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EXPLORING THE CONTRIBUTION OF ICT TO THE DEVELOPMET AND DELIVERY OF EDUCATION 5.0 IN PHYSICS TEACHING: A CASE STUDY OF KRISTE MAMBO HIGH SCHOOL.

By

RUDO PATIENCE CHIMOMBO

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A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DIPLOMA IN SCIENCE EDUCATION.

Approval Form

The undersigned certify that they have supervised the student in the research dissertation entitled, "Exploring the Contribution of ICT to the Development and Delivery of Education 5.0 In Physics Teaching: A Case Study Of Kriste Mambo High School." submitted in partial fulfillment of the requirements for a Diploma in Science Education at Bindura University of Science Education.

STUDENT: …………………….. **DATE: 07/07/25**

SUPERVISOR: ……………….. **DATE: 07/07/25**

CHAIRPERSON:……………………. **DATE: 24/10/25**

Dedication

I wholeheartedly dedicate this dissertation to my sister and my parents, Mr. and Mrs. Chimombo, whose unwavering belief in my abilities and constant support have given me strength throughout this academic journey. Their encouragement and commitment played a vital role in the successful completion of this work. This dedication is also extended to all aspiring Biology students—may you remain determined, overcome challenges, and strive to achieve your fullest potential.

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Abstract

This study explores the contribution of Information and Communication Technology (ICT) to the development and delivery of Physics teaching at Kriste Mambo High School, focusing on its role in preparing students for Zimbabwe's Education 5.0 framework. Education 5.0 emphasizes teaching, research, community service, innovation, and industrialization, necessitating foundational skills and technological literacy from secondary education. The research, conducted as a mixed-methods case study, assessed current ICT integration, identified challenges, and explored opportunities. Findings indicate a foundational but limited use of ICT, primarily for visualization and basic digital literacy, with minimal adoption of subject-specific software. Key barriers include inadequate infrastructure (computers, internet, power), lack of relevant software, and insufficient teacher training in pedagogical ICT integration. Despite these challenges, ICT presents significant opportunities to enhance learning and overcome resource constraints. The study recommends targeted investment in ICT infrastructure, procurement of Physics-specific software, consistent power supply, and specialized professional development for teachers to effectively leverage ICT for Education 5.0 preparedness, ensuring equitable access for all students within the heritage-based curriculum.

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List of Abbreviations

Abbreviation	Definition
ICT	Information and Communication Technology
HBC	Heritage-Based Curriculum
MoPSE	Ministry of Primary and Secondary Education
4IR	Fourth Industrial Revolution
STEM	Science, Technology, Engineering, and Mathematics
LMS	Learning Management System
AI	Artificial Intelligence
ML	Machine Learning
MoHTESTD	Ministry of Higher and Tertiary Education, Science and Technology Development
ZIMSEC	Zimbabwe School Examinations Council

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CHAPTER 1: PROBLEM SETTING

1.0 Introduction

Education 5.0 represents Zimbabwe's forward-looking educational framework, designed to integrate technological advancement and socio-economic transformation, primarily geared towards preparing learners for the demands of the Fourth Industrial Revolution (4IR) and beyond. While its full five-pillar model of teaching, research, community service, innovation, and industrialization is most visible at the tertiary level, the success of Education 5.0 fundamentally relies on cultivating the necessary skills, competencies, and technological literacy from the foundational stages of primary and secondary education. Physics, a key STEM subject, plays a crucial role in equipping students with analytical thinking, problem-solving abilities, and an understanding of the physical world – skills vital for thriving in technology-driven tertiary programs and ultimately contributing to innovation and industrialization.

This research specifically explores the contribution of Information and Communication Technology (ICT) to the development and delivery of Physics teaching at the secondary school level, using Kriste Mambo High School as a case study. Its purpose is to examine how the strategic integration of ICT in Physics education at this crucial stage can effectively prepare students for the rigours and expectations of Education 5.0 at university. The study provides an overview of the current state of e-learning in Physics teaching at Kriste Mambo High School, identifies existing e-learning activities, explores the barriers to optimal ICT integration for this preparatory goal, and examines how this aligns with the heritage-based curriculum. This introductory chapter outlines the rationale for the research, its background, statement of the problem, research objectives, delimitations, limitations, significance, and research assumptions.

