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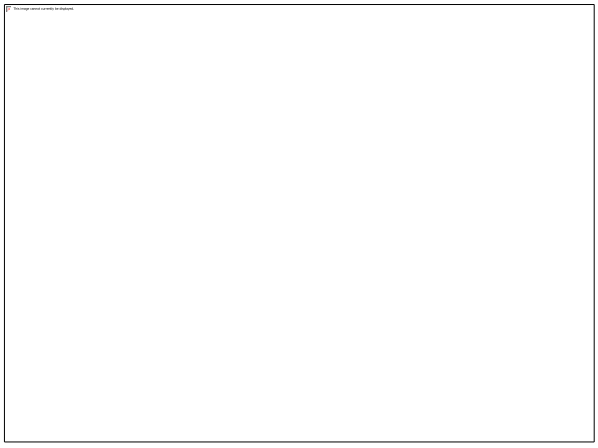
BACHELOR OF SCIENCE EDUCATION HONOURS DEGREE IN BIOLOGY



PROGRAMME: BACHELOR OF SCIENCE EDUCATION HONOURS DEGREE IN BIOLOGY

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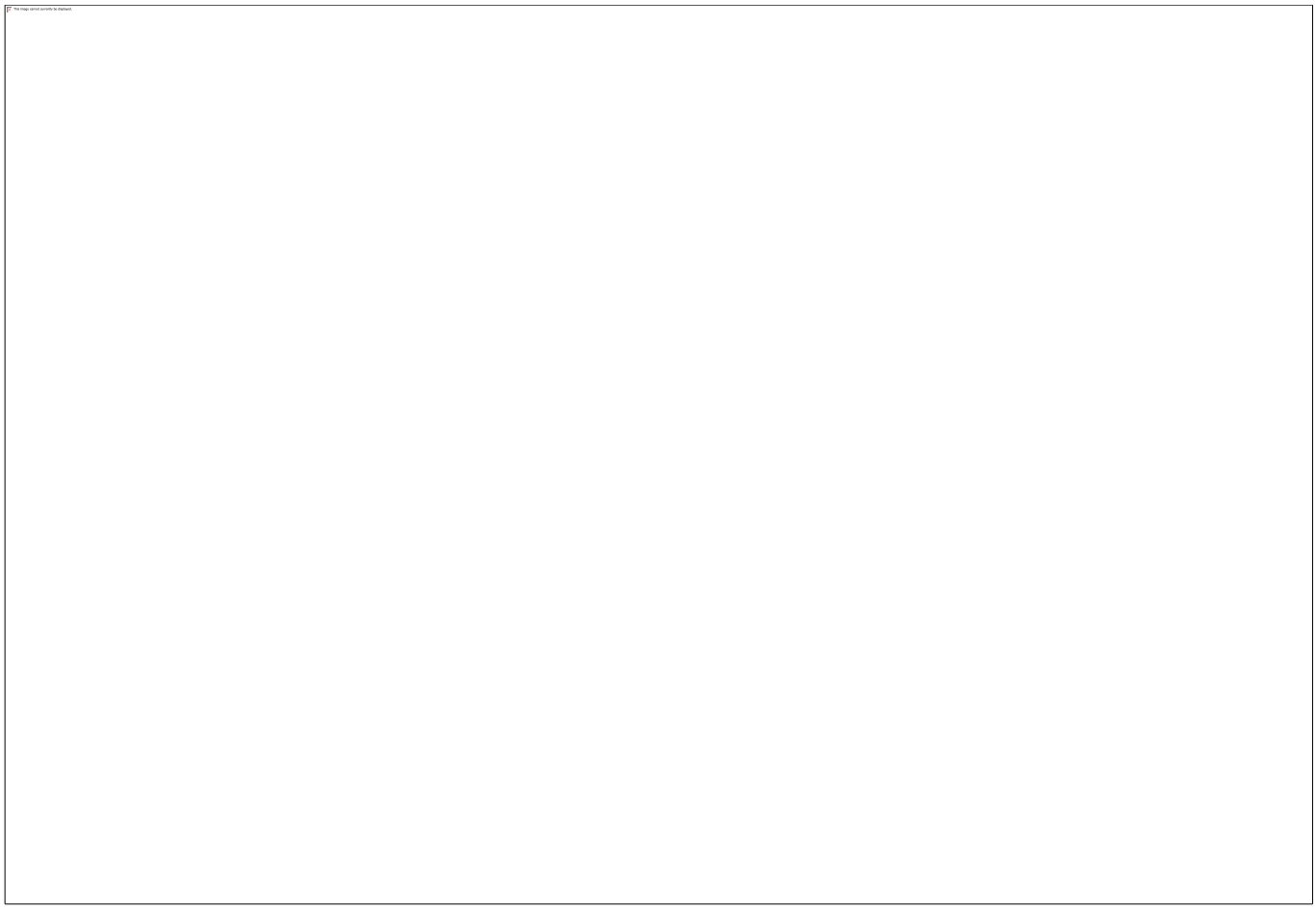
INVESTIGATING PERCEPTIONS OF ORDINARY LEVEL BIOLOGY STUDENTS ON ICT BASED LEARNING IN BIOLOGY TEACHING AND LEARNING AT "HONDOYAPERA" SECONDARY SCHOOL IN CHIPINGE DISTRICT.

A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF THE BACHELOR OF SCIENCE EDUCATION HONOURS DEGREE IN BIOLOGY EDUCATION

2024



To be completed by the chairperson 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

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APPROVAL FORM

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Degree Title: Bachelor of Science Honours Degree in Education. (Biology)

Year of completion: 2024

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AKNOWLEDGEMENTS

First and foremost, I would like to thank the Almighty God who provided me wisdom and strength to navigate through the research process. I would also like to extend my gratitude to my dissertation supervisor, Mr Mhishi who guided me through every detail of the project through reading, editing and polishing the ideas of this thesis. All the credit goes to him for his suggestions and valuable comments on this research. This project would not be possible without his support and guidance.

I also thank the Ministry of Primary and Secondary Education (MoPSE) through the Chipinge District Education Offices and administrators of "Hondoyapera" Secondary school for allowing me to carry out the researches at their institutions.

DEDICATION

This study is dedicated to my lovely wife Hilda Mukupe, my son Kudzaishe and my twin daughters Tapiwanashe and Isheanopa Zvenyika who encouraged me through all circumstances to persevere through the project. To my last-born son Kudakwashe Farirai Zvenyika, you are the reason I have so much courage to struggle through when the journey gets tough. To my dear friends and colleagues, I am thankful for all the encouragement you have given me.

ABREVIATIONS/ACCRONYMS

ICT- Information and Communication Technology

MoPSE- Ministry of Primary and Secondary Education

HBSCED- Honours Bachelors Science Education Degree

ABSTRACT

This study sought to investigate the perceptions of Ordinary level Biology students at Hondoyapera Secondary School in Chipinge District regarding ICT-based learning in Biology education. The population consisted of all Ordinary Level Biology students at the school, with 60 students selected through simple random sampling. Prior research has indicated that the perceptions of Ordinary level Biology students on ICT integration in the subject have significant implications for their future educational and career trajectories. The study employed a qualitative approach by including an in-depth interview and focus groups with students. The study revealed a positive attitude towards ICT based learning, with students citing enhanced visualization, interaction, and engagement, but also challenges such as limited access to devices, internet connectivity issues, and inadequate teacher training. Students suggested a balanced integration of ICT based learning with traditional methods to optimize benefits. Recommendations include investing in ICT infrastructure, teacher capacity building, and digital resources to enhance Biology education.

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CHAPTER 1: INTRODUCTION

1.1 Chapter Introduction:

The study assesses the perceptions of Ordinary level Biology students on ICT- based learning in Biology education at a Secondary School in Chipinge District. This chapter discusses the background of the study, statement of the problem, research aims/research objectives, research

questions, significance of the study, assumptions of the study, limitations of the study, delimitations of the study, definition of key terms, and chapter summary.

1.2 Background of the study:

The use of Information and Communication Technology (ICT)in education has become a global trend, with many countries incorporating ICT into their education system (Al-Rashidi & Al-Harbi,2024). In Zimbabwe, the government has also emphasized the importance of ICT in education, with MoPSE launching the ICT in Education Policy in 2012 (MoPSE,2012).The education system of Zimbabwe has evolved over the years, with the integration of technology in the classroom becoming a key focus. The Government of Zimbabwe (GOZ) has shown a commitment to enhancing the use of Information and Communication Technology (ICT) in education, in recognition to its potential in improving teaching and learning outcomes. New and emerging digital technologies, when incorporated into the classroom successfully, have the ability to revolutionize the quality of teaching and learning (Medichie, et al., 2019). (Maharaj-Sharma et al.,2017) indicate that it is not necessarily the sole presence of technology that influences the effectiveness of learning, but instead the pedagogical practice of putting that technology into use. This study set the stage for analyzing the perceptions of Ordinary level Biology students regarding the use of ICT in biology education since it is through this analysis that informed decisions can be made for its successful implementation.

In the secondary school curriculum, biology plays a crucial role as it provides students with an understanding of living organisms, ecosystems, and the fundamental principles of life science. Biology education, in particular, has been identified as an area that can benefit from ICT based learning (Oyekele et al.,2016). ICT can enhance biology learning by providing interactive and visual resources, such as animations, videos, simulations, that can help students understand complex biological concepts (Crompton,2015).Given its importance in day to day living, ensuring effective and engaging biology education is essential for students' overall scientific literacy and future academic and professional pursuits.

The rationale for investigating ICT based learning using the perceptions of Ordinary level Biology students in Chipinge District, in Zimbabwe, stems from the need to assess the impact of technological integration on their learning experiences. Students' learning is influenced by their perceptions towards the subject context (Ekici,2016).By understanding how students perceive the

use of ICT in biology education insights into their engagement, motivation, and the potential influence of technology on their academic performance can be revealed. In conducting this study, researchers may explore a variety of research questions like; How do ordinary level biology students perceive the use of ICT tools, such as digital simulations, online resources, and educational apps, in their biology learning? What are the factors that influence students' attitude towards ICT based learning in biology education? and How does the integration of ICT impact students' understanding of biology concepts and their overall academic achievements?

To gather comprehensive insights, qualitative techniques such as interviews or in-depth focus groups may be employed. This methodology allows for a nuanced understanding of students' perceptions and experiences with ICT in biology education.

The study's anticipated outcomes may include the identification of students' preferences for specific types of ICT resources, uncovering of potential challenges in the use of ICT, and highlighting the benefits of ICT integration. Furthermore, findings from the study can inform curriculum development, and educational policies aimed at enhancing biology education in secondary schools in Chipinge District and the country over.

ICT based learning enables students to discover new knowledge and learn actively. Apart from gaining biological concepts learners also get skills to use in life like how ICT tools are operated when researching on a given topic or concept. When ICT based learning methodologies are used, learners are assisted in developing skills like decision making and problem solving, team work, and presentation (Zafar & Kan,2017). Previous researches have shown that incorporating the ICTs has helped improve students' understanding of some concepts for instance the use of ICT simulations as compared to the use of non-ICT learning activities (Habber et al.,2016). In addition, virtual experiments and virtual environments saves experimental time and resources, allowing students to repeat experiments with ease, and provides experiences that would not otherwise be available to students (Uwizeyimana, et al.,2018).

ICT integrated active learning has proven to effectively enhance learning outcomes and learner engagement unlike the traditional classroom approach (Scott & Dube, 2014). This is due to the ability of active learning to transform the learning process and activities to shift from being teacher-dominated to become more child-centered, as is guided by the learner's learning ability. This way the learners engage more in the learning process and most importantly they learn in

accordance with their pace of learning. Hence, analyzing the perceptions of Ordinary level Biology students on these proven studies may guide and give informed decisions to all stakeholders of biology education in the given school and Chipinge District as a whole.

