through detailed, in-depth data collection.

Case study research design was used in this research because it helped to examine the views of participants who were interviewed during this research. This research design is suitable for this study in that it helped the researcher to investigate deeply on the factors leading to low performance in O Level Biology at Munhemba cluster in Mutoko district. The afore-mentioned research design enables the researcher to collect sufficient data as the focus is to be made on a small population (May, Albers, Greenwood & Murray, 2022). In case study research design, the researcher typically become a member of a culture, group or setting and adopted roles to conform to such a setting and in doing so the aim of the researcher is to gain closer insight into the study's practices, as well as motivations and emotions of people from different backgrounds. As such, it is imperative to use case study research because research findings emanating from case study research accurately reflect the views of people in a natural setting (Seyfried & Pohlenz, 2020).

The use of case study research design was important in this study because it was more dynamic and largely used structured methods of obtaining data like open-ended questionnaires thereby making data collection and analysis more flexible. Case study allowed for the collection of primary

data in a flexible and structured way that results in the emergence of new information relevant to the study (Ziajahromi & Leusch, 2022). Given this situation, case study research design was a very useful as a research design for this study.

3.3 Research Population

Population is defined by Mthuli, Ruffin, & Singh (2022) as all units, objects or individuals that were considered in a research study. Population is defined by Woodford, Christie, Bowman, & Evans (2022) as a group of people to be studied by the researcher. In this research, population was defined as a group of individuals with one or more similar features which are common or of interests to the researcher. However, in this case, the research population comprised of all cluster Biology teachers and O Level secondary school children (Firdaus, Aksar and Gong, 2022).

3.4 Research Sample and Sampling Procedures

The sample size was big enough to provide the necessary data according to research instruments used at the time. The researcher, using purposive sampling used a sample size of two Biology teachers, and five students from each of the two secondary schools bringing a total number of fourteen participants. According to Ruslin, Mashuri, Rasak & Syam (2020), a sampling procedure is a process used by researchers to select a sample from a large population for it to be participants in a study. The researcher purposively sampled biological teachers and learners. The researcher divided these sampled participants into different homogeneous groups. Participants were grouped as teachers and learners separately.

The researcher decided to work with teachers and form four learners. Systematic random sampling was used by the researcher. The researcher divided learners into two groups consisting of males and females respectively. This was done in order to have representation for both girls and boys. The researcher used cards that the learners shall pick. Those who picked cards with the researcher's secret number were selected. The teachers were selected in alphabetical order. This means that, those with names that start with letters on the alphabet were selected first. This however allowed everyone a chance to be selected.

3.5 Research Instruments

The study generated qualitative data and the researcher used interviews and questionnaires as research instruments.

3.5.1 Interviews

An interview is a conversation between an interviewer and interviewee according to Leonhardt, Noble, Poelzer & Belcher (2022), where the interviewer is the moderator collecting necessary information. However, May, Albers, Greenwood & Murray (2022) define an interview as a discussion between two or more people based on a mutual topic of interest. Assuming from the given explanations, an interview can be defined as a face-to-face interaction between two or more people for purposes of data collection. Dörnyei & Dewaele (2022) argued that during interview process, an interview guide with questions is used as a framework to guide the whole process. Interview questions related to the topic are prepared by the researcher. Qualitative data collection procedures use interviews as it plays a critical role to help the researcher to get a deeper understanding of ICT teaching and learning of Biology.

The researcher prepared semi-structured interviews consisting of open-ended questions administered to Biology teachers and learners. These types of interviews allow or encourages the interviewee to fully answer questions deemed necessary for the study. This implies that participants would not be restricted in their responses as in the case of closed-ended questions where they give a yes or no response to research questions. According to Mufanechiya et al. (2012), a two-way communication is created through an interview between the interviewees and researcher.

3.5.2 Questionnaires

Questionnaire is a data collection instrument comprising different questions used to gather data from participants. Questionnaires are almost like a written interview. Questionnaires can be used to collect data by email, or distribution of hard copies (Turner III, & Hagstrom-Schmidt, 2022).

When collecting data from large volumes of people from a large sample, it is relatively cheaper, efficient and quick to use questionnaires. Questionnaires were completed in the absence of the researcher so it became quick to collect data that way. Whenever interviews are no longer practical to collect data, questionnaires are the best ideal tool to use (Thunberg & Arnell, 2022). Questionnaires were used in this research as the best tool to measure effectively the attitudes, behaviors, preferences, intentions and opinions of huge number of participants very quick and cheaper in the absence of the researcher than other data collection instruments. Nevertheless, respondents used questionnaires and they were not watched and lie due to social desirability (Knott, Rao & Summers, 2022). Some people in order to look good, they may bend the truth in order to portray a strong positive image of themselves.

The researcher administered open-ended questionnaires written down which needs response or answers from participants. These questionnaires gave participants more time to answer them in their free time without interfering with their schedules. Thus, open-ended questionnaires gave participants freedom to give adequate important information for the study. These questionnaires were hand delivered by the researcher to all participants and advise them on the day to pick them up in person.

3.6 Data Collection Procedure

The researcher sought the authority of Bindura University of Science Education and was provided with a letter authorizing to make research. The letter was then used to apply for permission from the Ministry of Primary and Secondary Education for approval to visit sampled schools. The researcher, armed with the letter of approval, visited sampled schools to start collecting data from participants. This was done with consultations with the researcher's school head and all the heads of sampled schools in order to avoid disrupting the school programs. The researcher observed all ethical principles such as consent of participants during the data collection period.

3.7 Data Analysis Procedure

According to Creswell (2019), data analysis is a process that involves the sorting and categorizing of collected data and coding it according to provided themes which are used in drawing study findings. It was also alluded to by Kothari (2014) that data presentation involves the editing, coding, processing, tabulation and classification of collected data to make it amenable for analysis. This means that, data collected through interviews was subjected to inductive analysis procedure. Thunberg & Arnell (2020) argued that, this involves the description of data, condensing data into themes and categories for valid interpretation and inference. Such a method is a descriptive statistics analysis. In this study, the descriptive statistics was used by the researcher to describe the basic features of data. They provided simple summaries about the sample and the measures. Data collected from questioners and interviews was tabulated.

3.8 Ethical Considerations

Voltelen, Konradsen & Østergaard (2018) referred to more literature that can be used to guide researchers when designing an ethically suitable research approach. The most important of all ethical researches is the informed consent (Fleming & Zegwaard, 2018). The two terms, informed and consent which are two critical terms in research ethics required serious considerations. The researcher ensured that participants signed consent forms in order to take part in the research as well as to enforce their rights where necessary either to withdraw from the research or accessing their information (Milner-Gulland, Veríssimo & Lewis, 2020). Key confidential information, providing assurances, and ensuring anonymous were key in research ethics as well as avoiding the use of self-identifying information to protect participants. Participant anonymity is when the researcher does not know the participants' identity, home addresses, emails and contact numbers (Arifin, 2018).

3.9 Quality Assurance Procedure

The researcher shall ensure that all research ethics such as ensuring consent of participants, ensuring anonymous and protecting the identity of all participants. The researcher protected personal information of all participants such as their identities, home addresses, contact numbers and emails. The research cited every material work done by other academics used in the study and completely avoid plagiarism.

3.10 Conclusion

Research paradigm, design, population, research instruments, trustworthiness and authenticity and data collection procedures and data analysis and presentation were all explained in detail. The next chapter focuses on data presentation and analysis.

CHAPTER 4

DATA PRESENTATION, INTERPRETATION AND ANALYSIS

4.0 Introduction

This chapter presents, analyse and interpret the research findings that emerged from data that had been generated from fieldwork at three schools in Mutoko District of Mashonaland East Province of Zimbabwe. The study sought to find out the use of ICT in the teaching and learning of Biology at "O" level. The chapter will commence with demographic data of the participants.

4.1 Demographic Data

The study comprises of four biology teachers who participated in the study. There are two male and two female teachers which shows that teachers' numbers were distributed equally across two schools under study. The form four students who are participating in the study were four male and six female. It is important for the study to have male and female teachers and students so that the study becomes neutral in its findings.

4.1.1 Distribution of Teachers by Age

Table one below shows the gender of the four teachers who participated in the study.

Table 4.1 Teacher distribution by Gender

Biology Teachers	Gender
Male	2
Female	2

The study had four biology teachers from two secondary schools under study. There are two male and two female teachers and this balanced the research in terms of gender. This enabled the researcher to get the perspectives of both genders on the topic under study.