1.1 Background of the Study

Education is universally acknowledged as a pivotal engine for social and economic development, particularly in the dynamic landscape of the 21st century which necessitates a new set of skills and competencies. Zimbabwe's response to this need is Education 5.0, an educational system framework envisioned by the Ministry of Higher and Tertiary Education, Innovation, Science and Technology Development. According to Mopse (2015) and Muzira & Bondai (2020), Education 5.0 seeks to transform society through education focused on promoting research, innovation, and industrialization within a heritage-based framework. While this framework is strongly articulated for higher education, its principles of fostering critical thinking, problem-solving, innovation, and technology integration are intended to cascade down through the educational pipeline to effectively prepare students from an early age.

Effective primary and secondary education, therefore, serves as the indispensable groundwork upon which the pillars of tertiary Education 5.0 are built. Students require strong foundational knowledge in key subjects, coupled with digital literacy and an innovation-oriented mindset, developed before they reach university. The intensive use of ICT tools in teaching and learning across all levels has been recommended since the Nziramasanga Commission in 1999, aiming to modernize the education system.

The advent of Information and Computer Technology has significantly eased previously complex tasks. The education sector, undergoing a paradigm shift further accelerated by the global impact of events like the COVID-19 pandemic which popularized distance learning, now widely embraces technology. Traditionally, learning involved face-to-face interaction, but ICT tools like interactive boards and online resources now facilitate clearer conceptual understanding in complex subjects like Physics through visualizations and simulations, reducing the need for solely teacher-led, potentially less intuitive methods. Virtual learning platforms such as Google Classroom have enabled learning outside traditional settings, while virtual and augmented reality offer immersive experiences akin to those needed for practical skills development in tertiary fields (medical practice).

Physics is a fundamental subject that prepares students for various science, technology, engineering, and mathematics (STEM) pathways critical to Education 5.0's industrialization goals. Choosing the right A-Level subject combination, often centered around Physics for many technical disciplines, is a critical step for students aspiring to enter university programs aligned with Education 5.0. The foundational knowledge, experimental skills, and analytical abilities gained in secondary Physics are paramount. Integrating ICT into this process not only enhances understanding but also cultivates the digital skills and problem-solving approaches essential for tertiary study and the demands of the 4IR workforce. It is within this context that this research explores how technological advancements are being, or can be, utilised in Physics teaching at Kriste Mambo High School to better prepare its students for their eventual engagement with tertiary Education 5.0. The school has already begun adopting some technological approaches, providing a relevant site for this investigation into the preparatory role of ICT in secondary Physics.

1.2 Statement of the Problem

Effectively preparing students at the secondary level with the foundational knowledge, technological literacy, and 21st-century skills required to succeed in tertiary Education 5.0 programs and contribute to the national goals of research, innovation, and industrialization is crucial. Physics education, as a gateway to many STEM fields central to these goals, must leverage modern tools and pedagogies, including ICT, within the context of the heritage-based curriculum.

However, at Kriste Mambo High School, a secondary institution expected to equip students for higher education, challenges exist in fully integrating ICT into Physics teaching in a manner that maximally contributes to this preparatory function for Education 5.0. These challenges include inadequate ICT resources, potential gaps in teachers' technological pedagogical knowledge, and underutilization of virtual laboratories or simulations. Furthermore, practical subject scheduling issues like clashes limiting lab access highlight the need for ICT-based alternatives. Physics is inherently complex and requires extensive conceptual understanding and practical exposure. The existing situation may hinder the school's capacity to effectively equip students with the deep understanding, practical skills, and technological proficiency necessary to transition smoothly into and excel within the demands of tertiary Education 5.0 and select appropriate university pathways requiring strong Physics backgrounds.

This study aims to explore and articulate the contribution of ICT to preparing secondary school students through the development and delivery of Physics teaching at Kriste Mambo High School, specifically in the context of cultivating skills aligned with the demands and philosophy of tertiary Education 5.0.

1.3 Objectives of the Study

The study aims to achieve the following objectives:

- To assess the effectiveness of current ICT integration in Physics teaching and learning at Kriste Mambo High School in cultivating foundational skills for Education 5.0.
- To identify the challenges encountered and opportunities presented by using ICT in secondary Physics education at Kriste Mambo High School specifically regarding the preparation of students for tertiary Education 5.0.
- To explore how Physics subject choices and learning approaches at Kriste Mambo, supported by ICT, contribute to pathways relevant to tertiary Education 5.0 pillars.
- To propose strategies for improving the effective use of ICT in Physics teaching and learning at Kriste Mambo High School to enhance students' preparedness for tertiary Education 5.0, in line with the principles of the heritage-based curriculum.