1.3 Statement of the Problem.

ICT integrated active learning has proven to effectively enhance learning outcomes and learner engagement in classrooms unlike the traditional classroom approach (Scott & Dube,2014). Despite the potential benefits of ICT based learning in Biology education, there is a lack of understanding of how Ordinary level Biology students at Hondoyapera secondary school in Chipinge District perceive the use of ICTs in their learning. In order for students to perform well in Biology, their attitudes must be positive. This research sought to find out the students' views on ICT usage in biology education in secondary schools.

1.4 Research Aim

This research aims to establish the perceptions of Ordinary level Biology students on ICT based learning in Biology education at a Secondary School in Chipinge District.

1.5 Research Objectives

The research will be guided by the following three objectives:

To investigate the perceptions of Ordinary level biology students on the effectiveness of biological concepts and improving their academic performance.

To establish the relationship between the use of ICTs in biology education and the motivation and engagement of Ordinary level Biology students.

To suggest strategies for integrating ICTs into biology education that are responsive to the needs and preferences of Ordinary level biology students.

1.6 Research questions

1.What are the Ordinary level biology students' perceptions towards the benefits of ICT based learning in biology education?

2.How can ICT-based learning impact the motivation and engagement of Ordinary level biology students?

3.What are the challenges faced by ordinary level biology students in using ICT based learning resources in biology education?

1.7 Assumptions of the study

Rapid developments in ICT have shaped the education fraternity into a dynamic space in which curricular are no longer fixed but has shifted from the traditional methods of teacher-centeredness to learner-centeredness. The learning and teaching of biology is also affected by this technological transformation, making it easier for students to learn subjects like Biology that are considered difficulty because of terminology, and some of the concepts that have roots in Mathematics, Physics and Chemistry. However, though these technological transformations have proven to be positive and making learning and teaching easier and motivating, they have placed heavy demands on the already affected economy of Zimbabwe. Despite the heavy demands, (UNESCO,2017) cited benefits of ICT based learning which include access to a wide range and variety of context which support the information age and the enhancement of learning. On the other hand, barriers to ICT based learning can be noted. This may include technological fact like infrastructure planning (both hardware and software); pedagogical factors such as content analysis, goal analysis, medium analysis, design approach, organizational and learning strategies; and ethical factors which include social, political influence, cultural diversity and bias. Although the advantages of using ICTs in biology teaching and learning have been demonstrated in previous researches, barriers and challenges associated with its use are still existing in secondary schools like Hondoyapera Secondary school in Chipinge District. This has forced the researcher to explore the perceptions of Ordinary level biology students regarding ICT-based learning and suggest ways of overcoming the obstacles facing the teaching and learning of biology education at the nominated secondary school.

1.8 Significance of the study

This study is of great importance to stakeholders which include teachers, students, parents, administrators, policymakers and curriculum developers.

The study may motivate students to do biology studies at Ordinary level and beyond and also in using ICT tools to do research in other areas, since it is a requirement in the new curriculum.

Students may also find their learning to be meaningful since computer aided learning, that is ICT integrated learning, has proven to motivate learning and learning engagement for both introvert and extrovert students (Costa et al.,2018).

The research may also help biology teachers and other science teachers to realize the usefulness of ICT based learning. The teachers will adopt this teaching/learning methodology and motivate students to learn subjects they perceive as difficult. Moreover, the use of ICT based learning may erase misconceptions about science subjects like Biology and foster positive thinking. Teachers may also scheme and plan their work more effectively by using ICT related methodologies.

This research is also of paramount importance to schools. Schools may adopt the use of ICTs in the teaching and learning of biology and other areas, not only to Ordinary level biology students but also to learners at different levels of education so as to be at par with technology revolution. Since the use of ICT based learning motivates and engages learners pass rates in schools may increase in all subjects where ICT based learning methodologies are used.

Researchers can also get sufficient knowledge and skills to use during the teaching of biology and other subjects through the exploration of perceptions of Ordinary level Biology students on ICT based learning. Findings and recommendations of this study may also help other researchers to do further improvements on the study.

On the other hand, curriculum developers, Curriculum Development Unit (CDU), may be assisted by the research findings and recommendations to plan for biology curriculum which is at par with modern technology. Lastly, this study may help the Government of Zimbabwe (GOZ) to mobilize sufficient resources and create programmes which will enhance the successful development, implementation and evaluation of a curriculum which suits national demands.

1.9 Limitations of the study

The researcher identified the following limitations of the study:

1.9.1 Permission and access to enter schools

No one is allowed to do any business in schools without permission from the Ministry of Primary and Secondary Education, so an introductory letter from Bindura University asking for permission from the Ministry through Chipinge District Education Offices was used by the researcher in order to be granted permission to get access to schools for data collection.

1.9.2 Trustworthiness and truthfulness

The researcher stressed out that no names will appear on research tools to be used, even the real name of the schools, and that all information obtained will be treated with the confidentiality it deserves in order to gain trustworthiness and truthfulness.

1.9.3 Financial limitations

In order to access the internet, the researcher would need money to purchase data bundles. Moreover, transport costs to and from areas under research and typing and photocopying of materials to use during research would be needed. The use of the researcher's station and resort to external funding.

1.9.4 Time limitations

Time was a limiting factor as the respondents interacted with were very busy with their day-to-day work. To counterattack this, on spot interviews, questionnaires and insert groups were used get immediate feedback. In addition, the researcher has been teaching in the area for some time making it easier to conduct the research in a stipulated time.

1.10 Delimitation of Ordinary the study

This research will be confined to "Hondoyapera" Secondary School in Ward 28 Chipinge District in Manicaland Province in Zimbabwe. It will conceptually find out perceptions of Ordinary level Biology students on ICT based learning in Biology education.

1.11 Definition of terms

Biology: Is defined as a branch of science which deals with the study of organisms,(Orodho,2009). Biology is Greek word divided into two; "bios" meaning life, and "logos" meaning organisms. Hence, biology refers to the science of life and living organisms.

Biology education: Is a process of teaching and learning Biology, which is the scientific study of living organisms and their interactions with the environment (Cresswell,2012). According to this research biology education is the application of principles of learning of biology.

Learning: Is a process which should include first hand experiences, the broad range of secondary sources of data of evidence, dialogue and discussion of ideas (Sherry, 2020). Thus, learning refers to a process of acquiring scientific knowledge.

Information and Communication Technology (ICT): Encompasses innovate audiovisual, computing and telecommunication techniques which allow the acquisition, processing and storage of information, (UNESCO, 2020). In this context, ICT refers to a broad field of technology that encompasses the use of various hardware, software, and communication technologies to manage and process information.

ICT based learning: Is defined by (Abdullah, Al-Ansi et.al.,2021) as a kind of learning that use Information Communication and Technology (ICT) to foster, optimize, enhance and support gaining knowledge. Therefore, Information Communication and Technology (ICT) based learning refers to the use of digital technologies and communication tools to enhance the teaching and learning process which involves the integration of various electronic devices, software applications, and internet resources to facilitate educational activities and improve outcomes.

Perceptions: According to (Merriam ,2024), perception is an awareness of the elements of environment through physical sensation. In this study, perceptions are beliefs or opinions, often held by many people based on things seen.

1.12 Summary

This chapter was mainly focused on the background of the study and gives an overview of the research problem, research questions, assumptions of the study, limitations of the study, delimitations of the study, and definition of terms. The preceding chapter will mainly focus on literature review on studies which are related to the proposed study.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The literature review is aimed at presenting an elaborate summary of the current research on the application of Information and Communication Technology (ICT) in biology learning, with a particular focus on ordinary level students' perceptions and experiences. The chapter in the current study will be focused on the summary of the key themes, trends and debates on ICT- based learning in education to situate the current study within the broader literature on this area. It, however, aims at identifying hindrances and weaknesses in the research that has already been done, as well as areas that need more investigations. Moreover, the chapter establishes a theoretical and conceptual framework that provides a basis for the research questions and objectives by referring to applicable theories and models. Besides the discussion on the empirical evidence on the effectiveness of ICT based learning in biology education, the impact of ICT on student learning outcomes, attitudes, and engagement are also highlighted. Additionally, the chapter explores the elements that influence the views and the experiences of the students with ICT in biology education, such as the teacher's support, student's motivation, and ICT literacy. This section aims to provide a review of the literature as a foundation of this study, list the areas for further research, and serve as an input for coming up with an integrated ICT-based biology education. I will also try to be a part of the wider discussion on ICT integration in education and look for ways that ICT can be implemented in the teaching and learning of biology education.

2.2 Location of the Study in the Literature

The use of Information and Communication Technology in education has been considered as a leading topic since the 1990s, and many researchers have investigated its impact on student learning as postulated by (Marx et al.,2004). This literature portrays the ICT integration in teaching science education, especially in biology (Tsai, 2018). The present research study continues the existing research on this issue by looking at the perceptions and experiences of ordinary level students, the group that has received much less attention so far. The existing research that has been done about the effectiveness of ICT in learning outcomes for students has done a lot, however further studies are needed to know the specific perceptions and experiences of ordinary level

Biology students. The study contributes to a wider body of literature on the use of ICT in education which explores how technology affects student achievement, attitudes, and engagement. In addition, the research is also supported by the literature on science education which is known to be a key aspect in teaching methods and learning materials when it comes to biology and other science subjects which include Mathematics, Physics and Chemistry. Apart from that, the research is based on the literature on student motivation and engagement, which indicates the significance of the students' perception of learning and their views on it. Through reviewing literature, this research intends to provide a firm basis for the comprehension of the perceptions and experiences of ordinary level students in order to consequently have the development of appropriate ICT-integrated biology education programs. In short, the study is a part of the broader discussion on how ICT based learning can be utilized in education and the necessity of knowing the perceptions and experiences of students.

2.3 Theoretical framework

Social Constructivism approach as proposed by Lev Vygotsky in 1978 is an educational theory which emphasizes that learning is a socially constructed process. The main thrust of this theory is the belief that cognitive development is done through social interactions, language, and culture, according to (Vygotsky, 1978). Vygotsky's theory proposed that learning is a shared process between the student, the teacher, and the environment, leading to the formation of students' cognition and knowledge which are based on their interactions with others (Vygotsky, 1978). The theory also highlights that tutoring and support are the key elements in the learning process of students .Learners are incapable of moving from the lower helps to shape students' mental models and knowledge, where language is seen as a mean for thinking and communication. Cultural and social context are seen as key drivers of learning along with students' prior knowledge and experiences, which in turn affect their comprehension and interpretation of new data.

In the case of integrating Biology education with ICT, Social Constructivist Theory postulates that students' interaction with various ICT tools and resources determine the way they comprehend and learn about biological concepts. Moreover, students' learning through simulations and games can help them in acquiring a deeper understanding of complex biological processes while multimedia resources such as videos and animations can offer students with visual representations of biological concepts. Also, Social Constructivist Theory underscores the significance of the assistance and

scaffolding given by the teacher in the process of learning in which the teacher plays a vital role in guiding and making available important support to the learners, especially when the learners may be encountering some difficulties in using the ICT tools and resources. The teachers can give the students the means to have a scaffolding and assistance by providing them with clear instructions, demonstrations, and feedback, and by encouraging the students to work together and share their thoughts and ideas according to (Vygotsky, 1978).

The Social Constructivist Theory can be applied to this study by investigating how ICT tools and resources that students are exposed to during their learning period may have influence on their learning results and attitudes towards biology as posted by (Vygotsky, 1978). For example, the study may research the way in which the students' use of ICT tools such as simulations, games, and multimedia resources influence their development of biological concepts such as cellular respiration, photosynthesis, and genetics according to (Vygotsky, 1978). Along with the study, the researchers can also look into how teacher's support and scaffolding affect the students' use of ICT tools and resources and how this, in turn, is linked to their learning outcomes as highlighted by (Vygotsky ,1978). In addition, the investigation can also look at the role of students' prior knowledge and experiences in the process of construction and interpretation level of understanding to a higher level of understanding on their own according to (Vygotsky, 1978).