4.1.2 Teacher and Students' Distribution by Age

The research include teachers and "O" Level students thus is comprises adults and teenagers as presented in table 4.1.2

Table 4.2 Distribution of participants by age

Teachers and students	15-16	16-20	20-30	30-40	40-50	50-65
Male	3	1	-	1		1
Female	4	2	-	1	1	

They were four biological teachers from the two secondary schools with each school having two teachers. They were two female and two male teachers from these schools. The age range varied from 35 to 65 years. This would mean that the researcher would get a wider range of perception since the teachers had a 15year difference hence their world outlook differs.

4.1.3 Distribution of Teachers by Work Experience

The research includes teachers' years of experience in the service. Their experience ranges from two to twenty years. Such experience is important to the research because it would help in illustrating some points as some teachers with less than two years' experience understand better the use of ICT in teaching and learning than a teacher with twenty years' service at the age of sixty.

Table 4.3 Teachers work experience

Biology Teachers	5-10 years	2-5 years	2 years
Male	1	1	
Female		1	1

The teachers who participated in the research were two males with five years' working experience and one female with less than five years and another with less than two years working experience. Their age differences in experience were of great value to the research. The research would have different varieties from different age groups. Teachers with less than two years understand better the use of ICT in teaching and learning than teachers with more than fifteen years in service since they had never used ICT or a computer.

4.1.4 Distribution of Teachers by Qualification

The researcher also collected data on teacher qualifications. The results showed a mixed bag of qualifications ranging from certificate in education to degree.

Biology Teachers	Certificates	Diploma	Degree	Master's Degree
Male	-	1	1	-
Female	1	1		-

The teachers were all qualified but with different qualifications. One female teacher had a Certificate in Education and with another with a Diploma in Education, with one male with a degree and the other with a Diploma. These qualifications helped the researcher to draw differently with participants as they had different perception about the discussion under study. However,

because of their different qualifications, the teachers provided varying responses rich in depth on the study.

The study had students in different age groups. The majority of them above fourteen years and two between twelve and fourteen. One male and female students were between twelve and fourteen years with two male and three female students aged between fifteen and seventeen years old. One male student was between eighteen and twenty years old. Of these participants, six were female students and four males. The female students dominated the study.

4.3 Themes and Subthemes

The researcher interviewed four Biology teachers and ten students from two secondary school. The total number of participants was fourteen. Biology teachers were coded as BT1, BT2, from school **A** then BT3 and BT4 from school **B** while students were coded as S1, S2, S3, S4, S5 from school **A** and S6, S7, S8, S9 and S10 from school **B**. The background information helped the researcher to compare data gathered from different range of sub-groups, for example, the number of students and Biology teachers involved in the interviews and questionnaires. They are three main themes for the study are as follows: ICT tools used to teach Biology, importance of ICT tools used for teaching and learning and challenges faced by teachers and learners. These themes shall be broken down into subthemes and explained under each main theme.

4.3.1 THEME 1: ICT tools used to teach Biology

The use of ICT tools in the teaching and learning of Biology enhances the science learning goals of laboratory experiences include enriching the mastery of science subject matter, developing abilities of scientific reasoning, increasing understanding of the complexity and ambiguity of experimental work, thereby developing practical skills. This helps to increase the understanding of nature of science, cultivating an interest in science and

science learning and improving teamwork capabilities. The virtual laboratory, an onlinemicroscope, multimedia information systems and various animations are four ICT tools used in teaching and learning and they are the themes to be discussed.

4.3.1.1 The Virtual Laboratory

Virtual laboratory is a virtual teaching and learning environment intended to develop students' laboratory skills. They are one of the most important e-learning ICT tools. They are used over the internet, where the student can conduct many experiments without any constraints to place or time, in contrast to the constraints of real labs. This was reflected in an interview by teacher,

Virtual labs allow students to perform different experiments difficult to perform in real laboratories because of their risks. Virtual labs help teachers and students as they save time and effort because they do not need to adhere to certain times to enter the lab, or to move from one place to another. Virtual labs provide teachers with an opportunity to follow up and evaluate students electronically. (BT1, Interviews).

The aspect of the importance of ICT through the use of virtual labs was supported by a student in response to questionnaire question. This was also supported by Watson & Rockinson-Szapkiw (2021) who argued that teachers embrace the use of ICT tools that are consistent for being user friendly and accessible to be able to teach learners. Teacher's understanding of how ICT can be accessed helps to enhance the teaching and learning. In other words, teachers' ideas on the nature of teaching and learning in a classroom strongly influence how ICT tools are easy to use and accessible for teaching and learning of Biology.

The teaching and learning of Biology depend more on how easy to use and access of ICT tools such as the virtual labs. In an interview, this was echoed by a student stating that,

Virtual labs enable students and teachers to use the latest technologies. They help users to keep up with technological development of the digital age. Virtual labs also allow students to perform the practical experiments related to the theoretical courses, which helps them absorb the courses. It provides enjoyment during experiments and help students perform the experiment more than once. (Student 8, Interview).

The same thoughts and opinions were shared and agreed by teachers in response to questionnaire. This was also reinforced by Kilag, Segarra, Del Socorro, & Mahasol, (2023), who emphasized the easier to use and accessibility of ICT infrastructure that it can be used by all in the teaching and learning of Biology. The accessibility of internet and electricity connection are also relevant necessary infrastructure needed for the teaching and learning of Biology.

The ICT tools such as virtual labs by teachers and students should be emphasized by the school because of its massive benefits for the teaching and learning of Biology. This was pointed out by a teacher in an interview by reflecting that,

Online virtual labs protect students and teachers from hazards, given there is no direct contact with toxic or radioactive chemicals and there is no handling of explosive devices or electricity. They also provide the convenience of changing the inputs and transactions used in the experiment without worrying about any dangerous effects of these changes. Virtual labs help students learn basic technology techniques and practice methods used by lab technicians and researchers with keeping the advantages of biology laboratory and advantages of chemistry laboratory. (BT 3, Interview).

The was supported by a teacher BT2 in an interview who argues that the accessibility of ICT tools by learners is important for their growth and development. This was cemented by Thaheem et al. (2021) and Abbasi et al. (2021) who argued that learners should constantly be supported in order to improvised and successfully use ICT tools into educational approaches of their subjects especially in rural schools. In this regard,

concerned educational authorities should provide learners with the assistance they require to advance their technological and professional competencies.

4.3.1.2 Online Microscope

Screen-based microscopes allow for a shared visualization and task-directed conversations that offer significant pedagogic advantages for the science disciplines. It involves observation of natural samples such as the geosciences and biosciences disciplines. The role and development of a virtual microscope used in the teaching of geoscience is related to current developments in the collaborative web-based technologies and mobile computing. Data collected from student in a questionnaire reflected the importance of ICT tools to students. The student highlighted that,

Offering young students' opportunities to complete hands-on activities using microscopes shows them that science is not limited to the pages of textbooks. Rather, it is an active pursuit of knowledge and discovery. (Student 8, Questionnaire).

Teacher BT4, in a questionnaire response, highlighted the importance for learners to access ICT tools for their academic success. The teacher reflected by,

The use of ICT tools microscopes is important to stimulate great motivation of learners for O Level learners at secondary school. Such motivation is important in that it help in the improvement of academic performance of almost all learners. Such tools are important because they keep learners more engaged in class and is healthy for both teachers and learners. (BT4, Questionnaire).

This assertion was supported by student 3 in a questionnaire response. It was also agreed by Jadhav, Gaikwad & Patil (2022) who argued that, this way, ICT is used to develop student skills in terms of lifelong learning and problem-solving skills.

Teacher BT2, in an interview, stated that:

Microscopes have opened up many doors in science. By using microscopes, scientists, researchers and students were able to discover the existence of microorganisms, study the structure of cells and see the smallest parts of plants, animals and fungi. Additionally, digital microscopes provide the ability to capture and store images for future review and documentation purposes. (BT2 Interview).

This device is used for observing microorganisms and their features. In this field, microscopes are used to study bacteria, cells and many more. This device helps biologists in their study of living organisms and their cell structures. There is no longer a need for individual student microscopes, for technical staff for microscope maintenance or repair or worries about the loss of valuable specimens. There is no longer a need for individual slide sets or to prepare new slides.