1.4 Research Questions

Based on the above objectives, this study seeks to answer the following questions:

- How does the use of ICT in Physics teaching and learning at Kriste Mambo High School contribute to equipping students with foundational skills required for tertiary Education 5.0?
- What are the main challenges and opportunities in implementing effective ICT use in Physics at Kriste Mambo High School, particularly concerning its role in preparing students for future Education 5.0 engagement?
- How do current practices, including subject emphasis and ICT use in Physics, support students in developing preparedness for relevant tertiary pathways aligned with Education 5.0 goals?
- What strategies can be recommended to improve the use of ICT in Physics teaching and

learning at Kriste Mambo High School to better prepare students for tertiary Education 5.0 and ensure equitable access to this preparation?

1.5 Assumptions

- Everyone involved in the study has equal access to ICT equipment
- All questionnaires are to be completed accurately
- All secondary school learners are studying using ICT
- There is a strong and unlimited internet connectivity

1.6 Significance of the Study

The findings of this research are significant for various stakeholders involved in the education of secondary school students in Zimbabwe, particularly concerning their transition to higher education within the Education 5.0 framework.

For Kriste Mambo High School and other similar secondary schools, the study will provide concrete insights into the effectiveness of their current ICT use in Physics teaching for developing critical 21st-century skills aligned with Education 5.0. It will highlight specific challenges that need to be addressed and identify opportunities for leveraging ICT more effectively within the heritage-based curriculum to better prepare students for the research, innovation, and industrialization pillars of tertiary education. The findings can inform curriculum implementation, teacher training priorities, and resource allocation decisions.

In addition, Physics teachers and other STEM subjects teachers at the secondary level, this study will offer an in-depth exploration of various ICT tools and approaches suitable for their context. By exploring best practices (as drawn from the literature review and potentially emerging from the case study), it will assist teachers in choosing and using ICT tools effectively not just to teach content, but to cultivate the analytical, problem-solving, and technological skills foundational for Education 5.0 success.

Furthermore, learners at Kriste Mambo High School, the study will contribute indirectly by informing pedagogical improvements that can enhance their learning experience in Physics. It can serve as an eye-opener, helping them understand how their current learning, especially with ICT and within the heritage context, directly prepares them for the academic and practical demands of tertiary Education 5.0 programs and relevant career pathways. It will underscore the value of mastering subjects like Physics and utilizing everyday ICT gadgets for academic advancement.

Finally, policy makers and curriculum developers at the Ministry level, the research offers ground-level feedback on how the principles of Education 5.0 and the heritage-based curriculum are being implemented through technology integration in secondary STEM education. It can highlight implementation gaps and inform strategies for better supporting secondary schools in their crucial role of preparing students for the demands of tertiary Education 5.0 and contributing to the national development agenda.

1.7 Limitation of the Study

This research involves data collection within an educational setting, which may require access to various resources and entail activities that pose logistical challenges to the researcher. The single-school case study approach provides depth but inherently limits the generalizability of findings to all secondary schools in Zimbabwe. The researcher faces time constraints due to other paramount commitments, potentially diminishing the total time that can be dedicated solely to this study's execution and analysis.

While due care and diligence will be taken to employ robust data collection techniques to minimize bias, there remains a possibility of subjective interpretation or incomplete information gathered from participants. The focus on a single school site means the applicability of the specific findings and derived recommendations to the broader context of secondary science education in Zimbabwe is limited and must be treated with caution. It may lack sufficient coverage to be a universal yardstick for measuring the contribution of ICT to Education 5.0 preparation in sciences nationwide. Consequently, the broader statistical pertinence of this research is limited.

1.8 Delimitation of the Study

The study is primarily focused on the teaching and learning of Physics and specifically excludes other secondary school subjects, except where cross-curricular or general ICT skills acquisition is relevant to the core theme. Geographically, the study is limited to a single institution, Kriste Mambo High School, located in Nyanga District, Manicaland. The target population for empirical data collection is delimited to three classes of secondary school pupils aged approximately 14-18 years and their respective Physics teachers at Kriste Mambo High School.