The Social Constructivist Theory shows how language of new knowledge, with the focus of how ICT tools and resources can be designed to meet the needs of students with diverse backgrounds on the other hand as postulated by (Vygotsky, 1978). The use of Social Constructivist Theory in this study can help us to know how ICT- based learning can be positively integrated into biology education in order to support students' learning and improve their attitudes toward biology according to (Vygotsky, 1978). Moreover, the study can see how the Social Constructivist Theory can be incorporated in designing various kinds of ICT-integrated biology education programs that can suit the needs of students from different cultural backgrounds as highlighted by (Vygotsky, 1978). The study can be conducted to identify how ICT tools and resources can be designed to provide the learners with the opportunity for social interaction and collaboration and on how teachers can be supportive and provide scaffolding for the learners as they navigate the complexities of ICT tools and resources, for example, according to (Vygotsky, 1978). Lastly, (Vygotsky, 1978) points out that the research can also be used to investigate the design of ICT tools

and resources that will help students to have chances for language learning and cultural expression and how the teachers can provide students with feedback and assessments which are culturally responsive and inclusive.

2.4. Empirical framework

2.4.1 Social Constructivist Learning Environments

According to SCT (Social Constructivist Theory), knowledge is created from interactions with others through language and culture (Vygotsky, 1978). The SCT (Social Constructivist Theory) comes upfront when using ICT in the teaching and learning process in biology education. It encourages teacher-student and student-student rapport in the co-construction of knowledge and understanding according to (Byrne & Grace, 2020). (Ardac, 2020) postulated that ICT tools and technology can enable social constructivist environment for the learners, where they can learn by sharing their knowledge and thoughts together and develop their critical thinking in biology. The research also demonstrated that the collaborative learning activities which were supported through the use of ICT enhanced the understanding of biological concepts and promoted critical thinking according to (Ardac,2020). For example, (Ardac,2020) showed that students who were involved in collaborative learning activities with the help of ICT displayed a deeper understanding of cellular respiration and photosynthesis as compared to those students who did not. Similarly, (Barab, et al.,2019) established that students who cooperated in making a biology project through the use of ICT tools excelled in critical thinking and constructing scientific ideas.

The teacher facilitation is a factor that allows the constructivist social environments of ICT – supported biology education as propounded by (Byrne & Grace,2020). Teachers can effectively integrate ICT in the classrooms by guiding, offering feedback as well as scaffolding which make learners collaborate with each other as suggested by (Dori et al.,2018). According to (Byrne & Grace,2020) teachers who provided feedback and scaffolding support during ICT-based group work improved the students' understanding of biological concepts and the ability of critical thinking. Finally, the Social Constructivist Theory provides a basic cognitive structure for defining the use of ICT- based learning in biology education. Such applications of ICT as tools and resources will create a constructivist social learning environment, which will stimulate collaborative knowledge construction together with critical thinking in biology. Teacher

facilitation and scaffolding are key elements in enhancing the effectiveness of social constructivist learning environments that are ICT- based in biology education.

2.4.2 Language and Discourse

(Chang et al.,2019) postulate that language and discourse have a crucial role in the formation of Students' perception of biology in ICT- mediated learning environments. On the other hand, (Dori et al.,2018) is of the idea that the way teachers use language and feedback can be of high significance in students' conceptual understanding of science and development of scientific literacy. Similarly, according to studies done by (Chang et al.,2019) students' understanding of biological concepts was affected by the language and the discourse used in ICT- mediated learning activities, which emphasize the significance of teachers' choice of language. The investigation showed that the students who were taught through clear and precise language and discourse in ICT-based learning environment had a deeper understanding of biological concepts than those who were not. This is similar to the conclusion of (Dori et al.,2018) who discovered that the scaffolding and feedback provided by the teacher to the students during the ICT-supported activities helped them to develop a deeper understanding of the biological concepts and improve their scientific literacy. Feedback and scaffolding support from teachers enabled students to gain a deeper understanding of the biological concepts and profit from a more sophisticated view of scientific phenomena.

Social injustices and inequalities in ICT-based learning environments can be reproduced If the discourse and language used in ICT- based learning environments are not dealt with through inclusive and equitable teaching strategies, social injustices and inequalities in such environments can be reproduced as observed by (Devolder et al.,2019). For instance, the research of (Devolder et al.,2019) showed that language and discourse in ICT-based learning activities can marginalize students from diverse linguistic, and cultural backgrounds. This means that teachers should take into account students' linguistic and cultural diversity in designing ICT-based learning activities. The study showed that students who came from different linguistic and cultural backgrounds and had not been exposed to ICT-supported learning activities designed to meet their specific linguistic and cultural needs had difficulties in understanding biological concepts and developing scientific literacy. Through the recognition of the effect of language and discourse on students' understanding of biological concepts, educators and researchers will use ICT as a way to boost

inclusive and equitable learning disparities in biology education. This goal can be accomplished by creating a system whereby the teachers are given professional development platforms where they can learn how to design ICT-based learning activities that are specific to the language and cultural needs of diverse students.

2.4.3 Cultural and Social settings

(Dalacosta et al.,2020) cited that cultural and social settings are the key factors in influencing students' understanding and the use of ICT in biology education. Students' cultural and social backgrounds determine how they use ICT- based learning resources and whether this affects their performance in biology is a function of access to ICT (Devolder et al.,2019). On the other hand, (Dalacosta et al.,2020) revealed that students from different cultural and social backgrounds had different levels of access to ICT resources, resulting in some students being deprived of the opportunity to engage fully and meaningfully with ICT-based learning activities in biology. Students coming from the lower social-economic-status families might not have the opportunity to use ICT at home that may make it impossible for them to complete ICT-supported assignments and participate fully in ICT-mediated learning activities. In addition, (Devolder et al.,2019) has shown that in biology education, students' social and cultural contexts determine how they use ICT, with some students lacking access due to socio-economic factors. As a case in point, those from a rural set up may not be able to access high-speed internet and thus, they will find ICT-supported learning resources online.

(Dalacosta et al.,2020) posted that the cultural and social environments in which the students live can also impact the way they perceive biology and ICT, thus proving the need for inclusive and equitable teaching practices. For instance, the viewpoints of students from different social and cultural backgrounds, regarding biology education and ICT, were different, which contributed to disengagement from ICT-supported learning activities. Students coming from cultures where technology is seen as highly significant may be more inclined towards ICT- based learning activities in biology, whilst those from cultures where traditional teaching is highly esteemed may not be inclined towards ICT supported learning activities. Through the appreciation of the cultural and social circumstances of the students, the educators and researchers would be in a position to exploit ICT to the maximum in creating inclusive and equitable learning environments in biology education. Such an objective can be implemented by giving teachers the chance to attend training

sessions to learn how to organize ICT-based teaching and learning activities that are specially designed to suit the cultural and social needs of students of different origins. On the other hand, educators and researchers can engage in the effort to remove the socio- economic barriers that some students experience in the utilization of ICT in biology education. This can be achieved by giving students the opportunity to interact with ICT tools and support, like computer labs and online learning platforms, and by working towards dealing with the societal and economic factors that lead to the digital gap.

2.4.4 Teacher Professional Development

Teacher professional development is of vital importance for the proper integration of ICT- based learning in biology education as propounded by (Byrne & Grace,2020). To go beyond the mere use of ICT, teachers need professional training and assistance to gain the necessary skills and knowledge for designing and implementing ICT-based learning experiences in biology as highlighted by (Dori et al.,2018). For example, in their study, (Byrne & Grace,2020) gave the evidence that teachers who had ICT integration professional development were more likely to integrate ICT in their biology teaching, and they also reported higher levels of competence and ICT confidence. In the same vein, (Dori et al.,2018) noted that teachers who underwent professional development in ICT- based learning in biology education were able to create and implement ICT-supported activities that helped deep learning and understanding of biological concepts. This goes to the development of the skills of using educational technologies like learning management systems, multimedia tools and online resources as well as mastering the principles of integrating ICT into designs and education instructional practices.

(Byne & Grace,2020) are of the idea that the creation of a successful teacher professional development plan is complex and involves various approaches and methods. They include workshops, coaching, mentoring, and online learning communities, and also possibilities for teachers to work in teams and share their success stories and expertise as pointed out by (Dori et al.,2018). The teachers need to access up-to-date resources and assistance, which include, for instance, curriculum materials, software, and technical support, which are aimed at assisting them to use ICT- based learning approaches in biology education as cited by (Byrne & Grace,2020). On the other hand, teachers who are new to technology and different approaches to teaching, need to be given the time and the support to experiment and explore new technologies and teaching

approaches and reflect on their own learning and teaching practices. Continuous professional development and support for teachers will be an important tool in the work l of educators and researchers, as they will be able to ensure that ICT- based learning strategies are being used to encourage deep learning and a better understanding of biological concepts, and preparing students for the digital and complex world of the future.

2.4.5 Students' Prior knowledge and Experience

The knowledge and experience students bring to the classroom inclined to ICT-based learning of biology is a very important factor in how they will understand and experience the learning process. Recent findings by Tsai et al. (2018) have shown that the factors of prior experience and knowledge determine the students' motivation, engagement, and their learning outcomes . For an example, those students who have already gained some prior understanding of biology concepts are more likely to engage in ICT-based learning with a deeper comprehension and a positive attitude, as compared to students who are less familiar with those concepts who may have difficulties in linking new knowledge to their existing knowledge base according to (Chen et al.,2018). This is due to the fact that prior knowledge is important in the new learning process as it is the foundation for building new learning structures and helping students to make connections and to expand their current knowledge. In addition, acquired ICT experience in students may also affect their confidence and comfort level in using technology during learning. This is because prior experiences with ICT can determine students' beliefs and attitudes towards technology, which can in turn influence their inclination towards engaging in ICT-based learning activities. In this vein, (Kiili et al.,2014) stated that students' previous encounters with ICT also becomes a factor in their ability to be able to navigate digital tools and resources meaning that students with previous experiences with ICT are more likely to be proficient in using technology for learning. Besides, (Vygotsky,1978)'s notion of "the zone of proximal development" (ZPD) highlights the fact that ICT-based learning's importance relies on the students' prior knowledge and experiences. The ZPD is the learning range that students are able to achieve, with the assistance, of a better informed other. The ZPD concept in the context of ICT-based learning stresses the importance of considering students' previous knowledge and experiences when designing learning activities.

2.5 Synthesis

Students' perception of ICT- based learning in Biology is influenced by a range of factors which include their prior knowledge and experiences, digital literacy, and engagement with ICT-based learning activities as posted by (Tsai et al.,2018). According to (Wangu et al.,2020) research has shown that students who have positive experiences with ICTs in Biology tend to have a more positive perception of its usefulness and relevance to their learning. This is because positive experiences with ICTs in Biology can help to build students' confidence and motivation, and encourage them to engage more deeply with the subject matter. On the other hand, (Hmelo-Silver,2004) postulated that students' perception of ICT- based learning in Biology is also affected by the pedagogical approaches used by teachers, with student-centered and inquiry- based approaches tend to be more effective in promoting positive perceptions of ICT- based learning in Biology. This is because student-centered and inquiry-based approaches allow students to be active participants in their learning, and can help to promote a sense of autonomy and agency.