4.3.1.3 Multimedia information systems and various animations

Multimedia allows teachers to integrate text, graphics, animation, and other media into one package to present comprehensive information for their students to achieve specified subject outcomes. In a questionnaire, a teacher pointed out that,

The use of video, audio, graphics, and animations can help to break up text-heavy content and can make learning more interesting and memorable when employees need to retain important information. Multimedia also ensures learning is accessible to a diverse range of learners. The use of multimedia in education has several benefits. It can improve communication between students and teachers, allowing for quick and easy interaction. The media can enhance collaboration among students, enabling them to work together towards a common goal. (BT3, Questionnaire).

This assertion was in agreement with response from an interview by student 8. Hafeez, Ajmal & Kazmi (2021) also in agreement highlighted that, when using ICT in teaching and learning biology, it creates a good learning environment for students and it becomes

motivating, enjoyable and attractive to learners as they increase their attention to the subject thereby effectiveness in the teaching and learning of the subject.

Teacher BT4 in questionnaire response, stated that the use of ICT tools is important by,

Animation-based learning allows teachers to easily describe or explain complex topics that most learners find difficult to understand. Using animation enables students to visualize and understand complex subjects or processes. The use of animation in education is becoming increasingly widespread as new trends emerge. By making complicated ideas easier to understand, animation makes learning more engaging. It can be used for almost any subject and enables teachers to illustrate various ideas. Additionally, it encourages experiential learning. (BT4 Questionnaire).

This was also confirmed by student 2 in an interview. Hong, Hwang, Tsai, Liu, & Lee, (2022) was in agreement and highlighted that ICT use in teaching and learning advances the informatisation for both teachers and students as they acquire knowledge and great ICT skills. The scholars further stated that students would be able to select and use what they deem necessary information. This is in line with the importance of ICT in teaching and learning.

4.3.2 THEME 2: Challenges faced by teachers and learners using ICT in teaching and learning Biology

Integrating ICT into teaching and learning is a complex process and one that may encounter a number of difficulties. These difficulties are known as challenges. A challenge is defined as any condition that makes it difficult to make progress or to achieve an objective. The following are some of the key challenges that have been identified in the literature regarding teachers' use of ICT tools in classroom. Additionally, student attitudes and perceptions towards biology can affect their learning experience. Negative attitudes towards science and perceived inadequacy of their own background in biology can hinder learning. Engaging and motivating students in biology is also a challenge for educators.

4.3.2.1 Schools with Limited Technical Support

Without both good technical support in the classroom and whole-school resources, teachers cannot be expected to overcome the obstacles preventing them from using ICT found that in the view of secondary teachers. However, some of the top barriers to ICT use in the teaching and learning are limited technical support, lack of effective training for teachers, limited time and lack of teachers' competency.

BT4 teacher pointed out the challenges of shortage of ICT tools in an interview. The teacher said,

In many schools, technical problems are a major barrier for teachers. These technical barriers included waiting for websites to open, failing to connect to the Internet, printers not printing, malfunctioning computers, and teachers having to work on old computers. These technical barriers impeded the smooth delivery of the lesson or the natural flow of the classroom activity. (BT4, Interview).

In support of the above assertion, a study conducted by Daar & Nasar (2021) found and supported that, because of technical challenges of ICT tools, teachers tend to avoid using ICT tools into their classrooms and little technological proficiency. For example, Shah et al. (2020) looked into the breakdown of ICT tools and the fact that few teachers acknowledged the positive effects of using ICT tools into their lesson plans, while other teachers struggled to use broken down machines and make it work. This promotes teachers to have a negative view of the use of ICT in science and technology instruction, depriving students of a fair education.

Responding to questionnaire questions, a student highlighted the disadvantages of having technical challenges of ICT tools in schools. The student reflected by,

ICT support or maintenance contracts in schools help teachers to use ICT in teaching without losing time fixing software and hardware problems. If there is a lack of technical support available in a school, then it is likely that technical maintenance will not be carried out regularly, resulting in a higher risk of technical breakdowns. (Student 6, Questionnaire).

This assertion was echoed by BT2 in an interview. Scholars Hafeez, Ajmal & Kazmi, (2021) also supported the view that schools in rural areas are not yet to technical backup because the government or rural schools do not have the financial resources to employ skilled technicians to help with technical aspects of ICT. As a result, those schools have been left handicapped because they may not be able to offer computer studies worse still use ICT in teaching biology.

Teacher BT3, in an interview, stated the importance of technical support on ICT tools and reflected that,

Many of the technical faults may discourage teachers from using ICT in their teaching because of the fear of equipment breaking down during a lesson. Lack of technical support is the main barrier to using technologies. ICT in the teaching and learning needs a technician and if one is unavailable the lack of technical support can be a serious obstacle. (BT3, Interview).

Student 4 supported this view and it was also supported by Asad, Hussain, Khand and Churi (2020) who pointed out that, schools face serious challenges of technical support and knowhow to fix ICT tools as some of the difficulties faced by rural schools. The scholars further expressed some concerns on schools' serious shortage of fund to hire experts ICT technicians who are in short supply that schools end up suspending classes. Machines in most cases fail to respond when switched on due to breakdown and sometimes power may not be available because of load shedding by the power utility ZESA which also affect the availability of internet. These difficulties faced by learners affect learners' ability to easily learn new ICT skills and be knowledgeable.

4.3.2.2 Lack of Qualified ICT Teachers

Data collected using questionnaires and interviews highlighted some challenges faced in the use of ICT in teaching and learning of Biology. A teacher 1, in an interview hinted that,

There is a serious shortage of ICT teachers in rural secondary schools. Teachers are not incentivised to go and teach in rural schools. This is due to a variety of reasons. (BT1, Interview).

This was supported by student 6 responding to questionnaire. Izhar, Al-dheleai & Na, (2021) in agreement, cemented that, the main challenge is the shortage of qualified ICT teachers especially in rural schools. The number of qualified teachers to teach ICT cannot meet the demand for ICT teaching and learning on the rise tremendously. There are few teachers who are ready to transfer ICT skills and knowledge to a rising number of students who are willing to be taught computing skills.

A student stated, in an interview that few teachers are attracted by rural life especially those that live in urban areas. The student stated that,

The available teachers in rural schools are not willing to use ICT tools in the teaching and learning. They do not acknowledge the impact of ICT tools in the development and academic achievements of students. The teachers also do not have time to plan and integrate ICT tools into their teaching and learning. (Student 10, Interview).

This was supported by BT2 teacher. Gnambs (2021) supported the notion that teachers tend to avoid using technology into their class plans and have little technological proficiency. Shah et al. (2020) looked into the fact that few teachers acknowledged the positive effects of incorporating ICT into their lesson plans, while other teachers struggled to find the time and make it work given their busy schedules and limited free time. This,

according to Gnambs (2021), promotes teachers to have a negative view of the use of ICT in science and technology instruction, depriving students of a fair education. Teacher BT3 in questionnaire response, stated that,

Since teachers are less qualified in ICT tools, they prioritize social contact with their students, they do not believe that ICT teaching and learning is as engaging as learning that takes place in person. They thus have a negative perception of ICT teaching approach and choose in-person instruction. (BT3, Questionnaire).

Teacher BT1, in an interview agreed with the assertion of BT3 teacher. Correspondingly, recent research by Gomes (2019) relating to various subjects concluded that lack of training in digital literacy, lack of pedagogic and didactic training in how to use ICT in the classroom and lack of training concerning technology use in specific subject areas were obstacles to using new technologies in classroom practice. Similar reasons were reported by Alhamd, Alotaibi, Motwaly, & Zyadah, (2018) in a study on failures in using educational technology with the weakness of teacher training in the use of computers, the use of a delivery teaching style instead of investment in modern technology, as well as the shortage of teachers qualified to use the technology confidently.

4.3.3 THEME 3: The benefits of using ICT in teaching and learning biology at O Level

Data collected from participants using two instruments, interviews and questionnaire shows that the benefits of using ICT in the teaching and learning are explained using three themes: the improvement of concentration, flexibility, critical thinking and comprehension, facilitates communication between teachers and students, it incorporates new learning methods, simplified information sharing and improved literacy and motivation for students.