1.9 Definition of terms

Education 5.0 – is a Zimbabwe's advanced educational framework framework, introduced by the Ministry of Higher and Tertiary Education, Innovation, Science and Technology Development, that merges technology with socioeconomic transformation to prepare learners for the Fourth Industrial Revolution. It outlines five key pillars: teaching and learning, research, community service, innovation, and industrialization. While fully realized at the tertiary level, its principles and demands necessitate the development of corresponding skills and foundational knowledge throughout the primary and secondary school system, guided by the heritage-based curriculum, to equip students for their future engagement with the 5.0 framework and national development. (Muzira & Bondai, 2020; Murwira, 2018).

Information Communication Technology (Ict) – It is the diverse set of technological tools and resources used to transmit, store, create, share, or exchange information. These include, but are not limited to, computers, the Internet (websites, blogs, emails). In the context of this study, it refers to the specific ICT resources available and utilized in Physics teaching and learning at Kriste Mambo High School.

e-Learning – Also referred to as online learning or electronic learning, it is the acquisition of knowledge that takes place through electronic technologies and media. It typically involves conducting learning activities via the internet or digital platforms, allowing learners to access materials and interact at potentially any place and time. It represents a key mode of delivery facilitated by ICT, relevant to both the preparatory stages in secondary school and the full implementation of Education 5.0 at tertiary level. (Simplified).

Heritage Based Curriculum (HBC) – Is Zimbabwe's educational framework principle aiming to integrate indigenous knowledge systems, cultural values, and historical experiences into formal education. Its underlying principle is to create an education, science, and technology system that generates goods and services based on this heritage. In the context of Education 5.0, the heritage-based approach seeks to contextualize research, innovation, and industrialization within Zimbabwean identity and needs, requiring preparatory learning environments that foster skills using relevant local contexts, which ICT can help facilitate.

Machine Learning – Machine learning is a subfield of artificial intelligence (AI) that enables machines to learn from data, make decisions, and improve their performance on a specific task over time. While primarily a high-level concept for tertiary and industrial application within Education 5.0, understanding basic computational thinking principles related to how data can be used (facilitated by subjects like Physics) contributes to the foundational knowledge for students pursuing ML/AI-related fields in university. (Based on Chrisoph Molnar, 2023).

1.10 Summary

This chapter has introduced the research study, contextualizing it within Zimbabwe's national Education 5.0 framework and highlighting the critical role of secondary education, specifically Physics teaching via ICT, in preparing students for this future-oriented paradigm. It has presented the background explaining the rationale, clearly stated the problem addressing challenges at Kriste Mambo High School that impede effective preparation, and outlined the specific objectives and research questions guiding the investigation. The assumptions and delimitations define the scope, while the limitations acknowledge potential constraints. Finally, the significance of the study underscores its potential impact on stakeholders in enhancing secondary education's contribution to the broader goals of Education 5.0. The definitions provided clarify key terms used throughout the study. The following chapter will delve deeper into the existing literature related to Education 5.0, ICT integration in Physics, and the links between secondary preparation and tertiary expectations.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Zimbabwe's implementation of Education 5.0 signals a transformative shift in the teaching and learning landscape, strategically positioning Information and Communication Technology (ICT) as a pivotal enabler. While the complete realization of Education 5.0's five pillars – teaching, research, community service, innovation, and industrialization – is most evident at the tertiary level, the framework inherently demands that primary and secondary education effectively cultivate the foundational skills and competencies required for students to seamlessly transition into and excel within this system. Physics, recognized as a foundational science, requires robust teaching methods for students to grasp complex concepts, developing the analytical and problem-solving skills essential for 21st-century challenges.

This literature review explores the theoretical and empirical contributions of ICT to this vital preparatory role within secondary Physics education, examining its benefits and challenges at this level. It specifically positions ICT integration in secondary Physics as a means to enhance learners' understanding, engagement, and critical thinking, thereby improving learning outcomes in ways that directly contribute to equipping students with the readiness needed for tertiary Education 5.0 programs. Furthermore, the review examines existing research on how effective ICT integration aligns with national curriculum principles, such as the heritage-based curriculum, and addresses the importance of fostering early preparedness for specialized subject pathways crucial for tertiary studies under Education 5.0.