2.6 Research Gap

Despite the importance of understanding students' perception of IT in Biology, (Li et al.,2019) is of the opinion that there is a need for further research in this area, especially lack of research on the specific factors that influence students' perception of ICTs in Biology, as highlighted by (Kirschner & Karpinski,2010), and how these factors interact with each other. For example, more research is needed on how students' prior knowledge and experiences with ICT- based learning influence their perception of its usefulness and relevance to their learning. Additionally, there is a need for research on how to effectively promote positive perceptions of ICT-based learning in Biology among students, and how to dwindle the digital gap and ensure that all students have access to ICT tools and resources according to (Ertmer & Ottenbreit-Leftwich,2010). This could involve investigating the effectiveness of different pedagogical approaches, such as student- centered and inquiry-based learning, and investigating the impact of ICTs on student learning outcomes in Biology. Furthermore, (Koehler & Mishra ,2009) postulate that research is needed on how to support teachers in developing the technical skills and pedagogical knowledge required to effectively integrate ICT- based learning into Biology education, and how to assess the impact of ICTs on student learning outcomes in Biology. This could involve exploring the effectiveness of different professional development programs, and investigating the impact of ICT- based learning on student learning outcomes in Biology. Addressing these research gaps can help to ensure that ICT-

based learning is effectively used to support student learning in Biology, and that all students may have the opportunity to develop the skills and knowledge required to succeed in the digital age.

2.7 Conclusion

In conclusion, this chapter has explored the complex relationship between students' perception of ICT- based learning in Biology and their learning outcomes; identifying key factors such as prior knowledge and experiences, digital literacy, and engagement with ICT-based learning activities that influence students' perception of integrating ICTs in Biology. The chapter highlights the importance of pedagogical approaches like student-centered and inquiry-based learning in promoting positive perceptions of ICT based learning in Biology and notes the need for further research to address the digital divide and ensure equal access to ICT tools and resources. The findings have implications for teaching and learning in Biology, with emphasis on the importance of considering students' perception of integrating ICT in Biology when designing ICT-based learning activities to build students' confidence and motivation and encourage deeper engagement with the biological concepts. Overall, this chapter contributes to our understanding of the relationship between students' perception of ICT- based learning in Biology and their learning outcomes, highlighting areas for further research to create a more effective and enabling learning experiences for all students.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter encompasses the research procedures used to determine ordinary level students' perception about ICT- based learning in Biology, potential sources of these perceptions and the likelihood of improving them. The justification of choosing the qualitative approach revolves on the need to understand students' perception on certain matters in a comparative manner. In its vitality, qualitative research still addresses the possibility of investigating multifaceted entities or events by gathering and evaluating comprehensive and descriptive data. This research method is well suitable in educational research in which the focus is on interpreting the inclination of students and or their disposition towards different scenarios resulting in differing experiences. This chapter describes the research methodology that includes the approach, design and population, sampling techniques, instruments, method of data collection and analysis and considerations of ethical issues that would enhance the understanding of the research method used in this study.

3.2 Research Approach

Due to the nature of the study in which the importance was to get as much information as possible from the Ordinary Level students about ICT- based learning in their biology class, a Qualitative research approach was used in contrast with quantitative research, which focuses on the number of variables, the qualitative research investigates the participants' attitudes and the meanings they attach to such experiences. Cresswell and (Poth,2018) identified that qualitative research is suitable when the context and participant's views are important in studying events that are rapidly growing or multiplying. It indicates that the authors enable researchers to know from students' voices the level of complexity involved in their interaction with ICTs and the antecedents that shape their perceptions about such technologies. The qualitative approach is especially suitable for educational environments because the possibilities of using learning technologies, as well as the outcomes of such use, are in many cases the focus of investigation as posted by (Merriam & Tisdell ,2016).

3.3 Research Design

Phenomenological research design was employed in this study with the view to giving face and voice to students' voice and understanding regarding ICT- based learning in Biology education.

(Vân Manen ,2014) stated that phenomenological research design is a type of research design that tries to capture the main features of an experience by closely describing the idea as it is felt and seen by the person in question. This design is appropriate for addressing students' perceptions because it aims at discovering the significance that they assign to their interactions with ICTs when learning Biology. The phenomenological approach involves the description of relevance structures and phenomena, which is ideal in revealing how ICTs affects students' learning activities, interest, and impression about biology. This design is relevant to this research's goal since it helps to describe the students' subjective perceptions of the standpoints in depth and offer a rich picture of their perceptions concerning ICT- based learning in the educational context.

Figure 3.1 Research Design Illustration

3.4 Target Population

The group of target population for this study will be the Ordinary level (O-Level) students at "Hondoyapera" Secondary school who are taking Biology and using Information and Communication Technology tools in their studies. These students are usually at the age of between 14 and 19 years old, that is such a developmental period which Attitudes towards learning and the technology can effectively determine the learner's education as posted by (Eccles & Roeser, 2011). Targeting O-Level students is more appropriate since this group is at the crossroad of being

introduced to ICT in schools which makes their perception relevant for understanding effectivity and challenges of ICT- based learning at the required curriculum level. The choice of the above target population means that the study focuses on the experiences of users involved and presently using ICTs in learning Biology thus bringing out current information to support improvement of ICT usage in STEM trajectories.

3.5 Sample and Sampling Techniques

This study employed a mixed-methods research design, utilizing both qualitative and quantitative approaches. For the qualitative, the researcher used a purposive sampling technique to select 60 Ordinary level Biology students from 3 different classes from Hondoyapera Secondary School.

The sample size was determined on the principle of data saturation, where in-depth interviews and focus group discussions were conducted until no new themes or information emerged (Cresswell & Poth, 2018). The 60 students were evenly distributed across the 3 classes with 20 students from each class. The sample included both male and female students, regarding a range of academic performance levels to ensure a diverse perspective.

The researcher first obtained permission from school authorities and informed consent from the participants and their guardians. The participants were then purposively selected based on the following criteria (Patton, 2015):

-Enrolled in Ordinary level biology classes.

-Willingness to participate in the study.

-Able to provide rich and detailed information on their experiences with ICT integration in Biology education.

For in-depth interviews, the researcher used semi-structured interview guide to explore 30 students' perceptions, experiences, and perspectives on the integration of ICT in their Biology lessons (Yin, 2018). The interviews were conducted individually, with each participant engaging in a one-on-one discussion with the researcher. The discussions would last for 30 to 45 minutes in intervals comfortable for the participants. The interviews were audio recorded and transcribed verbatim.

The researcher also conducted 5 focus group discussions with 6 participants in each group. The focus group discussions allowed the researcher to gather more in-depth and nuanced information about the students' collective experiences and perceptions (Krueger & Casey, 2015). Each focus group discussion lasted between 45 to 60 minutes. The discussions would be audio-recorded and transcribed verbatim. Focus groups will explore students' views, opinions, and experiences on ICT-based learning in Biology lessons.

The qualitative data from the in-depth interviews and focus group discussions were analyzed using thematic analysis, as described by (Braun & Clarke, 2006). Thematic analysis will be used to identify patterns and themes. Codes and categories would be developed and refined. Themes will be analysed and interpreted. Data from in-depth interviews and focus group discussions will be triangulated to increase validity and reliability.

For ethical considerations, informed consent was obtained from participants. Confidentiality and anonymity were ensured, and participants were free to withdraw from the study any time

This research design will provide a comprehensive understanding of Ordinary level Biology students' perceptions on ICT- based learning in Biology education exploring their experiences, opinions and views through in-depth interviews and focus group discussions.

3.6 Research Instruments

The two major research tools that were employed in this study were interviews and focused group discussions.

3.6.1 In-Depth Interviews

In order to provoke the students' perceptions of ICT use in Biology learning, the sources of these perceptions and any suggestions they had for changing these perceptions, selected students participated in semi-structured interviews. According to Kallio et al. (2016), semi-structured interviews are extremely useful when conducting research on context-specific and multifaceted phenomena as they often include both a standard set of questions and follow-up questions depending on participants. To maintain theoretical consistency and answers relevant, while simultaneously giving the interviewer freedom to diversify the questions are based on the participants' responses, an interview guide was used. The interview questions consisted of probes

related to the students' experience with ICT- based learning in Biology, attitude towards the use of ICT in learning, and the factors promoting or negatively affect their attitude towards the use of ICT in Biology learning. Interviews ranged between 45-60 min and ensured that the participant was comfortable, and in a friendly and quiet environment to facilitate capturing of their candid response.

3.6.2 Focus Study Groups

Sometimes group discussions with students were also arranged in the class where all could interact with each other and see the group's views and disparities present in perception of topic among them. The interview guide for this study was used to guide the discussion and to ensure participants' engagement with one another is fostered. There were 6-8 students in each focus group identified, and the whole focus group session spanned 60-90 minutes. The interaction sessions were taped with participants' permission and later transcribed to allow analysis. The focus group meetings offered the students a great opportunity to report about their ICT usage in Biology lessons, to express opinions, and to brainstorm about approaches to alter the attitudes collectively.

3.6.3 Data Analysis Methods

The data analysis in this qualitative study begins with the detailed process of transcribing the tapes from the session of semi-structured interviews, focus group discussions and thus using a voice recorder to capture the voices of the responses by the students. All transcriptions on memory cards are reviewed to ensure high quality and reliability that form a good basis for the further analysis. After transcription, the researchers undergo an embodied data immersion process by constantly reviewing the transcribed data using the help of the recorded audios on memory cards. This enables the specification of voices to the participants' complex and diverse experiences and perceptions regarding integration of ICT in their Biology learning.

The coding phase only makes use of coding manual that has been instituted systematically in conformity with the research questions of the study. To analyse the data, the researchers use audios on memory cards to obtain data that condense participants' various attitudes and interactions with ICT in Biology education. This process progresses in cycles, with attention paid to how abstract and emerging themes are nuanced to capture participants' experience, free from distortion by the researcher's bias. These thematic domains are subjected to peer debriefing and member checking

procedures, thereby increasing the credibility of the study to stakeholders. Also, a concurrent nested mixed- methods approach incorporates quantitative data from self or questionnaires and strengthens data triangulation, yielding a holistic view of students' perception towards ICT on Biology studies. The final stage of analysis is thematic synthesis, where extracted themes are discussed using literature, theories, and context in which the study is set, thus enriching the understanding of ICT's effects on the students' learning experiences and perceptions of Biology education. In this analytical process, the researcher was very much careful about the ethical issues of the study and dealing with the participants' identities, their consent, and their information privacy before, during and after the study thus meeting the methodological research best practices.

3.7 Validity and Reliability

As this study seeks to establish the perceptions of ordinary level students towards the use of ICT in their Biology lessons, it is important to have the study's validity and reliability established as a way of enhancing the credibility and dependability of the research findings. Validity can be defined as the reliability and credibility of the data collected and the findings in qualitative research study while reliability is the consistency and precision in the study processes and results. To enhance validity of the study the following procedures were used; the first being the use of triangulation. This included employing multiple sources of data, different methods of data collection, and analysis, as well as integrating at least two theoretical frameworks to increase the objectivity and reliability of the results. Triangulation was made possible by collecting data from three sources: semi-structured interview, focus group discussion and records from the education system, thus this study offered a richer and more holistic view of the students' perception and experience due to the convergence of different methods. Furthermore, member checking was used as another form of validation whereby the initial conclusions and interpretations of the data were discussed and compared with participants to ensure that the emerging themes were both valid and representative of participants' experiences. This helped not only in boosting the validity of the findings, but also in guaranteeing the participants' consent in the way their testimonies are presented in the study. The involvement and reassessment of the participants in this spiraling validation cycle strengthens the internal credibility of the study, and maintained a check if the themes emerging in the study are as they actually are – the students' perspective and interpretation of ICT in their Biology learning-teaching process.

Issues of reliability were dealt with a lot of seriousness through documentation and adherence to the systematic research approach. Contemporaneous field notes were taken with great detail, which included audio recordings and written transcriptions of the interview sessions, so that the readers have clarity on the data collection method implemented in this study. Coding was carried out most systematically starting with the construction of a comprehensive code manual that was used in the classification of data segments. Since students' coding reliability was employed and to increase credibility, the researcher had subjects' data coded and then jointly compared. The researcher made coding and cross-checking possible, thus eliminating the subjectivity of coding and the subsequent inconsistencies that can this procedure may produce when the phenomenon of interest is not always clean-cut.