4.3.3.1 ICT improves concentration, flexibility, critical thinking and comprehension

According to data collected from participants through interviews and questionnaires, the use of ICT in the teaching and learning is key in improving students and teacher concentration, flexibility, critical thinking and comprehension in class. In an interview, a teacher, hinted that,

The activities carried out through digital and interactive tools increase student concentration, thereby assimilating concepts more quickly, and enhance learning. This type of tool involves students in more practical learning, with the aim of reinforcing what they have learnt. (BT2, Interview).

This was supported by teacher 1 responding to questionnaire questions. According to Hong, Hwang, Tsai, Liu, & Lee (2022) the effective use of ICT in teaching and learning of biology plays a key role by improving concentration, flexibility, critical thinking and comprehension of both teachers and learners. Teacher BT3 in questionnaire response, stated that,

New technologies promote autonomous learning for students. With the incorporation of digital alternatives such as online courses, each student can learn at their own pace, optimizing time and resources thanks to the flexibility provided by digitalization and connectivity. (BT3, Questionnaire).

This was disputed by student 9 in an interview. As Guillén-Gámez, & Mayorga-Fernández (2020) stated that, the traditional teaching and learning are different from ICT use in many ways which makes it difficult and challenging for it to provide effectiveness to students when teachers lack necessary knowledge and skills. Student 2 in an interview reflected by,

The diverse sources of information that technologies provide bring new points of view to students. In this way, information and communication technologies encourage debate and

the acceptance of other people's opinions. In addition, the exchange of thoughts allows students to learn about different cultures.

Teacher, BT3 partially agreed in a questionnaire response. Therefore, Abel, Tondeur & Sang (2022) argued that, since teachers favor technical tools that match their academic beliefs and pre-existing views about effective teaching and learning methods, their attitudes about using ICT in teaching and learning have a substantial impact on teachers' teaching practices.

4.3.3.2 It facilitates communication between teachers and students

The use of ICT in teaching and learning, according to participants responding to questionnaire and interview questions, highlighted communication between teachers and students. In a questionnaire response, student 8 highlighted that,

The whole educational community has quick access to the same resources. In this way, digital tools allow direct and immediate interaction, without the need to be physically present. This was especially important during the confinement experienced during the 2020 COVID-19 crisis. (Student 8. Questionnaire).

This was supported by teacher BT3 in an interview. Raygan & Moradkhani (2022) highlighted that those teachers and students benefit daily in the use of ICT in the teaching and learning of Biology since the COVID crisis. ICT tools access is important for both students and teachers. Student 3, in an interview highlighted that,

New technologies in the classroom, specifically those that allow access to online content, improve learning productivity by optimizing instruction time, and thanks to connectivity, it feeds collaborative work, thanks to new teaching formulas.

Pongsakdi, Kortelainen & Veermans, (2021) teachers and learners live in the information age and it is important for them to be competitive enough by having access to ICT tools and that would help them to enjoy the teaching and learning of Biology. Student 5, in questionnaire response, pointed out that,

The incorporation of technologies in the classroom improves the motivation of students, it is a quick and practical technique to stimulate the study of new concepts. Digital tools are the daily communicative support of the new generations, therefore, they are easily handled in this environment thereby motivating their use.

This was in agreement with BT2 in an interview response. ICT provides different aspects of benefits such as improved participation and enjoyment of learning by students which improve their class engagements. Katemba (2020) stated that ICT benefits teachers as they would be able to design or develop teaching materials that are necessary for class with easy.

4.3.3.3 It incorporates new learning methods

Data collected from participants through the use of interviews and questionnaires emphasized the importance of ICT in incorporating new learning methods. Teacher 4, in a questionnaire responds stated that,

ICT improves student learning efficiency. For instance, in the past, students would take notes of what the teacher had written on the blackboard, and then reread the notes to consolidate their memory of the lesson. With ICT, however, students no longer need to move their hands because of the use of tablets and other devices, and they will be able to concentrate more on the class. ICT can also make it easier for students to express their opinions, even if they do not like to raise their hands or be the centre of attention during class. (BT4. Questionnaire).

This was supported by another student 7, in an interview. Inganah, Darmayanti & Rizki (2023), supported the use of ICT in teaching and learning also help students to easily

comprehend and concentrate key subject concepts which makes easier for students and teachers to relate. Teacher 2, in a questionnaire responds stated that,

ICT in education helps teaching professionals to incorporate new teaching methodologies, thus improving academic results and encouraging dynamism in the classroom. Moreover, their use implies the development of the digital skills needed to avoid the digital divide.

This was supported by Teacher 1 in an interview. Katemba (2020) highlighted that ICT use helps teachers and students improves the incorporation of new teaching methodologies and encourage dynamism in their learning approach and independence. It therefore inspires critical thinking by students. Greater communication, Mohd & Shahbodin (2021) use of ICT is improved between teachers and students and this kind of communication is of paramount importance because it demystifies some unnecessary myths of the student teacher relationship. Student 8, in an interview stated that,

As ICT in education advances informatization, not only teachers who support learning but also students will be able to acquire knowledge and skills of IT devices. Literacy will help students to select and use necessary information and to develop the ability to think for themselves.

Teacher 3 supported this view in a questionnaire responds. According to Hong, Hwang, Tsai, Liu, & Lee, (2022) the effective use of ICT in teaching and learning of biology plays a critical role by using teachers' professional expertise in improving their teaching techniques.

4.4 Chapter Summary

The findings from participants indicated the major factors contributing to the use of ICT tools, challenges and use of ICT in the teaching and learning of Biology which include ICT tools used to teach Biology at "O" Level, the lack of ICT tools such as computers, projectors, laptops and internet amongst others. The benefits of the use of ICT in the teaching and learning of Biology include improved cooperation between teachers and students, easy presentation of concepts that can be understood by students, imparting new knowledge and skills and enjoyment of the subject

by students. There is an improvement in the communication between the teachers and students in the use of ICT in teaching and learning of Biology. Chapter 5 will summarize the study and present the proposed recommendations.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

The purpose of the study was to explore the use of ICT in the teaching and learning of Biology at O Level, a case of Munhemba Cluster in Mutoko district. The study adopted an interpretivism philosophy. A qualitative research approach for data collection was used, thus the researcher used face to face interviews and questionnaires as data gathering tools. Data was collected from the ICT teachers and "O" Level learners. The explanation of the findings was given in the previous chapter. This chapter discusses the summary of the research findings, conclusions and recommendations. Areas for further research are also suggested.

5.1 Summary of the research

The study focused on the exploration of the use of ICT in the teaching and learning of Biology at "O" Level, a case of Munhemba Cluster in Mutoko district. The new global economy has been created since the introduction of ICT in every sector of society, fuelled by information and driven by knowledge. Governments had been compelled by the advent of the global economic competition and knowledge economy to prioritize lifelong learning, quality education and the provision of educational opportunities for everyone. The access to ICT in education had been widely viewed as creating global competitive individuals who are well skilled and facilitate social mobility. In Mashonaland East Province, Mutoko district Munhemba cluster students have been failing their Ordinary Level Biology. Most learners in the cluster have been streamed according to their abilities hence learners in A class outshine the rest of the classes such as B, C and D classes. The A class had proved that brilliant learners always outclass other learners or classes in the use of ICT in teaching and learning of Biology. The use of ICT in teaching and learning of Biology help to improve to prioritize lifelong learning, quality education and the provision of educational opportunities for everyone. The quality of teachers and their continuing professional education

and training is central to the achievement of quality education. However, schools in Munhemba Cluster faces serious shortages of ICT tools such as computers, laptops, projectors, smart phones, internet and computer laboratories and this limit the use of ICT in the teaching and learning of Biology.

The study was guided by the systems theory which was modelled by Ludwing Vin Betsalanffy (1928) and advocated by Kate & Kahn (1966). The theory state that, a system is a collection of some interrelated parts which then form some whole. The researcher preferred this theory over the neo-classical organizations theory which was felt that it cannot not serve the desired purpose because they emphasized schools as closed and fragmented social units which are independent of external force. According to the systems theory, there are two types of systems, which are open and closed systems. Closed systems do not interact with the environment and are self-supporting systems. On the other hand, open systems interact with the environment which they rely on to get essential inputs and discharging of outputs. ICT infrastructure refers to the software and hardware used to enhance the teaching and learning of biology. The ICT hardware includes computers, mobiles phones, scanners, projectors, printers, cameras, radios, television sets, while software include some application such as data logging as well as simulations. ICT infrastructure must be easily accessed and used by all in the teaching and learning. The use of ICT tools in the teaching and learning of biology create a conducive learning environment whereby students actively participate constructively. However, the use of ICT should not be taken as a way of replacing the current teaching methods but should be used to support existing teaching and learning processes.