2.2 E-learning in Physics education

E-learning refers to a learning system based on formalized teaching with the assistance of electronic resources. It involves the use of computers and the internet as the primary components of the learning process. E-learning can be conducted in or out of traditional classrooms, and it enables the delivery of education to a large number of recipients at the same or different times. It encompasses various forms of online education, training, and knowledge sharing, and it can be utilized in academic education, corporate training, continuing professional development, and skill development courses. E-learning has evolved to enable more multi directional communication using increasingly interactive tools, allowing learners' greater freedom in choosing how they receive and respond to e-learning content. It has become an important method for delivering instruction, especially with the digital transformations brought about by the COVID-19 pandemic, which made distance learning possible (Lutkevich & Hashemi-Pour, 2024). This evolution has also underscored e-learning's potential in building student self-direction, digital literacy, and the ability to access and process information independently – skills that are highly valued within the Education 5.0 framework's emphasis on research and lifelong learning (Lutkevich & Hashemi-Pour, 2024).

2.3 Education 5.0

Education 5.0, as introduced by the Ministry of Higher and Tertiary Education, Innovation, Science and Technology Development in Zimbabwe, is fundamentally a heritage-based philosophy aiming to create an educational system that is responsive to national needs by generating knowledge that translates into tangible goods and services (Professor A. Murwira, 2018). It is often characterized by five intertwined pillars: teaching and learning, community service, research, innovation, and industrialization (Dzingirai, Murombedzi & Ndoro, 2024).

While the full operationalization and impact of these pillars are most evident in tertiary institutions, the principles of Education 5.0 permeate the entire educational structure. It is conceptualized as a national imperative that requires the development of a skilled workforce capable of thriving in the Fourth Industrial Revolution. Therefore, Education 5.0 implicitly demands that primary and secondary levels must provide a strong foundation by cultivating key competencies such as creativity, critical thinking, problem-solving, collaboration, and technological fluency (Mopse, 2018; Ahmad, Umirzakova, Mujtaba, Amin, & Whangbo, 2023). These are skills explicitly needed for success in the research, innovation, and industrialization pillars of tertiary 5.0 programs. Integrating digital tools like ICT from an early stage, within the context of a heritage-based curriculum that grounds learning in local knowledge and values, is seen as crucial for this preparatory process. Effective secondary education, particularly in STEM subjects like Physics enhanced by technology, is therefore a prerequisite for producing students well-equipped to engage with the immersive, problem-solving focused environment envisioned at the tertiary 5.0 level.

2.4 ICT and its use in Physics Learning

2.4.1 Use of computers in the teaching of physics

Computers in education are used to provide Audio-Visual learning, research, online learning, maintain records, make documents, and learn new evolving technologies. Computers are used to provide audio-visual learning to learners in various ways. Computers can access online educational videos, tutorials, and lectures that provide audio-visual content for learners. They can also run interactive multimedia software that combines text, images, audio, and video to create engaging and immersive learning experiences. With the introduction of virtual and augmented reality learning can now do virtual field trips and perform virtual surgeries for those in the medical field. Computers can take learners on virtual field trips, exploring places and environments that may be difficult to visit in person. Application software like Microsoft PowerPoint can be used to create and display audio-visual presentations, such as slideshows and videos, to support teaching and learning.

2.4.2 Impact of ICT on the learner's performance

ICT is of paramount importance as far as learner’s performance is concerned. In this day and era the advent of ICT tools has led to new developments in education. The impact of Information and Communication Technology (ICT) on learner performance is significant and multifaceted. Some of the impacts are as follows. ICT makes learning more interactive, enjoyable, and engaging, leading to increased learner motivation and participation. This improves the learning process as the use of ICT has been shown to positively impact learner performance, leading to improved academic achievement, retention, and overall success.

ICT provides learners with vast digital resources, including e-books, articles, and online tutorials, broadening their knowledge base. The vast digital resources simply translate to more people tackling identical topics thus leading to a better understanding of complex topics. The vastness of resources ICT provides helps learners get millions of different explanations on any concept of their choice, and visualize complex concepts making them easier to comprehend and retain.

ICT also enables tailored learning experiences, catering to individual learners’ needs, pace, and learning styles. It makes learning more efficient as it provides increased accessibility to people from all walks of life. It provides equal access to learning for learners living with disabilities. This increases efficiency as lessons can be streamlined for different individuals hence, saving time and effort, and enabling learners to focus on higher-level thinking skills. By harnessing the power of ICT, educators can create dynamic, inclusive, and effective learning environments that support diverse learner needs and promote exceptional performance. By harnessing the power of ICT, educators can create dynamic, inclusive, and effective learning environments that support diverse learner needs and promote exceptional performance, thereby enhancing students' preparedness for the demanding environment of tertiary Education 5.0 and the 4IR.