3.8 Documentation procedures

To ensure transparency and accountability in the research process, an audit trail was meticulously maintained. This trail documented every decision, methodological approach, and analytical step taken throughout the study. It not only justified the choices made during the research but also allowed for institutional review and verification.

In addition, the principle of reflexivity was rigorously applied. The researchers engaged in continuous self-reflection, acknowledging their own biases, assumptions, and potential influences on the research outcomes. These reflections were recorded in detailed accounts, capturing their insights, evolving thoughts, and learning experiences. This practice was essential in minimizing researcher bias and enhancing the reliability and validity of the study. Peer debriefing was another key component of the research process. Regular meetings with peers provided an opportunity to review the research methods, preliminary findings, and interpretations. These sessions offered external perspectives that strengthened the analytical rigor and critical depth of the study.

3.9 Ethical considerations

Evaluations of ethical issues were central to the study because it aimed at achieving high levels of reliability and credibility of the conclusions made. The participants were read the rights and the purpose of the research and all the procedures that will be used and they all signed consent forms indicating that they willingly agreed to be part of the study and that they could withdraw at any time they wished. Participants' identity was well protected and all information collected was kept as confidential as possible to prevent disclosing the participants' identity. In as much as this study was

conducted on human participants the researcher ensured that, permission was sought and approved from the right ethical committee. Not only have the general ethical practices helped to protect the participants' rights and their welfare, they have also ensured the credibility of the research study.

The use of a voice recording tool and coding manual were rather crucial to adhere to the strict methodological requirements and achieve methodological purity while at the same time providing comprehensive methodological documentation. The final process of carrying out the data analysis plan entailed detailed presentation and communication of the results through write ups, staff developments and other forums. The research report then encapsulated the implementation of the identified themes employing veritable quotes as well as concrete specifics obtained directly from the study findings enhancing the portrayal of the participants' true voices and experiences. In summary, the enhancement of validity and reliability measures made the research findings reliable, credible and trustworthy, hence, making meaningful contribution to scholarly literature on educational technology and science education. The care taken in identifying the places, people and procedures needed in a research study enlightens the reader on the research credibility and ethical issues that arises in a research study makes this aspect very crucial in any research study thus improving the quality of the study.

3.10 Conclusion

This chapter elucidated on the overall qualitative approach employed to identify the Ordinary Level learners' perception of ICT integration in Biology, origin of such perception and the possibility of changing it. A research design that embraced phenomenological research permitted the identification of the special experiences and attitudes of students while paying certain regard to their own personal points of view. Future research should target Ordinary Level students from other regions and use a random sampling technique to increase the generalizability of the study's findings so as to enrich the data. The research method primarily used for data collection was through in-depth interviews and focus group discussions which provided rich, qualitative details of the student-ICT relations. Overall, careful and rigorous methods of data analysis, transcription, coding, and thematic synthesis with the help of the voice recorder software provided the ways of finding significant patterns and themes. Purposive sampling, peer debriefing, memorizing, and member checking also helped strengthen the credibility of the study's findings and conclusions. Pursuant to the established guidelines, issues of ethics were respected to ensure that the

participant's rights and identification were well protected. In turn, this methodological approach did not only shed light on the students' perceptions but was useful in offering practical recommendations on how best the use of ICTs can be promoted in Biology classes.

CHAPTER 4: DATA ANALYSIS AND DISCUSSIONS

4.1 Introduction

This chapter presents details on data analysis from ordinary level students on the perception of ICT- based learning in Biology, sources of these perceptions, and how they might be modified. First, descriptive statistics provide a quantitative outline of the information received, followed by a detailed thematic analysis of qualitative exploration of the gathered information. This is supplemented with word-to-word statements from participants in both Shona and English, to give a rich, authentic perspective on students' experiences; tables and charts will be used in ordering data to provide visual displays that add depth and clarity to the discussion. This chapter has tried to integrate both quantitative and qualitative approaches so as to present an all-rounded view of the complex dynamics that influence students' perceptions and the effectiveness of ICT integration in Biology education.

4.2 Descriptive Statistics

Descriptive statistics provide an insight foundation into students' perceptions of ICT- based learning in Biology, offering a snapshot view of demographic characteristics, ICT usage frequency, and general perceptions. The chapter opens with a proper summary of demographic information of the participants on age, gender, and prior ICT background, which is followed by frequency and percentage distributions of some key variables under study—mainly usage and perception variables of ICT. Such statistics set the stage for the qualitative analysis that follows more extensively and, importantly, provide contextual substantiation for making sense of the allowance results that come out in the thematic findings. In formation of a foundation for the deeper exploration of themes identified in the qualitative data, this section will present some of the key trends and patterns noted from the survey responses by bringing order and accessibility to the data. .

Table 4.1: Demographic Characteristics of Participants

Variable	Category	Frequency	Percentage
Age	14	15	22.4%
	15	25	37.3%
	16	27	40.3%
Gender	Male	34	50.7%
	Female	33	49.3%
Prior ICT Exposure	Yes	52	77.6%
	No	15	22.4%

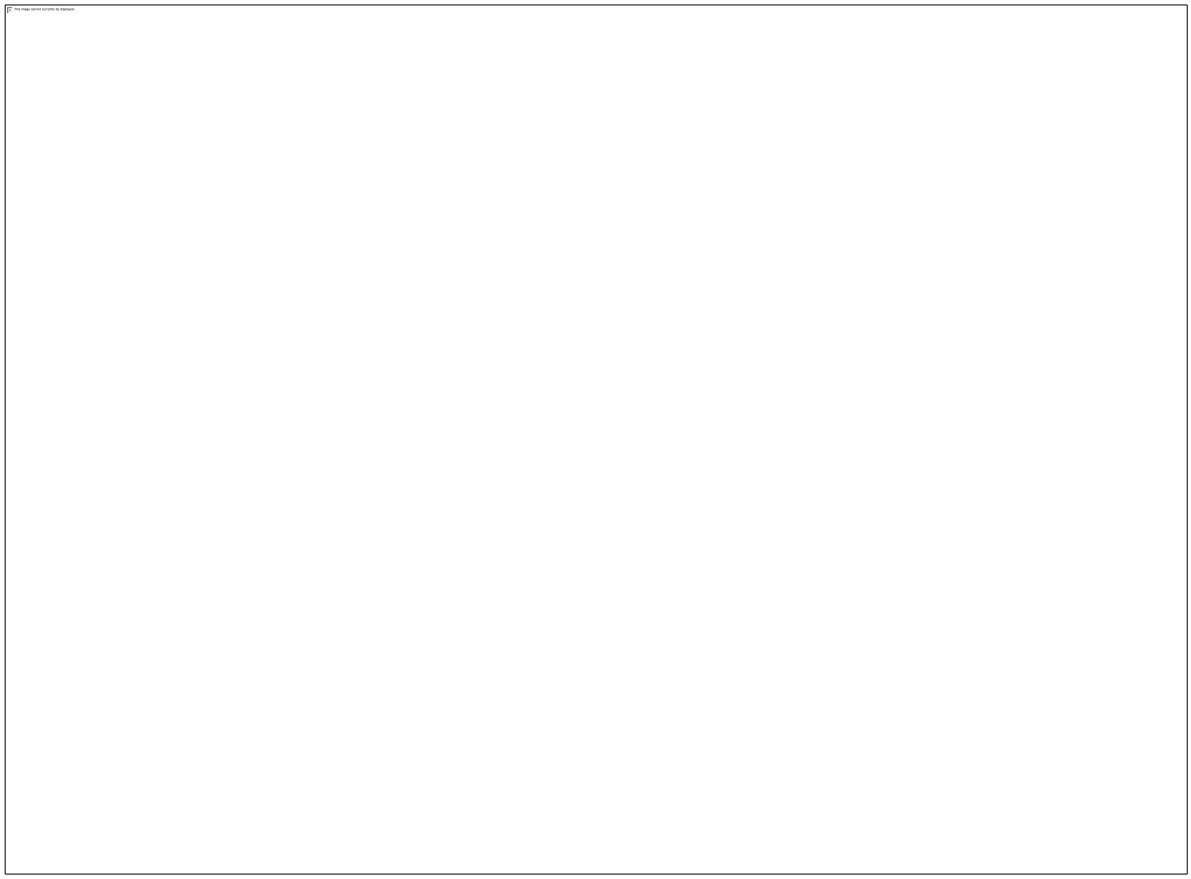

Figure 4.1 Distribution of Participants

Demographic data indicates a good balance in terms of gender representation, with most participants aged 16. This balance is important in ensuring that the results obtained from the research are representative of the larger student population. Most learners have had some kind of involvement with ICT before; this therefore means that some level of familiarity likely influences their perception. This background information is important in indicating that, for example, the majority of students were not completely new to the use of ICTs; this might influence their feeling of comfort or attitude towards the integration of ICT into Biology classes. The Dispersion of ages indicates a concentration within the mid-teen years, typical for ordinary level students, ensuring that the views expressed by the students would be relevant to this study's focus. Knowing the demographic composition of the respondents will then put their responses into better perspective and enable us to pick out trends or patterns in their responses that may be due to these characteristics. The chart indicates different levels of use of ICT in Biology classes, but in all cases, the majority of students report high or very high usage.

This frequent usage suggests that ICT is becoming an integral part of Biology education; this agrees with the feeling of contemporary educational tendencies orienting towards incorporating technology. The variation, however, also points out a disparity in access and utilization that may be the result of differences in school resources, teacher proficiency, or student engagement levels. On the other hand, the chart of overall perception indicates that a fair number of students plus views on ICT integration in biology exist, reflecting perceived benefits in enhanced learning and engagement. Even so, the fact that there are neutral and negative perceptions shows there are some underlying challenges that must be attended to and that the situation needs to be more crystallized. These visualizations offer an immediate, concrete understanding of the data, thus enabling one to recognize in a glance general tendency of trends and outliers within a dataset. .

4.3 Thematic Analysis

Thematic analysis identifies a number of major themes and sub-themes from the qualitative data emanated from the interviews and focus group discussions. The analysis provides rich detail about students' perceptions, factors influencing these perceptions, and their suggestions on the improvement of ICT integration in Biology education. Each theme is presented along with verbatim statements to illustrate, in a more authentic way, examples of participants' experiences and views. The chapter is therefore an attempt at encompassing this complexity and diversity of

student perception in the bid to create an all-rounded understanding of the perceptions on the effect of ICT on students' learning.

Table 4.2: Themes and Sub-Themes from Thematic Analysis

Theme	Sub-Theme
1. Perception of ICT	1.1 Positive Experiences
	1.2 Negative Experiences
2. Impact on Learning	2.1 Engagement and Motivation
	2.2 Challenges and Barriers
3. Sources of Perceptions	3.1 Teacher Influence
	3.2 Peer Influence
4. Recommendations	4.1 Enhancing ICT Integration
	4.2 Addressing Challenges

4.4 Perception of ICT

4.4.1 Positive Experiences

Many of the students who responded to the study recounted good experiences in using ICT during Biology classes and rested on the core of technology in improving their learning experience. Most of the students pointed out that ICT packages, such as interactive simulations and visual aids, presented the ability for them to comprehend complicated biological concepts and attracted their interest. One of the students reported,

"*Kubatsira kwetekinoroji muBiology kunoita kuti dzidzo inyatsonakidza, zvichikonzera kuti tive nemufaro pakudzidza" ("The use of technology in Biology makes learning really enjoyable, making us happy to study").*

This statement reflects a broader sentiment among students who found that ICT transformed their learning environment, making it more dynamic and interactive. The multimedia elements allowed the students to envision and manipulate biological processes in ways that traditional teaching did not; therefore, promoting a deeper understanding and memory of the topic. Animations and 3D

models that helped demystify complex processes like cellular respiration and photosynthesis proved very useful.