This qualitative study used an interpretivists paradigm. It is the belief of interpretivists that because human behaviour is complex so there is no single reality but multiple realities in existence. Interpretivists is the popular research paradigm that is mostly used by the majority of qualitative researchers in social sciences. The behaviours and events created by people interpreting meanings create knowledge. The research paradigm is used as a research plan or guide including the aims of the study, research questions, instruments and data analysis methods. The interpretivist research paradigm shall be used by the researcher. The paradigms are expected to be aligned with the purpose of the study. A case study research design was utilized for this study as it seeks to extract

purely descriptive and in-depth data such as structured interviews, closed ended questionnaires were utilized in order to allow for structured responses. In this study, the researcher's population comprises of all cluster Biology teachers and "O" Level secondary school children. The researcher shall purposively sample biological teachers and learners. The researcher divided these sampled participants into different homogeneous groups. Participants were grouped as teachers and learners separately. The researcher decided to work with form four learners. Systematic random sampling shall be used by the researcher. The researcher divided learners into two groups consisting of males and females respectively. This was done in order to have representation for both girls and boys. The researcher shall use cards that the learners shall pick. Those who picked cards with researcher's secret number was selected. The teachers were selected in alphabetical order. This means that, those with names that start with letters on the alphabet were selected first. This however allowed everyone a chance to be selected. Interviews and questionnaires were used by the researcher to gather necessary data related to the study's objectives and how the data was utilised in the study. When research tools are effectively used, they enhance the reliability, objectivity, and authenticity of the gathered data.

The researcher faced different challenges such as the availability of participants to be interviewed. Participants were always committed elsewhere and provided the researcher with very limited timeframes. The researcher also faced time constraints to continue visiting participants during normal working hours. However, the researcher managed to interview almost all participants regardless of limited time available for interviews. The participants failed to fill in questionnaires in time as most of them do so rushing while the researcher was waiting. Such challenges sometimes negatively affected the quality of data collected.

5.2 Conclusions

1. The study concluded that teachers and students are not fully accessing ICT tools such as virtual laboratory, online microscope, multimedia information systems and various animations in the teaching and learning of Biology at secondary school "O" Level. `

2. It was concluded that rural schools do not have access to more ICT tools such as desktop computers, laptops, data projectors, software programs, printers, scanners and interactive box. The study concluded that rural schools are facing serious shortages of ICT tools that can be used in the teaching and learning of Biology at secondary school level. These tools are key to the success of a digital world where learners are able to interact with their fellows in this fast-changing world.

3. The study also concluded that, rural schools also face serious shortage of limited technical support, and lack qualified ICT teachers. Lack of technical support and qualified ICT teachers are the main barrier to using technologies.

4. The study also concluded that use of ICT benefits teachers and students by improving students and teacher concentration, flexibility, critical thinking and comprehension in class. The activities carried out through ICT tools such as digital and interactive tools increase student concentration, thereby assimilating concepts more quickly, and enhance learning.

5. The study also concluded that ICT benefits students by improving students learning efficiency because in the past, students would take notes of what the teacher had written on the blackboard, and then reread the notes to consolidate their memory of the lesson. With ICT, however, students no longer need to move their hands because of the use of tablets and other devices, and they will be able to concentrate more on the class.

5.3 Recommendations

1. Teachers are recommended to improve their own ICT skills in order to keep up to date with the current ICT skills and knowledge necessary for their profession. The use of ICT tools helps to lessen their burden as these tools help them to make their teaching easier. Teachers are the biggest bridge that help students bridge the ICT gap and enable them to learn more skills and acquire valuable knowledge.

2. It is recommended that the school administrators advocate for the construction of an ICT laboratory for use by the whole school and ensure that students may rotate the use of the lab with a minimum of fifty computers or laptops.

3. Policy makers should prioritise the availability of different ICT tools in rural areas as a way of stimulating the use of ICT in the teaching and learning of different subjects. The policymakers are also recommended to provide internet services, alternative power such as solar systems at different rural schools, ICT tools such as laptops, projectors and computers. Training of teachers in ICT skills and knowledge will go a long way in helping in the advancement of ICT knowledge to students.

4. The study recommends that students use available ICT tools effectively in order for the teaching and learning to be enjoyable and be more attentive in class. The students may also use these gadgets for easier communication with their teachers and fellow students.

5.4 Recommendations for further studies

The research was conducted in rural areas and the findings may not be generalised to all districts. It is therefore, recommended that further studies are conducted in other districts or in urban centres, the findings may be different from rural areas since urban centres have better incomes compared to rural areas. So, it is recommended that further studies are in other educational environments in Zimbabwe to allow generalisation and informed decision making.

REFERENCES

Abel, V. R., Tondeur, J., & Sang, G. (2022). Teacher perceptions about ICT integration into classroom instruction. *Education Sciences*, *12*(9), 609.

Alharahsheh, H.H. & Pius, A., (2020). A review of key paradigms: Positivism VS interpretivism. *Global Academic Journal of Humanities and Social Sciences, 2*(3), pp.39-43.

Alkhawaldeh, M. A., & Khasawneh, M. A. S. (2022). Problems faced by English language teachers in teaching students with learning disabilities. *Science and Education*, *3*(5), 677-687.

Alvarado, L. E., Aragón, R. R., & Bretones, F. D. (2020). Teachers' attitudes towards the introduction of ICT in ecuadorian public schools. *TechTrends*, *64*(3), 498-505.

Alyoubi, K. H. (2020). The role of ICT projects in enterprises: Investments, benefits and evaluation. *International Journal of Advanced Computer Science and Applications*, *11*(6).

Arifin, S.R.M., (2018). Ethical considerations in qualitative study. *International journal of care scholars, 1*(2), pp.30-33.

Aristovnik, A., Kovač, P., Murko, E., & Tomaževič, N. (2021). The use of ICT by local general administrative authorities during Covid-19 for a sustainable future: Comparing five European countries. *Sustainability*, *13*(21), 11765.

Aurini, J.D., Heath, M. & Howells, S., (2021). *The how to of qualitative research*. Sage.

Aydin, M.K. and Gürol, M., 2019. A Systematic Review of Critical Factors Regarding ICT Use in Teaching and Learning. *International Journal of Progressive Education*, *15*(4), pp.108-129.

Becvar, R.J., Becvar, D.S. and Reif, L.V., 2023. *Systems theory and family therapy: A primer*. Rowman & Littlefield.

Bhuana, G. P., & Apriliyanti, D. L. (2021). Teachers' encounter of online learning: Challenges and support system. *Journal of English Education and Teaching*, *5*(1), 110-122.

Bouncken, R.B., Qiu, Y., Sinkovics, N. & Kürsten, W., (2021). Qualitative research: extending the range with flexible pattern matching. *Review of Managerial Science*, *15*(2), pp.251-273.

Brander, S.M., Box, C., Cherniak, S. & Andrews, R.C., (2020). Sampling and quality assurance and quality control: a guide for scientists investigating the occurrence of microplastics across matrices. *Applied Spectroscopy, 74*(9), pp.1099-1125.

Brown, M.E. & Dueñas, A.N., (2020). A medical science educator's guide to selecting a research paradigm: building a basis for better research. *Medical Science Educator*, 30(1), pp.545-553.

Cabero-Almenara, J., Romero-Tena, R., & Palacios-Rodríguez, A. (2020). Evaluation of teacher digital competence frameworks through expert judgement: The use of the expert

competence coefficient. *Journal of New Approaches in Educational Research (NAER Journal)*, *9*(2), 275-293.

Chidzonga, M.M., Haruzivishe, C., Chikwasha, V. and Rukweza, J., 2022. Health professions faculty's perceptions of online teaching and learning during the COVID-19 pandemic. *PloS one*, *17*(11), p.e0276170.

Chinakidzwa, M. and Chamba, L.T., 2023. Resources and capability need for teaching in dynamic technological environments: Evidence from schools in Harare, Zimbabwe. *E-Learning and Digital Media*, p.20427530231217040.

Chisango, G., Marongwe, N., Mtsi, N., & Matyedi, T. E. (2020). Teachers' perceptions of adopting information and communication technologies in teaching and learning at rural secondary schools in eastern cape, South Africa. *Africa Education Review*, *17*(2), 1-19.