2.4.3 Contribution of ICT in the teaching of Physics

ICT has revolutionized the way students visualize and understand physics concepts, enabling them to explore and interact with spatial data in a more immersive and engaging manner. Real time experimentation, visual representation of complex concept and virtual labs have become an essential tools in physics education, allowing students to vast scientific data, ensuring deeper understanding of scientific phenomena and encourages motivation and critical thinking skills among students at Kriste Mambo High School (Graham & Hunter, 2020). For instance, Phet simulations allow students to visualize and inter prate wave properties, they can observe how waves interact, constructive and destructive of a disturbance. They can also manipulate parameters such as wavelength, amplitude period among others, providing a hands on experience that enhances their understanding, spatial thinking and problem-solving skills (Kerski, 2018).

These activities cultivate problem-solving skills and analytical thinking, providing a fundamental base required for the research and innovation pillars of Education 5.0. Furthermore, by preparing students with robust knowledge in subjects like Physics through these advanced methods, ICT indirectly supports students in selecting appropriate A-Level subject combinations that pave the way for relevant university degrees aligned with the demands of the 5.0 framework. ICT has enabled the creation of interactive and immersive learning experiences (Baker & White, 2018) and (Mwakalinga, 2020). This increased engagement and motivation in secondary Physics fosters a deeper interest and competency crucial for pursuing science and technology fields at the tertiary level within the Education 5.0 paradigm.

ICT has provided unprecedented access to real-time data and resources (Mwakalinga, 2020). This skill in accessing and analyzing relevant information is a cornerstone of the research and innovation pillars central to tertiary Education 5.0. ICT has facilitated collaboration and communication (Singh & Thurman, 2020). Developing these collaborative skills is essential for the community engagement and research aspects emphasized in Education 5.0. ICT has enabled the development of digital literacy and essential skills (Graham & Hunter, 2020). These skills, cultivated through hands-on use of ICT in subjects like Physics, directly prepare students for the technological demands of tertiary Education 5.0 and the modern workforce, particularly in fields linked to innovation and industrialization. ICT has enabled teachers to tailor instruction suited to each student's progress and learning style (Dziuban, Moskal, & Williams, 2018). This personalized approach in secondary education helps students build confidence and mastery, better preparing them for the self-directed learning often expected in tertiary 5.0 environments.

ICT has revolutionized assessment and feedback as it provides a more comprehensive understanding of student learning (Gibson & Webb, 2018). Developing students' ability to use digital feedback tools prepares them for the technologically mediated assessment methods used in tertiary Education 5.0. ICT has enabled students to conduct virtual fieldwork preparing students for real-world applications and careers in sciences and related fields (Kerski, 2018). These simulated practical experiences at secondary level lay the groundwork for the innovation and industrialization-oriented projects within tertiary Education 5.0. ICT has enabled teachers to incorporate real-world examples developing a deeper understanding of issues and scientific phenomena, as well as essential skills like critical thinking, problem-solving, and decision-making (Graham & Hunter, 2020).

Learning to apply Physics concepts to real-world contexts using ICT connects secondary education directly to the problem-solving and innovation goals of Education 5.0. ICT has enabled teachers to create inclusive and accessible learning environments (Singh & Thurman, 2020). Ensuring equitable access to quality Physics education through ICT at the secondary level is vital for preparing a diverse pool of students who can contribute to the national development goals embedded in Education 5.0. This also aligns with the heritage-based principle of providing relevant education to all students.

2.4.4 Pros of ICT in the implementation of education 5.0

While the full manifestation of Education 5.0's pillars is primarily associated with tertiary institutions, secondary schools contribute significantly by laying the groundwork and developing the necessary skills for students to effectively engage with these pillars later. ICT plays a critical role in facilitating this preparatory phase. Firstly ICT has revolutionized the teaching and learning pillar of Education 5.0 principles even at the secondary level by enhancing instruction delivery. ICT fosters engagement, provides resources, personalization and quick feedback. These enhancements at the secondary level build foundational learning habits and technological fluency necessary for tertiary study under Education 5.0.

For the research pillar, ICT transforms access to information for secondary students, enabling them to conduct preliminary research and analysis, facilitating critical thinking and problem-solving and fostering early collaboration. While not tertiary-level research, these experiences are essential precursors to the in-depth research expected in Education 5.0. Regarding the community engagement pillar, ICT enables connections for secondary students and schools, facilitating participation in community-based projects and global collaboration. This promotes early awareness of social responsibility and sustainability, aligning with 5.0 goals.