In addition, the respondents revealed that the infusion of ICT into teaching increased students' participation significantly. Among these interactive features were quizzes, educational games, and virtual labs that prompted them to maintain attention and interest. One respondent answered,

"*Patinoshandisa ICT mudzidzo, tinonyanya kufarira nekuti zvinotipa mukana wekutora chikamu zvakanyanya."*

"When we use ICT in class, we are more interested because it gives us more opportunities to participate.".

This interactive participation enhanced the enjoyment of learning but also ensured active involvement in the process, which is a precondition for effective learning.

Students felt positively about receiving immediate feedback from ICT tools, helping in detecting and correcting mistakes on the spot and therefore reinforcing learning. This also ensured that, instead of just being supplied with information, students were engaging with the content and so the process was much more involving and supportive of motivating students to learn. Moreover, ICT tools provided better personalization in the process of learning. Resources such as online tutorials and e-books helped students to work at their own pace, revisiting concepts that were not clearly understood. This flexibility helped those students who need more time to understand certain concepts study more effectively. As one of the students commented,

"*Tinogona kudzidza nenzira yedu tichishandisa tekinoroji, izvo zvinotibatsira chaizvo." ("We can learn at our own pace using technology, which really helps us").*

This personalized approach not only catered to the different learning needs among these children but also empowered the students to be responsible for their learning. This built independence and self-drive in them. Through the use of ICT tools, students had the freedom to engage with learning materials at their own pace and according to their will, hence making the educational environment more inclusive and supportive by recognizing and accommodating the different needs for learning that existed among the students. Integration of ICT in biology education has also promoted collaborative learning whereby technology provides tools such as online discussion forums where

students can work together and share ideas and knowledge about a certain biology concept. Through this approach, the understanding of the subject matter is enhanced as well as important related skills like teamwork and communication. One student commented,

"*Kushanda pamwe chete tichishandisa tekinoroji kunotibatsira kudzidzisana uye kuvandudza hunyanzvi hwekushanda mumapoka." That is, "Working together using technology helps us learn from each other and improve our group work skills."*

Being able to collaborate and communicate effectively is an important skill in contemporary life, and the use of ICT in education helps to nurture these skills in students.

4.4.2 Negative Experiences

Despite all the benefits cited above, some students indicated that they were not having positive experiences related to ICT. It could be that problems related to computers and lack of adequate training are a significant cause of frustration and eventually feelings of disconnection from the process of learning. Enath supplied this evaluate from one respondent:

"*Dzimwe nguva michina inotadza kushanda zvakanaka, zvinonetsa kuenderera mberi nedzidzo." ("Sometimes the equipment doesn't work properly, making it difficult to continue with the lesson").*

Technical difficulties, faulty devices, software, and internet connections that were not reliable disrupted the learning process, diminishing the effectiveness of these very important ICT tools. These issues affected some very critical learning activities more often than not, with the potential to delay or interrupt the smooth flow of lessons. The development of such frequent technical difficulties created uncertainty and frustration among students, thus tainting their perception of ICT and the whole learning experience. Another shortcoming was insufficient skills training for students and teachers. Most students said they were not well guided on how best to use the tools, hence lacking the full capacity to benefit from such resources. This was expressed by one of the students who said,

"Tinoda kuti tiitwe zvekudzidziswa kuti tishandise michina yacho nemazvo" ("We need to be trained how to use the devices properly").

This lack of training consequently affected students' confidence in using ICT and led further to an underutilization of available tools. In the side of teachers, insufficient professional development in ICT led to not being confident enough to freelance technology use into teaching practices. Even with this, both learners and teachers could not use the capacity of ICT tools to one hundred percent and received suboptimal results. This envelope of benefits that technology can offer to educational practice had been lessened in such a way. On the other hand, some students put forward the idea that ICT tools, no matter how beneficial, are still able to distract them from their learning process. The availability of non-educational content and applications on devices did sometimes give way to off-task behavior, having learners sidetracked by playing games or browsing social media. One of the participants commented,

"*Dzimwe nguva zvinonetsa kuramba tichitarisa mudzidzo kana pane zvinokanganisa." It means "Sometimes try to stay focused on the lesson when there are some distractions."*

The problem underlines the establishment of proper class management strategies and, further to that, the institution of controls that minimize distraction and ensure that ICT is used productively. The ease of distraction through ICT tools called for close management and supervision to keep the students focused on their educational assignments and avoid the allure of non-educational material. A second huge challenge was the large digital divide between schools and geographic areas in terms of access to ICT resources. Some students mentioned that their schools were not well facilitated with the appropriate infrastructure and equipment for effective integration of ICT. One student added,

"*Hatina michina yakakwana uye zvivakwa hazvina kugadzirirwa zvinodiwa neICT" ("We don't have enough gadgets and infrastructure isn't equipped to support ICT needs")*.

The resultant inadequacy of resources throttled certain students, rendering them unable to benefit from gainful ICT usage due to inadequate equipment. Those are disparities that should be addressed if the students are to have equal opportunities in benefiting from the use of ICT in education.

4.5 Impact on Learning

4.5.1 Engagement and Motivation

ICT integration in Biology classes disrupted student interest and motivation. Many students reported that ICT tools make learning more entertaining and stimulating, which increases interest and motivation for studying. One of the students commented,

"*Patinoshandisa ICT mudzidzo, tinonyanya kufarira nekuti zvinotipa mukana wekutora chikamu zvakanyanya." ("When we use ICT in class, it interests us more since it gives more opportunities to participate").*

Subsequently, higher engagement was transitively described as aided by the interactivity sustainably created by ICT tools, which gave way to more hands-on participation and dynamism in the process of learning. Building further on this point, a number of the multimedia elements incorporated—such as videos, animations, and interactive simulations—contributed to gaining students' attention and holding their interest throughout the lesson. The different formats for content made it more engaging and therefore increased the possibilities for better understanding and retention of complex biological concepts. Moreover, the feedback from the ICT tools was immediate and fundamental in reinforcing learning and increasing students' confidence. Interactive quizzes and assessments helped the learners understand the subject matter by giving them a chance to understand where they stood and instant feedback on how well or poor their performance is. As one participant said,

"*Tinowana mhinduro nekukurumidza, izvo zvinotibatsira kuona patinoda kugadzirisa" ("We get feedback quickly, that helps us see where we need to improve")*

This immediate feedback helped students to identify their strengths and weaknesses, hence putting more emphasis on those subject areas that needed more study and practice. This facility for real-time progress tracking had the further effect of keeping students engaged and working toward improving performance. Through this provision of relevant and timely feedback, ICT tools thus facilitate a more iterative and responsive learning process in which students are actually in the position to improve and refine their understanding. The use of ICT further provided an individualized experience of learning. Students could comfortably proceed at their own pace and repeat areas they did not understand with the help of digital resources like online tutorials, e-books, and educational apps. One of the students explained,

"*Tinogona kudzidza nenzira yedu tichishandisa tekinoroji, izvo zvinotibatsira chaizvo" ("We will be able to learn at our own pace using technology; it really helps us")*

The approach personalised learning differences and styles of pupils, thereby giving them the opportunity for an effective and efficient study. Students had control over their learning, which fostered independence and self-motivation from the flexibility that arose from the use of relevant ICT tools. These tools of ICT use helped in creating an inclusionary and supportive educational environment, taking care of the diversified learning needs of all students. The use of ICT tools in biology education also fostered collaborative learning. Among other tools, students used online discussion forums and worked group projects technologically in order to work on projects and tasks together and become exposed to what others had learned. This served not only to deepen basic understanding of content, but also helped develop very critical competencies such as teamwork, communication, and critical thinking. One student said,

"*Kushanda pamwe chete tichishandisa tekinoroji kunotibatsira kudzidzisana uye kuvandudza hunyanzvi hwekushanda mumapoka."*

In fact, collaboration and effective communication with peers in general are important skills in the modern world, and the use of ICT in Education helps cultivate these in students.

These tools helped to enhance students' social and cognitive skills by creating an interactive learning environment that made learning much easier. Students were able to easily interact with one another through their application, and this strengthened bonds between them and other students. Apart from that, ICT in Biology gave the students very wide scope in terms of information and exposure not obtainable from the use of textbooks alone. The abundant support materials derived from online databases, journals, and education websites deepened their learning and fostered a clear understanding of the concepts being articulated. One of the learners commented,

"*Kubudikidza neinternet, tinokwanisa kuwana ruzivo rwakawanda runoshandiswa pakutsvaga mazano matsva." ("Through the internet, we are able to access a lot of information that helps us explore new ideas.").*

This increased the availability of information enabled students to extend their knowledge of Biology and get involved in research and newer developments in this field.

4.5.2 Challenges and Barriers

Despite several advantages, the use of ICT in Biology education brought along various challenges and barriers. The most prominent amongst these was the limited access to devices and poor infrastructure. Most of the students indicated that computers or tablets were not enough to accommodate all students, hence their involvement in most learning activities that required the use of ICT was compromised. One of the students asserted,

"*Hatina michina yakakwana uye zvivakwa hazvina kugadzirirwa zvinodiwa neICT." (We don't have enough devices, and the infrastructure isn't equipped to support ICT needs.).*

This shortage of resources created the disparities in access and utilization, where some students could not enjoy the benefits of ICT since there was inadequate equipment. This disparity ought to be addressed to help all students have equal opportunities that would help them reap benefits associated with information and communications technology in education. The technical issues were another major cause of the barrier, especially malfunctioning equipment and unreliable internet links. These challenges most often interrupted the learning process, frustrating both students and teachers. One of the participants lamented,

"*Dzimwe nguva michina inotadza kushanda zvakanaka, zvinonetsa kuenderera mberi nedzidzo" ("Sometimes the equipment doesn't work properly, making it difficult to continue with the lesson").*

Technical problems didn't not only interrupt lessons, but also lower the effectiveness of ICT tools by students not having the capacity to fully participate with the material because of these breaks. Such technical problems can only be dealt with efficiently through regular maintenance and proper technical support, making sure that an ICT tool works smoothly without faults and failures. Due to the frequent occurrence of such technical problems, students were facing uncertainty and frustration that hampered their whole learning experience and perception towards ICT. In addition to inadequate technical support, inadequate training to both students and teachers was another major challenge. Many students felt that they had not received enough guidance on how to use ICT tools effectively; this has reduced the extent to which students can benefit from such opportunities.

"*Tinoda kuti tiitwe zvekudzidziswa kuti tishandise michina yacho nemazvo," said one of the students ("We need to be trained on how to use the devices properly").*

The teachers themselves were also challenged by a lack of adequate professional development in ICT, which hindered their capacity to integrate technology into their teaching seamlessly. If the students and their teachers are not suitably trained on the use of the tools of ICT, then both parties will remain far from capitalizing on the capabilities, resulting in poor and suboptimal results, hence tainting the prospects of gains from integrating technology into school. Full trainings for both students and teachers are fundamental in maximizing the potential of ICT in education. This training is important to ensure all stakeholders are fully equipped with skills and knowledge. The preparation of instructors is positively related to many variables describing the use of computers in schools. Instructors who have received training are more likely to integrate computers into instructional activities. Some students, however, indicated that ICT tools were sometimes distracting. Availability of non-educational content and applications on devices occasionally led to off-task behavior with students sidetracked by games and social media. One of the participants responded,

"*Dzimwe nguva zvinonetsa kuramba tichitarisa mudzidzo kana pane zvinokanganisa." This offer means, "Sometimes it is hard to stay focused on the lesson when there are distractions."*

The question that comes out from this underscores what good class management strategies will be required, together with the controls to ensure a minimum of distractions and maximum productivity in the use of ICT. The ability for one to be distracted by the ICT tools in use made it of necessity that it was required to have proper management and control over the students so as they could have balance focus on their educational tasks without wandering over to other non-educational content. There is a need for explicit guidelines and policies agreed upon by teachers and administrators governing ICT usage in the class, so that the technology does not take away from learning but complements it. Another big challenge noted was the difference in the availability of ICT resources between schools and regions. Some learners sometimes claimed that their school infrastructure and equipment could not support any meaningful application of ICT. One student commented insightfully,

"*Hatina michina yakakwana uye zvivakwa hazvina kugadzirirwa zvinodiwa neICT" ("We don't have enough devices, and the infrastructure isn't equipped to support ICT needs").*

This no availability of resources opened up inequalities in access to the technology, as some students were not able to benefit from the advantages of using ICT due to inadequate equipment. The disparities have to be addressed so that the students can have equal opportunities that provide them a chance to benefit from ICT usage in education. The efforts should level the playing field with proper financing and resources in underprivileged areas to bridge the gap in the digital divide so that no student is left behind in the access to any tool or any resource in today's modern educational landscape.