Christopoulos, A., Mystakidis, S., Cachafeiro, E. and Laakso, M.J., 2023. Escaping the cell: virtual reality escape rooms in biology education. *Behaviour & Information Technology*, *42*(9), pp.1434-1451.

Cresswell, K., Domínguez Hernández, A., Williams, R. & Sheikh, A., (2022). Key challenges and opportunities for cloud technology in health care: Semi structured interview study. *JMIR human factors*, 9(1), p.e31246.

Daar, G. F., & Nasar, I. (2021). Teachers challenges in the learning process during the covid-19 pandemic in rural areas. *Jurnal Inovasi Dan Teknologi Pembelajaran*, *8*(2), 186-193.

Daudi, Y. and Nzilano, J.L., 2019. ICT integration in teaching and learning: perceptions and practices of secondary school students in Tanzania. *University of Dar es Salaam Library Journal*, *14*(2), pp.38-52.

Dörnyei, Z. & Dewaele, J.M., (2022). *Questionnaires in second language research: Construction, administration, and processing.* Taylor & Francis.

Erlangga, D. T. (2022). Student Problems in Online Learning: Solutions to Keep Education Going on. *Journal of English Language Teaching and Learning*, *3*(1), 21-26.

Firdaus, A., Aksar, I.A. & Gong, J., (2022). Small world sampling: *Qualitative sample reliability and validity for efficient and effective recruitment of journalists as research participants.* Journalism, p.14648849221124997.

Fleming, J. & Zegwaard, K.E., (2018). Methodologies, methods and ethical considerations for conducting research in work-integrated learning. *International Journal of Work-Integrated Learning*, 19(3), pp.205-213.

Forrest, J.Y.L., Forrest, S. & Strauss, 2018. *General Systems Theory*. Springer International Publishing.

Fuchs, M., Baggio, Pesonen, J., Zanker, M. & Xiang, Z., (2020). e-Tourism beyond COVID-19: a call for transformative research. *Information Technology & Tourism*, 22, pp.187-203.

Gandolfi, E., Ferdig, R.E. and Kratcoski, A., 2021. A new educational normal an intersectionality-led exploration of education, learning technologies, and diversity during COVID-19. *Technology in Society*, *66*, p.101637.

Garzón Artacho, E., Martínez, T. S., Ortega Martin, J. L., Marin Marin, J. A., & Gomez Garcia, G. (2020). Teacher training in lifelong learning—The importance of digital competence in the encouragement of teaching innovation. *Sustainability*, *12*(7), 2852.

Guillén-Gámez, F. D., & Mayorga-Fernández, M. J. (2020). Identification of variables that predict teachers' attitudes toward ICT in higher education for teaching and research: A study with regression. *Sustainability*, *12*(4), 1312.

Guillén-Gámez, F. D., & Mayorga-Fernández, M. J. (2020). Identification of variables that predict teachers' attitudes toward ICT in higher education for teaching and research: A study with regression. *Sustainability*, *12*(4), 1312.

Gurung, S. (2021). Challenges faced by teachers in online teaching during Covid-19 pandemic. *The online journal of distance education and e-Learning*, *9*(1), 8-18.

Hafeez, M., Ajmal, F., & Kazmi, Q. A. (2021). Challenges faced by the teachers and students in online learning. *International Journal of Innovation, Creativity and Change*, *15*(2), 325-346.

Hailegebreal, S., Sedi, T.T., Belete, S., Shibiru, T. & Mengiste, S.A., 2022. Utilization of information and communication technology (ICT) among undergraduate health science students: a cross-sectional study. *BMC Medical Education*, *22*(1), p.215.

Hart, C., Da Costa, C., D'Souza, D., Kimpton, A. and Ljbusic, J., 2021. Exploring higher education students' critical thinking skills through content analysis. *Thinking skills and creativity*, *41*, p.100877.

Hassan, M. M., & Mirza, T. (2020). Exploring Benefits of Information and Communication Technology (ICT) in the Primary Education. *Journal of Xidian University*, *14*(7), 1842-1847.

Hennink, M. & Kaiser, B.N., (2022). Sample sizes for saturation in qualitative research: A systematic review of empirical tests. *Social science & medicine*, 292, p.114523.

Hong, J. C., Hwang, M. Y., Tsai, C. M., Liu, M. C., & Lee, Y. F. (2022). Exploring teachers' attitudes toward implementing new ICT educational policies. *Interactive Learning Environments*, *30*(10), 1823-1837.

Inganah, S., Darmayanti, R., & Rizki, N. (2023). Problems, solutions, and expectations: 6C integration of 21 st century education into learning mathematics. *JEMS: Jurnal Edukasi Matematika Dan Sains*, *11*(1), 220-238.

Izhar, N. A., Al-dheleai, Y. M., & Na, K. S. (2021). Teaching in the time of COVID-19: The challenges faced by teachers in initiating online class sessions. *International Journal of Academic Research in Business and Social Sciences*, *11*(2), 1294-1306.

Jacob, O. N., Dahir, N., & Jegede, D. (2021). ICT usage for primary school administration in Nigeria: Challenges and way forward. *International Journal of Human Computing Studies*, *3*(7), 1-9.

Jadhav, P., Gaikwad, H. & Patil, K.S., 2022. Teaching and learning with technology: Effectiveness of ICT integration in schools. *ASEAN Journal for Science Education*, *1*(1), pp.33-40.

Jandrić, P., 2021. Biology, information, society. *Postdigital Science and Education*, *3*(2), pp.261-265.

Johnson, C. C. (2022). *Information and Communications Technology Integration in Bahamian Public High School Biology Classrooms* (Doctoral dissertation, Walden University).

Katemba, C. V. (2020). Teachers' Perceptions in Implementing Technologies in Language Teaching and Learning. *Acuity: Journal of English Language Pedagogy, Literature and Culture*, *5*(2), 123-136.

Khan, N. M., & Kuddus, K. (2020). Integrating ICT in English Language Teaching in Bangladesh: Teachers' Perceptions and Challenges. *Rupkatha Journal on Interdisciplinary Studies in Humanities*, *12*(5).

Khatri, K.K., (2020). Research paradigm: A philosophy of educational research. International Journal of English Literature and Social Sciences (IJELS), 5(5).

Khtere, Ahmed Ramadan, and Ahmed Mohamed Fahmy Yousef. (2021). "The professionalism of online teaching in Arab Universities." *Educational Technology & Society* 24, no. 3 1-12.

Kilag, O.K.T., Segarra, G.B., Del Socorro, A.S., & Mahasol, E.T., 2023. ICT application in teaching and learning. *Science and Education*, *4*(2), pp.854-865.

Knott, E., Rao, A.H. & Summers, K. (2022). Interviews in the social sciences. *Nature Reviews Methods Primers*, 2(1), p.73.

Kozlova, D. and Pikhart, M., 2021. The use of ICT in higher education from the perspective of the university students. *Procedia Computer Science*, *192*, pp.2309-2317.

Leonhardt, R., Noble, B., Poelzer, G., & Belcher, K., (2022). Advancing local energy transitions: A global review of government instruments supporting community energy. *Energy Research & Social Science*, 83, p.102350.

Levitt, H.M., Morrill, Z., Collins, K.M. & Rizo, J.L., (2021). The methodological integrity of critical qualitative research: Principles to support design and research review. *Journal of Counselling Psychology*, 68(3), p.357.

Liesa-Orús, M., Latorre-Cosculluela, C., Vázquez-Toledo, S., & Sierra-Sánchez, V. (2020). The technological challenge facing higher education professors: Perceptions of ICT tools for developing 21st century skills. *Sustainability*, *12*(13), 5339.

Lukas, B. A., & Yunus, M. M. (2021). ESL Teachers' Challenges in Implementing E-learning during COVID-19. *International Journal of Learning, Teaching and Educational Research*, *20*(2), 330-348.

Madondo, M.M., 2020. *Curriculum reform and classroom practice: teaching geography in the Zimbabwean Curriculum Framework 2015–2022* (Doctoral dissertation, University of the Free State).

Mahdum, M., Hadriana, H., & Safriyanti, M. (2019). Exploring teacher perceptions and motivations to ict use in learning activities in Indonesia. *Journal of Information Technology Education: Research*, *18*.

Makuru, B. and Jita, T., 2022. Information and Communication Technology Practices in Biology Teaching in Lesotho High Schools. *International Journal of Information and Education Technology*, *12*(7).