The innovation pillar is supported by ICT even in secondary settings by providing platforms for creativity and problem-solving, enabling students to access online resources and collaborate with peers. These activities encourage an innovative mindset from an early age, crucial for tertiary innovation hubs within Education 5.0. Furthermore, Physics, a key subject, provides the scientific foundation for many technical innovations envisioned by the industrialization pillar.

Finally, the industrialization pillar is implicitly addressed through ICT use in secondary Physics. By providing opportunities for students to engage with data analysis, simulations, and real-world applications, ICT helps build the essential skills needed for technical fields. While full industrialization initiatives are tertiary/professional, developing foundational competencies and digital literacy through ICT at secondary level is crucial for preparing the future workforce for these demands. Physics education, particularly with ICT-enhanced practical and problem-solving elements, is key in this regard, helping students identify interests and select relevant subject combinations for university programs aligned with industrial needs.

2.5 Perceptions of learners and teachers at Kriste Mambo High School towards ICT and Education 5.0?

The perceptions and attitudes of learners and teachers at Kriste Mambo High School towards ICT, within the broader context of understanding the skills needed for Education 5.0, are significant. These perceptions can either facilitate or hinder the successful integration of technology for the purpose of preparing students for tertiary 5.0. Learners at Kriste Mambo High School perceive ICT as a valuable tool for enhancing their learning experience in a way that feels modern and relevant. They appreciate the interactive and engaging nature of digital resources, which they likely instinctively understand as part of a changing educational landscape, making learning of Physics more enjoyable and effective and developing digital familiarity essential for Education 5.0. This flexibility and autonomy prepares them for the self-directed learning and resource management expected in tertiary 5.0.

Teachers at Kriste Mambo High School also recognize the potential of ICT in enhancing the teaching and learning of sciences towards building modern skills. They appreciate the ability to create interactive and multimedia-rich lesson plans, which helps engage learners and promote active learning(Mishra & Koehler, 2006). Moreover, teachers value the ease of accessing and sharing resources, which saves time and enhances collaboration among colleagues (Dexter, 2008). They also acknowledge the potential of ICT in facilitating formative and summative assessments, which helps to monitor learner progress and identify areas for improvement (Sambell, 2012). Their acknowledgment of ICT's role aligns with the pedagogical shifts required to prepare students for the Education 5.0 environment.

However, some learners at Kriste Mambo High School may have negative attitudes towards ICT, or struggle with it, which directly impacts their preparedness for the demands of Education 5.0. For instance, feeling overwhelmed or struggling with digital literacy(Hart, 2011). Some learners may also be distracted by the abundance of digital resources and social media, leading to decreased focus and productivity (Kolek & Saunders, 2008). Furthermore, learners may be concerned about the potential for ICT to replace traditional teaching methods and the personal interaction with teachers (Rosen, 2012). These issues are significant barriers to effectively leveraging ICT for 5.0 preparation at the secondary level.

Similarly, some teachers at Kriste Mambo High School may have reservations about using ICT, which affects the quality of preparation students receive. Concerns about time, technical expertise (Ertmer, 2005). Teachers may also be concerned about the potential for ICT to create a digital divide among learners, exacerbating existing inequalities in the classroom (Warschauer, 2006). These teacher-related challenges impede the consistent and effective integration of ICT needed to build strong foundational skills for Education 5.0. Worries about over-reliance leading to a lack of critical thinking nd problem-solving skills among learners (Bok, 2013) also point to important pedagogical considerations when using ICT for preparation.

2.6 Limitations of ICT in the implementation of education 5.0

While ICT holds vast potential in facilitating preparation for Education 5.0, particularly in secondary subjects like Physics, limitations in its implementation pose significant challenges to this goal. These include inadequate infrastructure within schools like Kriste Mambo, insufficient teacher training on pedagogically effective ICT use for preparing students, and unequal access to technology among learners, exacerbating the digital divide which hinders uniform preparation for Education 5.0. Additionally, potential overreliance on certain forms of ICT can diminish face-to-face interaction and attention span, impacting skill development also needed for holistic 5.0 engagement. The quality of digital resources varies, and teachers may struggle to integrate ICT effectively into their pedagogy in ways that specifically build the skills prioritized by Education 5.0.