4.6 Sources of Perceptions

4.6.1 Teacher Influence

It is observed that the teacher played a very significant role in influencing students' perceptions of ICT. Teachers' abilities to use technology and their own attitude toward its use have been very important in the way students perceive and use ICT tools. One of the students contributed,

"*Mudzidzisi wedu anoziva kushandisa ICT zvakanyanya, uye zvinotipa chido chekushandisa michina iyi" ("Our teacher is very skilled in using ICT, and thus it encourages us to use these tools").*

The statement shows how the learning environment can be best construed in favor of a student by the competence and enthusiasm of the teacher in using ICTs. In those instances where teachers were confident and skilled in using ICTs, they could integrate technology into lessons, providing the opportunity for students to learn in an engaging, interactive way. This attitude was also fiercely molded by the potential of teachers to model effective ways to use ICTs and to show its benefits in improving learning. By showcasing the affordances of ICT tools and integrating them seamlessly in their teaching, teachers will motivate students to use and explore these tools in innovation, which will enhance their learning experiences. Again, the attitude of the students toward the technology was greatly influenced by teachers who actively advocated the use of it and integrated it into their teaching. When the teacher teaches us using technology, we enjoy and want to learn more," one of the participants noted. It's through teachers who embraced ICT and showed its worth in enhancing learning that helped develop a positive perception of technology amongst students. Their enthusiasm combined with the effective use of ICT tools motivated the pupils to look towards exploring and using such resources for learning purposes. Accorded teachers are seen

combining ICT tools in their lessons in ways that provide meaningful and creative openings to students so as to foster curiosity and a love for learning.

However, the peers' influence often was not always positive. Some said teachers were not well trained in the use of ICT and, as such, could not integrate technology well in lessons. One of the students responded,

"*Mudzidzisi wedu haana ruzivo rwakakwana rwe ICT, zvinokonzeresa kuti tishaye kunzwisisa." This translates to mean, "Our teacher has a lack of sufficient knowledge of ICT, which causes us not to understand."*

Such lack of proficiency and confidence among teachers thwarted the effective use of ICT and had an impact on the negative perception by students. It therefore calls for extensive packaging of programs on professional development that is to help teachers acquire the relevant skills and knowledge in the use of ICT in their teaching. Continuous training and support in ICT would help the teacher acquire confidence and competence, which is important in smoothly integrating technology into lessons to achieve the maximum enhancements in learning. Furthermore, even the attitude of teachers towards ICT affected students' perceptions. Those who were initially resistant to using the technology or expressed a negative attitude towards its use tended to have an equivalent negative effect on the view ICT held for the students. As one student commented,

"*Kana mudzidzisi achiona ICT sekuti haibatsiri, isuwo tinotanga kuona saizvozvo" ("If the teacher sees ICT as not useful, we also start to see it that way").*

This therefore puts a stress on the development of a positive disposition towards ICT within teachers since sentiment and perception are things that are easily passed from teacher to students. The teachers' adoption of ICT and their support and provision with resources to enable them to do so would help in creating a more positive and conducive environment for the integration of technology in education.

4.6.2 Peer Influence

Peers also had a major role in relation to the influence of students' perceptions of ICT. It was perceived that students' attitudes toward technology, with collaborative learning and interaction through peers with the use of ICT tools, were positive. According to many students, collaboration

with peers on ICT-based projects and activities increased the understanding and enjoyment of the subject. One of the students contributed,

"*Kushanda pamwe chete tichishandisa tekinoroji kunotibatsira kudzidzisana uye kuvandudza hunyanzvi hwekushanda mumapoka." This means "Working together using technology helps us learn from each other and improve our group work skills."*

This approach did not just make them have an enriched understanding of the subject matter at hand but greatly helped in developing relevant skills like people, effective communication, and critical thinking. This is an important skill in today's times, and the use of ICT in education cultivates this set of skills in students. At intervals, the researcher did note positive peer influence when students see classmates having successful experiences using ICT tools and gain from them. One of the participants indicated,

"*Patinoona vamwe vedu vachibudirira nekushandisa tekinoroji, isuwo tinoda kuedza." This means, "When we see our peers succeeding with technology, we also want to try."*

It is this positive reinforcement from peers which has, in fact, influenced students to start working with these very ICT tools and consider possible ICT-related benefits. Their peers' success motivated them to start using technology in order to learn. By witnessing the success of fellow students' engagement in ICT, one builds up a more positive and motivating attitude towards the incorporation of technology into their own learning experiences. Nevertheless, peer pressure was not always a positive effect. Some students attested to scared or pressured feelings from seeing peers who were competent with ICT, which had an effect on the confidence or will to use the technologies. One of the students said,

"*Dzimwe nguva tinoita tisina kuita mushe pamberi pevamwe vedu vanoziva kushandisa tekinoroji zvakanyanya." This might contribute to a feeling of inadequacy, comparing themselves with others, and as a result hamper the involvement of these students in ICT.*

This means that the environment of learning created should make students at all levels of competence feel comfortable and confident using the technology made available to them. Encouragement of peer collaboration and assigning roles to have students learn from one another helps to offset the negative influence of ICT perception. It was not an in-class phenomenon. They

very often shared experiences about using ICT outside school. Students would share tips, resources, and insights with their friends.

"*Itinogara tichikurukura nezvekushandisa tekinoroji neshamwari dzedu, zvinotibatsira kudzidza zvakawanda," said one of the students.* This literally means*, "We often discuss using technology with our friends, which helps us learn more."*

It was this informal exchange of knowledge and experience that expanded the students' perception and appreciation of ICT. By exploiting the power of peer influence, educators will create an environment that is more collaborative and supportive of learning, heightening students' interest in ICT tools to explore and use for better learning. .

4.7 Discussions of Findings

The results obtained in this research are thus very much in line with research conducted at the local and regional level that has incorporated investigations on the integration of ICT into teaching and learning environments, specific to Biology classrooms. Much of the literature reports on issues associated with ICT access and infrastructure, similar to the sentiments expressed by the students in this research. For example, in Kenya, a study by (Makokha & Mutisya, 2016) found the same challenges, majorly being inadequate resources to effectively implement integration of ICT in curriculum. According to these researchers, inadequate funding, insufficient devices and poor internet connectivity were major adversities to the effective integration of ICTs—issues that ring a bell with our findings in this research. This may, therefore, imply that these issues relating to ICT infrastructure and resources are generalized and not particular to one location, thereby requiring serious comprehensive policy interventions targeting the systemic barriers. Although research in this region has reported general positive attitudes of teachers towards computers, the impact of teacher competency and attitude towards ICT, as identified in our findings, is supported by many studies in this region.

A study carried out in South Africa by Chigona et al. established that the effectiveness of integrating ICT in education is dependent on teachers' skills and ability to embrace technology in their teaching practice. It was established by Chigona and her colleagues that well-trained and positively attitudinal teachers in the use of ICT in teaching practices largely influenced students' perceptions and engagement with technology. In this case, our study is in coherence where students

mentioned the ability and interest of a teacher in ICT had a great impact on them. These similarities stress the important role put up by teacher training and educational development in fostering an in-service teacher with a positive ICT culture. This goes to show that investing in teacher education has absolutely precise gains from the adoption and usage of ICT in the classroom. This use of peer influence to shape students' views in ICT is another factor identified in our research and also recognized as such in the literature. According to (Hennessy, Harrison, & Wamakote,2010), collaborative learning and peer interaction were key factors that predicted students' acceptance and use of ICT.

The researchers discovered that students working collaboratively on ICT-based projects are more likely to form positive attitudes toward technology and develop digital skills. This is also echoed in our findings, whereby students testified that the ability to share ideas and work collaboratively using ICT tools aided in improving learning experiences and fostering a positive perception toward the usage of technology. This coincidence with the existing literature might supply evidence that indeed promoting collaborative learning environments can be an effective way to improve ICT integration and students' engagement with technology.

4.7.1 National Studies and Local Perspectives

At the local front, a number of studies provided insights that coincide with the findings of this research on the integration of ICT in education. For example, , a study done in Zimbabwe by (Gombe & Mavhunga,2020) showed vast disparities in ICT access and infrastructure between schools. It simply concurred with our finding that the schools that are poorly equipped and unwell-placed belong to less well-off areas; this was typical of back-areas schools that altogether had little access to devices and poor internet access. This local view underpins the issue of attending to inequalities in resources so all should share an equal opportunity to gain the benefits of using ICTs in education. In this respect, policymakers will be guided by focused support and disbursement of the resources in disadvantaged schools in efforts aimed at bridging the digital divide and thus creating a more inclusive learning environment. It has also been emphasized by local studies on the importance of teacher training in any effectively integrated information and communication technology. Mafundikwa, (2019), did a study on how teacher professional development influences the use of information and communication technology in schools in Zimbabwe. In that regard, Mafundikwa (2019) has established that teacher who received comprehensive training with

continuous support acquired confidence and proficiency in using information and communication technology tools hence influencing students' engagement and learning outcomes. This finding concurs with our research whereby students indicated that the competence and enthusiasm of their teachers towards ICT were key determinants of their attitude towards technology.

The findings are quite consistent with prior studies in the local context recommending continuous professional development programs aimed at equipping teachers with the required skills and knowledge to effectively integrate ICT into teaching practices. The influence of peers on ICT integration has been noted as another factor within local contexts. Research conducted by Nyemba et al. in secondary schools in Zimbabwe suggests that students are influenced to a great extent by peers' interactions and collaborative learning activities towards the acceptance and use of ICT. In this study, it has been noted that students working together on ICT-related tasks are likely to develop positive attitudes toward technologies and enhance their digital literacy skills. It supports our research where it had been reported that peer collaboration using tools of ICT enhances learning experiences and creates positive perceptions of technology for students. The key lesson that emerges from these local perspectives seems to be how the creation of opportunities for collaborative learning and peer interaction can be a very valuable means of promoting ICT integration and increase students' engagement with technology.

4.7.2 Broader Implications and Future Directions

These findings provide meaning when considered with the regional and local literatures on this very issue. They demonstrate how ICT integration in education is multivariate and point to a number of important future directions for research and policy. One of the critical implications is the appeal for comprehensive and fair resource allocation in relation to addressing ICT access and infrastructure discrepancies. This emerging theme on problems relating to insufficiency of resources, reiterated across several studies, perhaps should be taken up collectively by way of policy-level initiatives. Policymakers must assertively consider funding for ICT infrastructure in general and, more specifically, in the disadvantaged areas, so that all students get appropriate tools and resources to truly benefit from ICT use in education. Further, there is a need to research resource allocation measures for effectiveness and also to identify best practices that take into consideration bridging this gap.