Makuru, B., & Jita, T. (2022). Information and Communication Technology Practices in Biology Teaching in Lesotho High Schools. *International Journal of Information and Education Technology*, *12*(7).

Markovsky, I.& Dörfler, F., 2021. Behavioral systems theory in data-driven analysis, signal processing, and control. *Annual Reviews in Control*, *52*, pp.42-64.

Marpa, E. P. (2021). Technology in the Teaching of Mathematics: An Analysis of Teachers' Attitudes during the COVID-19 Pandemic. *International Journal on Studies in Education (IJonSE)*, *3*(2).

Mashoko, D. and Dudu, W., 2023. Use of Information Communication Technology in Science, Technology, Engineering, and Mathematics: Insights During the COVID-19 Pandemic in Zimbabwe. In *Practices and Perspectives of Teaching and Teacher Education in Africa* (pp. 24-43). IGI Global.

Maupa, E. and Goronga, P., 2023. School Heads' Perceptions on ICT Integration in Teaching and Learning in Rural Primary Schools in Buhera South District Zimbabwe. *Journal of African Education*, *4*(3).

May, C.R., Albers, B., Greenwood, K. & Murray, E., (2022). Translational framework for implementation evaluation and research: a normalisation process theory coding manual for qualitative research and instrument development. *Implementation Science*, 17(1), pp.1-15.

Milner-Gulland, E.J., Veríssimo, D. & Lewis, J., (2020). Ethical considerations when conservation research involves people. *Conservation Biology*, 34(4), pp.925-933.

Misra, D.P., Zimba, O. & Gasparyan, A.Y., (2021). Statistical data presentation: a primer for rheumatology researchers. Rheumatology International, 41(1), pp.43-55.

Mohd, C. K. N. C. K., & Shahbodin, F. (2021). Issues and challenges from teachers' perceptions in creating online learning in the midst of covid-19 pandemic. *Journal of Theoretical and Applied Information Technology*, *99*(12), 3039-3049.

Mthuli, S.A., Ruffin, F. & Singh, N., (2022). 'Define, Explain, Justify, apply' (DEJA): An analytic tool for guiding qualitative research sample size. *International Journal of Social Research Methodology*, 25(6), pp.809-821.

Mulimani, M.N. & Naikar, S., 2022. Use of ICT in teaching and learning: A role of institutions, teachers, students and technology. *Pearl: A Journal of Library and Information Science*, *16*(2), pp.121-128.

Newman, P.A., Guta, A. & Black, T., (2021). Ethical considerations for qualitative research methods during the COVID-19 pandemic and other emergency situations: Navigating the virtual field. *International Journal of Qualitative Methods*, 20, p.16094069211047823.

Nikolić, V., Petković, D., Denić, N., Milovančević, M. and Gavrilović, S., 2019. Appraisal and review of e-learning and ICT systems in teaching process. *Physica A: Statistical Mechanics and its Applications*, *513*, pp.456-464.

Nunguye, I., Mugabo, R. and Niyonzima, N., 2021. Effect of Continuous Professional Development on Teaching Biology in Nine Year Basic Education Schools of Gicumbi District, Rwanda. *Education*, *6*(3), pp.221-228.

Park, Y.S., Konge, L. & Artino, A.R., (2020). The positivism paradigm of research. *Academic medicine*, 95(5), pp.690-694.

Pesurnay, A.J., 2018. Local wisdom in a new paradigm: Applying system theory to the study of local culture in Indonesia. In *IOP Conference Series: Earth and Environmental Science* (Vol. 175, No. 1, p. 012037). IOP Publishing.

Pongsakdi, N., Kortelainen, A., & Veermans, M. (2021). The impact of digital pedagogy training on in-service teachers' attitudes towards digital technologies. *Education and Information Technologies*, *26*(5), 5041-5054.

Qaddumi, H., Bartram, B., & Qashmar, A. L. (2021). Evaluating the impact of ICT on teaching and learning: A study of Palestinian students' and teachers' perceptions. *Education and information technologies*, *26*(2), 1865-1876.

Rahayu, R. P., & Wirza, Y. (2020). Teachers' perception of online learning during pandemic covid-19. *Jurnal penelitian pendidikan*, *20*(3), 392-406.

Rana, K. and Rana, K., 2020. ICT Integration in Teaching and Learning Activities in Higher Education: A Case Study of Nepal's Teacher Education. *Malaysian Online Journal of Educational Technology*, *8*(1), pp.36-47.

Raygan, A., & Moradkhani, S. (2022). Factors influencing technology integration in an EFL context: investigating EFL teachers' attitudes, TPACK level, and educational climate. *Computer Assisted Language Learning*, *35*(8), 1789-1810.

Ruslin, R., Mashuri, S., Rasak, M.S.A., & Syam, H., (2022). Semi-structured Interview: A methodological reflection on the development of a qualitative research instrument in educational studies. *IOSR Journal of Research & Method in Education* (IOSR-JRME), 12(1), pp.22-29.

Sayfullayeva, D. A., Tosheva, N. M., Nematova, L. H., & Inoyatov, I. S. (2021). Methodology of using innovative technologies in technical institutions. *Annals of the Romanian Society for Cell Biology*, 7505-7522.

Seyfried, M. & Pohlenz, P., (2020). Assessing quality assurance in higher education: quality managers' perceptions of effectiveness. *In Impact Evaluation of Quality Management in Higher Education* (pp. 24-37). Routledge

Shah, S.S., 2022. Teaching and learning with technology: Effectiveness of ICT integration in schools. *Indonesian Journal of Educational Research and Technology*, *2*(2), pp.133-140.

Shava, E., 2022. Reinforcing the role of ICT in enhancing teaching and learning post-COVID-19 in tertiary institutions in South Africa. *Journal of Culture and Values in Education*, *5*(1), pp.78-91.

Shemshack, A. (2021). What Supports Do Teachers Need on Effective Instructional Technology Integration? *Journal of Literacy & Technology*, *22*(1).

Sifelani, J., 2022. *Science Teachers' Information and Communication Technology (ICT) Self-Efficacy and Classroom Technology Integration: The Case of Mashonaland West Province, Zimbabwe* (Doctoral dissertation, UNIVERSITY OF WITWATERSRAND Johannesburg).

Suparjan, S. (2021). Integrating Information and Communication Technology In Elementary Schools: Teachers' Attitudes and Barriers. *Ta'dib*, *24*(1), 149-163.

Supriyadi, E., Indro H, Y., Priyanto, E., & Surwi, F. (2020). Students' Evaluation on Teaching in Vocational and Technical Schools. *International Journal of Instruction*, *13*(2), 621-636.

Suri, H., (2020). Ethical considerations of conducting systematic reviews in educational research. *Systematic reviews in educational research: Methodology, perspectives and application*, pp.41-54.

Thunberg, S. & Arnell, L., (2022). Pioneering the use of technologies in qualitative research–A research review of the use of digital interviews. *International Journal of Social Research Methodology*, 25(6), pp.757-768.

Turner III, D.W. & Hagstrom-Schmidt, N., (2022). Qualitative interview design. Howdy or Hello*? Technical and professional communication*.

UGWU, N. P., & Nnaekwe, K. (2019). The concept and application of ICT to teaching/learning process. *International Research Journal of Mathematics, Engineering and IT*, *6*(2).

Varas, D., Santana, M., Nussbaum, M., Claro, S., & Imbarack, P. (2023). Teachers' strategies and challenges in teaching 21st century skills: Little common understanding. *Thinking Skills and Creativity*, *48*, 101289.

Voltelen, B., Konradsen, H. & Østergaard, B., (2018). Ethical considerations when conducting joint interviews with close relatives or family: an integrative review. *Scandinavian journal of caring sciences*, 32(2), pp.515-526.

Wolfram, S., 2018. Complex systems theory 1. In *Emerging syntheses in science* (pp. 183-190). CRC Press.

Woodford, L., Christie, C.R., Bowman, A.S. & Evans, D.J., (2022). Quantitative and qualitative changes in the deformed wing virus population in honey bees associated with the introduction or removal of Varroa destructor. *Viruses*, 14(8), p.1597.

YAPICI, Ü. (2022). The experiences of biology education master students in web 2.0 content development. *Journal of Educational Technology and Online Learning*, *5*(2), 336-352.

Zafar, M.W., Zaidi, S.A.H., Mansoor, S., Sinha, A. and Qin, Q., 2022. ICT and education as determinants of environmental quality: The role of financial development in selected Asian countries. *Technological Forecasting and Social Change*, *177*, p.121547.

Zagouras, C., Egarchou, D., Skiniotis, P. & Fountana, M., 2022. Face to face or blended learning? A case study: Teacher training in the pedagogical use of ICT. *Education and Information Technologies*, *27*(9), pp.12939-12967.

Zhang, H., Zhao, S., Kou, G., Li, C.C., Dong, Y. & Herrera, F., (2020). An overview on feedback mechanisms with minimum adjustment or cost in consensus reaching in group decision making: Research paradigms and challenges. *Information Fusion*, 60, pp.65-79.

Ziajahromi, S. & Leusch, F.D., (2022). Systematic assessment of data quality and quality assurance/quality control (QA/QC) of current research on microplastics in biosolids and agricultural soils. *Environmental Pollution*, 294, p.118629.

Appendices B
Permission to conduct research

MANHEMBA SECONDARY SCHOOL

MANHEMBA SECONDARY SCHOOL
P.O. BOX 206

MUTOKO

18 MAY 2024

The head

Katsukunya Secondary School

P.O Box 91

Mutoko

Dear sir/madam

RE: APPLICATION FOR PERMISSION TO CONTACT A RESEARCH PROJECT IN YOUR INSTITUTION

The above subject refers a request for your permission to carry out my research in your institution. I am a teacher at Manhemba Secondary School and i am currently furthering my education with Bindura University of Science Education under the Teacher Capacity Development Block Program (TCD) with student registration number B1438501. The research project is a requirement which should be submitted in partial fulfillment of the HBScEdBz degree program. The research title being :EXPLORING THE USE OF ICT IN THE TEACHING AND LEARNING OF BIOLOG AT O LEVEL ,A CASE OF MUNHEMBA CLUSTER IN MUTOKO DISTRICT.

Your cooperation and assistance is greatly appreciated.

Thank you

Wushe Berita

Buise

MINISTRY OF PRY & SEC EDUCATION
THE HEAD
KATSUKUNYA SECONDARY SCHOOL

P.O BOX 198, MUTOKO

SIG

THE HEADMASTER
MANHEMBA SECONDARY SCHOOL
P.O.BOX 206

MUTOKO

18 MAY 2024

The head

Manhemba Secondary School

P O Box 206

Mutoko

Dear sir/madam

RE: APPLICATION FOR PERMISSION TO CONTACT A RESEARCH PROJECT IN YOUR INSTITUTION

The above subject refers a request for your permission to carry out my research in your institution. I am a teacher at Manhemba Secondary School and i am currently furthering my education with Bindura University of Science Education under the Teacher Capacity Development Block Program (TCD) with student registration number B1438501. The research project is a requirement which should be submitted in partial fulfillment of the HBScEdBz degree program. The research title being :EXPLORING THE USE OF ICT IN THE TEACHING AND LEARNING OF BIOLOGY AT O LEVEL ,A CASE OF MUNHEMBA CLUSTER IN MUTOKO DISTRICT.

Your cooperation and assistance is greatly appreciated.

Thank you

Wushe Berita

THE HEAD
MANHEMBA SECONDARY SCHOOL
PO BOX 206 MUTOKO
DATE 18-06-24

THE HEAD
MANHEMBA SECONDARY SCHOOL
PO BOX 206 MUTOKO
18-06-24

Date: 10/04/2024

TO WHOM IT MAY CONCERN

NAME: WASHE B   REGISTRATION NUMBER: B1438501

PROGRAMME: HBScEd Biology   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 HBSc Ed Biology   programme. The research topic is:

Exploring the use of ICT in the teaching and learning of biology at O level, A case of manhemba cluster in Mutoko District.

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

9 APR 2024

P. BAG 1020
BINDURA

Z Ndemo (Dr.)
CHAIRPERSON - SAMED

THE HEAD
MANHEMBA SECONDARY SCHOOL
PO BOX 206 MUTOKO
DATE 10-05-24

Appendix C

My name is **Berita Wushe** doing **Honours Bachelor of Science Education in Biology at Bindura University of Science Education**. I am intending to carry out research on, **"Exploring the use of ICT in the teaching and learning of biology at O Level, a case of Munhemba cluster in Mutoko district."** You have been chosen to participate in this study. Your participation in this study is on voluntary basis. The information you provide in the study will be considered confidential and will be used for research purposes only. I thank you for your assistance.

Section A: Demographic Information

Gender: Male [ ]   Female [ ] **Age:** [ ]   >50 [   ] 40-50   [   ] <40

Work experience: >5 years [ ]   2-5 years [   ]   <2 years [   ]

Subject of specialization……………………………

Section B: ICT tools used to teach Biology at O Level

1. Which ICT tools are used in your school in the teaching and learning of Biology?
2. How can ICT tools be effectively used in the teaching and learning?
3. Are the tools readily available for ICT teaching and learning?

Section C: What are the challenges faced during the teaching and learning of Biology?

1. Which challenges facing teachers in teaching Biology using ICT?
2. What are the challenges faced by learners in the use of ICT in learning Biology?

Section D: The benefits of using ICT in teaching and learning biology at O Level

1. What are the benefits of using ICT in teaching Biology?
2. Are these benefits helping in improving the quality of Biology?

3. How can these benefits be improved in the teaching and learning Biology?

A questionnaire Form Four Learners

My name is **Berita Wushe** doing **Honours Bachelor of Science Education in Biology at Bindura University of Science Education**. I am intending to carry out research on "**Exploring the use of ICT in the teaching and learning of biology at O Level, a case of Munhemba cluster in Mutoko district.**" You have been chosen to participate in this study. Your participation in this study is on voluntary basis. The information you provide in the study will be considered confidential and will be used for research purposes only. I thank you for your assistance.

SECTION A

Section A: Demographic Information

Please tick in the appropriate box

Gender: Male: ☐   Female: ☐

Age: 12-14 years ☐   15-17 years ☐

18-20 years ☐

Level of Education

Qualifications:

O Level ☐

A Level ☐

Do you own any ICT tool?   Yes ☐   No: ☐

SECTION B: ICT tools used to learn Biology at O Level

1. Which ICT tools are used in your school in the teaching and learning of Biology and are they readily available and effective?

    …………………………………………………………………………………………………
    …………………………………………………………………………………………………
    …………………………………………………………………………………………………
    …………………………………………………………………………………………………
    …………………………………………………………………………………………………
    …………………………………………………………………………

2. How can ICT tools be effectively used in the teaching and learning?

    …………………………………………………………………………………………………
    …………………………………………………………………………………………………
    …………………………………………………………………………………………………
    …………………………………………………………………………………………………
    …………………………………………………………………………………………………
    …………………………………………………………………………………

3. Are the tools readily available for ICT teaching and learning?

    …………………………………………………………………………………………………
    …………………………………………………………………………………………………
    …………………………………………………………………………………………………
    …………………………………………………………………………………………………
    …………………………………………………………………………………………………
    ………………………………………………………………………….

SECTION C: Challenges faced by teachers and learners in teaching and learning Biology using ICT.

1. What are the challenges faced by teachers and learners during the teaching and learning of Biology?

   …………………………………………………………………………………………………
   …………………………………………………………………………………………………
   …………………………………………………………………………………………………
   …………………………………………………………………………………………………
   …………………………………………………………………………………………………
   …………………………………………………………………..

   …………………………………………………………………………………………

2. What are the challenges faced by learners in the use of ICT in learning Biology?

   …………………………………………………………………………………………………
   …………………………………………………………………………………………………
   …………………………………………………………………………………………………
   …………………………………………………………………………………………………
   …………………………………………………………………………………………………
   …………………………………………………………………..

Section D: The benefits of using ICT in teaching and learning biology at O Level

1. What are the benefits of using ICT in teaching and learning Biology?

   …………………………………………………………………………………………………
   …………………………………………………………………………………………………
   …………………………………………………………………………………………………
   …………………………………………………………………………………………………
   …………………………………………………………………………………………………

2. How can these benefits be improved in the teaching and learning Biology?

   …………………………………………………………………………………………………
   …………………………………………………………………………………………………

………
………
………
………
………
………

3. How can ICT tools be effectively used to benefit learners in the teaching and learning?

………
………
………
………
………
………
………

Your participation is greatly appreciated

Thank you