As another major conclusion in this study, there is definitely a need for continuous focusing on the pivotal role of teacher training in ICT integration. Our findings are thus consistent with regional and local studies that place high importance on the need for professional development to be offered continuously for the enhancement of teachers' proficiency and confidence in using ICT. Future research should attend to the more effective models of teacher education and training focused on long-term support of ICTs integration within pedagogical practices. Policymakers need to be concerned about investing in comprehensive training programs that, at a minimum, afford initial training but also allow for ongoing support and development opportunities for teachers. The establishment of a strong foundation of ICT competence among educators can help foster a better environment within schools for the integration of technology in education. Moreover, the results of the research with respect to the impact of peer interaction on students' perception of ICT also lend support to the need to create collaborative learning environments where student peer groups can work together on activities.

Based on these findings of the study and literature, it can be stated that promoting peer collaboration and group activities using ICT tools can improve students' engagement and attitudes toward technology. Future studies should further investigate how peer influence propagates ICT integration and its conditions for maximum positive impact. Educators would have to leave more space in their curricula for collaborative learning activities capitalizing on the surge in peer interaction and thus contribute to surging the development of students' learning experiences and their digital skills.

4.8 Conclusion

The use of ICT in Biology classes presents challenges and opportunities that have to be tackled by a holistic, multifaceted approach. These findings are further supported by regional and local literature, underscoring issues of resource disparity, teacher training, and collaborative learning environments. Attention to these areas will allow educators and policy makers to provide a more inclusive and supportive educational environment that maximises the resources available in terms of ICT to improve both teaching and learning outcomes. Future research should proceed along these themes to continue elaborating with deeper insights and actionable recommendations on how to effectively integrate ICT in education. It is interesting to note that including ICT in Biology education has combined benefits, such as higher degrees of motivation and engagement, while it

also provides a more individual path of learning. However, at the same time, it has, in its way, certain limitations and challenges that, if catered for or removed, have the potential to make it very fruitful. The study speaks for itself that all the students and teachers receive the required resources, training, and support so that the integration of ICT is done effectively. By solving all the hurdles and promoting positive perceptions, ICT can enhance a more inclusive and supportive learning CV that optimizes the full potential of ICT to enhance teaching and learning.

CHAPTER 5: SUMMARY, RECOMMENDATIONS AND CONCLUSION

5.1 Introduction

This chapter presents the summary and draws recommendations and the conclusions. It first presents the summary of discussions presented in chapter 4 and further concoct more rigorous recommendations. It concludes the study by providing the research conclusions based on objectives of the study.

5.2 Summary

The thematic analysis Identifies a range of key themes and sub-themes, each discussed in detail with illustrative verbatim statements from participants, so that authentic views with regard to their experiences and views can be found. The first theme, “Perception of ICT,” has both positive and negative experiences. The positive experiences relate to how the ICT tools help students to understand complex concepts in biology through interactive simulations and visual aids, allow increased participation, and provide an avenue for immediate feedback, therefore reinforcing learning. It made learning enjoyable and dynamic, hence promoting a greater understanding and memory for the learned, according to the students. Furthermore, this created a more supportive and inclusive educational environment by providing personalized learning opportunities and tools for effective collaboration. Some of the negative experiences include technical problems, inadequate training, and some distractions from non-educational content. These challenges in hindering the proper working of ICT and standing in the way of enjoying learning reflect a need for better infrastructure, adequate training, and effective ways of managing classrooms, which are elements that would make it possible for students to be productive when working with technology.

Another of the large themes was “The use of ICT increases involvement and motivation in studying.” Students stated that ICT tools make learning more amusing and stimulating, thus increasing interest and motivation toward studying. The interaction through quizzes, educational games, and virtual labs available in the ICT tools was hands-on and attention-gripping. Multimodal elements like videos and animations helped catch and retain the interest of students towards complex concepts and increased their level of understanding and retention. With the help of immediate feedback from the ICT tools, students could observe their strengths and weaknesses on the spot and work to improve them, building confidence. It is further providing flexible access to digital resources to learn at their own pace, catering to different learning needs and learning styles, fostering independence and self-motivation. In addition, online forums for group discussion and group projects provided avenues for students to learn from one another, enriching their knowledge in Biology while attaining other basic competencies of teamwork and communication.

Despite its benefits, the use of ICT in Biology education is not devoid of challenges and barriers. Major challenges that involve students less in ICT-based learning activities are access to devices and infrastructure problems. Technical issues, from broken devices to unstable internet access,

derail the learning process frequently enough to cause frustration for both students and teachers. Moreover, training for both students and teachers is not highly sufficient, lowering the confidence to be able to engage with ICT tools fully. It also underscores the necessity of proper class management strategies and controls for the productive use of technology, avoiding possible distractions toward non-educational content. Along with improving infrastructure and providing comprehensive training, especially on effective classroom management practices, the challenging dimensions should be intertwined to meet these challenges. This way, by securing these barriers, potential of ICT can be unleashed in enhancing biology teaching for a more inclusive and supportive learning environment.

5.3 Recommendations

To enhance an integration of ICT in Biology education several recommendations can be made from the findings of the study. It is therefore suggested that the issue of not enough devices and infrastructure has got to top the list of priorities. There has to be enough funds available to these schools to ensure that they are well-resourced in used ICT tools and that all the pupils can access the tools. That means not just providing students with computers and tablets, but also that the appropriate infrastructure is put in place. For this to happen, an enabling framework that promotes successful integration of ICT into the learning process requires regular internet service, the necessary software, and the maintenance of systems. Supplying these basic requirements will enable schools to develop an environment in which ICT may be accessible to all students in an equitable and supportive manner.

Following the ancillary issues, adequate training facilities must be provided for both students and teachers to help in increasing skill levels and confidence in using ICT. Students could have the right to workshops and tutorials, for example, on how to use effectively various ICT tools and resources. Training activities for teachers should be implemented to ensure the needed familiarity with ICT in order to bring their practices into a fully effective manner. Continued support and training will ensure the potential of the ICT tools is harnessed and that both students and teachers remain current in the knowledge base of technological advancement. Through continued training and support, competent levels in ICT among the educators can be established, whereby the basis of this competency enhances the learning process itself. In addition, another step required is to develop effective classroom management so that the number of distractions is minimized and the

use of ICT remains productive. Guidelines and policies for using ICT in the classroom environment should be clear and must specify acceptable behaviors and the expectations. Teachers need the appropriate tools and resources to monitor and control students' use of ICT integration so that the technology essence supports learning and does not itself take away learning. A controlled and orderly ICT environment enables the educators to maximize technology's potential benefits for technologies that minimize the potential disturbing effects. Encouragement of a positive attitude toward the use of ICT-based learning in biology education in both students and teachers is important to apply the same effectively.

This is achievable from the ICT benefit and success story initiatives experienced in education using the same. Sharing experiences and best practices by teachers can be a great way to build up a community of practice and propagate a culture of continuity in improvement. It is in this that educators create an enabling environment through the celebration of successes and giving opportunities for joint participation and sharing of information to foster the right use of ICT for education.

Any investment in activities meant to integrate ICT for education should be seen in a multidisciplinary approach starting from the students, teachers, administrators, and even the policymakers. However, one of the critical issues identified by this study is that of poor access to devices and inadequate infrastructure. It is essential for there to be adequate funding and resources in schools whereby all the students in a learning institution will have adequate ICT tools that will help them. In this regard, the provisioning of the devices has to accompany adequate infrastructure to facilitate the same. The first of these challenges perceives that reliable Internet connectivity through the use of WIFI's, appropriate software, and other regular maintenance of the ICT infrastructure in a learning institution are critical to achieve success in the integration of Instruction Technology into the teaching and learning process of education. The second major challenge that has been identified is that of technical problems such as inoperative equipment and unreliable Internet connection. So, running supports of technical services should be in place in schools in case any emergencies happen. ICT hardware also requires regular maintenance and upgradation to work smoothly and without any breakdown. The disruptions and breakdowns can be minimized at school level by providing ICT resources with adequate technical support and resources so that the same remain utilizable at maximum capacity-something that enhances learning for everyone.

Another most important hindrance to effective integration of ICT is the inadequate training for students and teachers.

Holistic comprehensive training programs for learners and teachers should be designed in such a way that adequate capacity and confidence in the use of ICT are enhanced. For instance, this may be through workshops and tutorials on how to use various resources and ICT tools in an effective manner. Professional development on the side of teachers should be designed so that the teachers acquire the requisite skills and knowledge in integrating ICT into their teaching practices. It will ensure continuous support and development of training, thus keeping teachers and students maximally up to date with technologies and using them to their full potentials. Other than these, it is also necessary to have classroom management policies to help in the reduction of distraction in using ICT and so that the ICT is put in its effective use. This includes the rules and regulation policies that are supposed to guide the class for effective ICT use, your behavior, and what from you they will expect. Teachers should be equipped to facilitate effective monitoring and management of student ICT use so they ensure ICT supports, not distracts from, learning.

5.4 Conclusion

In giving positive perceptions of ICT- based learning to students, various ways need to be tried and considered depending on factors that influence student attitudes and experiences about ICT. One of the success factors that was realized in this research was on the part played by the teachers. Therefore, for inculcation of a positive perception, there was a need to equip the teachers with sufficient support to use ICT and foster a desired culture of technology infusion within their practices. This was made possible by professional development and collaboration with peers, where they could share best practices. Given the proper training and support, the teachers would become confident and competently handle ICT, and that would be reflected in the students. The other indicant major factor is peer influence. Peer interaction and heating up the environment for collaborative learning through ICT tools can boost in increasing student perception and attitude toward technology. Others can be through providing an environment where students can collaborate in working on ICT-based projects and activities that would generate a supportive and inclusive learning situation. The power of peer influence should be harnessed to make the uptake of the technology a positive and accepting situation. The successes should be celebrated, and the benefits of ICT in education need to be lauded. This way, positive experiences and great examples

of the integration of ICT can be harnessed toward painting a positive script regarding the use of technology in the classroom. This could, in a way, best be carried out at school level through an ICT fair, exhibition, and presentation for the sharing of various experiences and achievements by students and teachers. This can be ideal for having the benefits and successes of ICT advertised in order to create a more affirmative and supportive environment engendered by educators.

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APPENDICES

APPENDIX A: RESEARCH INSTRUMENTS

Research Instruments

In-Depth Interviews

Interview Guide:

Introduction

Brief the participant on the study's purpose and ensure informed consent.

Core Questions

Can you describe your experience with using ICT in your Biology classes?

Use

How do you feel about the use of ICT tools in learning Biology?

What benefits do you think ICT brings to your biology learning experience?

What challenges have you faced while using ICT in Biology?

How do you believe your perception of ICT in Biology has been formed?

What changes would you suggest to improve the use of ICT in your Biology classes?

Probing Questions

Can you provide an example of a positive/negative experience with ICT in Biology?

How do your peers influence your perception of ICT in Biology?

Recording Setup:

Ensure a quiet, private environment for the interview.

Use audio recording devices with participants' consent.

Take detailed field notes during the interview.

Focus Group Discussions

Discussion Guide Introduction

Explain the purpose of the discussion and obtain consent from all participants.

Discussion Topics

General perceptions of ICT in Biology classes.

Comparative experiences of traditional vs. ICT-based learning in Biology.

Group brainstorming on the advantages and drawbacks of integrating ICT in Biology education.

Collective suggestions for improving ICT integration in Biology lessons.

Facilitation Questions

How do you all feel about the use of ICT tools in your biology classes?

What are some common challenges you face with ICT in your learning?

Can you discuss any differences in your engagement or understanding when using ICT versus traditional methods?

Logistics

Organize groups of 6-8 students.

Ensure sessions last between 60-90 minutes.

Record sessions with consent and transcribe for detailed analysis.

APPENDIX B: LETTER FROM THE UNIVERSITY


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