Furthermore, in leveraging ICT for preliminary research and learning activities at the secondary level as part of 5.0 preparation, challenges arise including information overload, data privacy concerns, and the critical need for advanced digital literacy skills to evaluate online resources accurately. The internet can perpetuate misinformation, and both students and teachers must be critical consumers, a crucial skill for the research pillar of 5.0. Moreover, easier access to information via ICT can unintentionally facilitate academic dishonesty and plagiarism, issues that must be addressed rigorously from secondary school onwards through clear policies and guidelines for responsible ICT use, ensuring the ethical standards required for tertiary research and innovation are established early.

ICT-enabled preliminary community engagement initiatives at the secondary level, while valuable preparation, can be limited by unequal access, language/cultural barriers, and the nuance lost in online interaction. This highlights that while ICT aids in connecting students to broader issues (relevant for 5.0 community engagement), it does not replace all traditional learning components crucial for well-rounded preparation.

While encouraging innovation-mindedness through ICT at the secondary level is important for future 5.0 innovators, limitations include the need for specialized guidance, intellectual property awareness (even in simplified forms), and the risk of reinforcing existing inequalities in access to innovation tools. The focus on technological solutions must also not overshadow other forms of creativity and problem-solving essential for a holistic Education 5.0 approach.

Finally, laying the groundwork for industrialization understanding via ICT in secondary Physics can face limits due to infrastructure and the conceptual complexity. While ICT allows exploring models or data, direct exposure is limited. It is also crucial that the narrative around industrialization, even in early education, incorporates discussions around potential job displacement and the need for re-skilling (relevant to future studies and careers), prioritizing social responsibility and sustainability as highlighted by the heritage-based context of Education 5.0.

2.7 Conclusion

The literature review has demonstrated the substantial potential of integrating ICT into secondary Physics education as a vital mechanism for preparing students for the demands and philosophy of tertiary Education 5.0. Effective ICT use in subjects like Physics can significantly enhance student engagement, foster the development of essential 21st-century skills (such as critical thinking, problem-solving, digital literacy, and collaboration), and promote the inquiry-based learning crucial for the research, innovation, and industrialization pillars of 5.0. Furthermore, ICT can support the understanding of how subjects like Physics provide fundamental knowledge necessary for selecting relevant tertiary pathways within the 5.0 framework. However, significant challenges persist at the secondary level, including inadequate ICT infrastructure, the need for enhanced teacher training on pedagogically effective integration for preparatory purposes, and ensuring equitable access to technology to avoid digital divides that impede uniform readiness for tertiary Education 5.0. The effective cultivation of skills aligned with the heritage-based curriculum through technology integration is also crucial. To fully harness the benefits of ICT in preparing students for Education 5.0, secondary schools like Kriste Mambo High School must prioritize strategic investment in infrastructure, implement targeted professional development for teachers focusing on ICT's preparatory role, and proactively address issues of digital access and effective, ethical technology use among students. By doing so, secondary institutions can unlock the full potential of ICT in foundational science education, preparing students not just for academic success, but for the increasingly interconnected, technology-driven world and the specific challenges and opportunities presented by Zimbabwe's Education 5.0 framework. Further research, such as this case study at Kriste Mambo, is necessary to investigate the practical impact of ICT integration on student outcomes, teacher pedagogy, and overall school readiness within this specific national context, ensuring that the preparation for Education 5.0 is effective, sustainable, and equitable.

CHAPTER 3: RESEARCH METHODOLOGY

3.0 Introduction

This chapter outlines the research methodology employed to address the research questions and achieve the objectives of this study. It details the research design, research approach, study area and site, population and sampling procedures, data collection instruments and procedures, data presentation and analysis methods, issues of validity, reliability, and trustworthiness, and the ethical considerations that guided the research process. The methodological choices were made to ensure a systematic and rigorous investigation into the contribution of ICT to Physics teaching and learning at Kriste Mambo High School, specifically in relation to preparing students for tertiary Education 5.0 within the prevailing heritage-based curriculum.

3.1 Research Design

This study adopted a mixed-methods case study design. A mixed-methods design is appropriate because it allows for the collection and analysis of both quantitative and qualitative data, providing a more comprehensive understanding of the research problem than either approach could achieve alone (Creswell, 2014). The research questions require exploring not just how much ICT is used or how effective it is rated (quantitative aspects), but also delving into why challenges exist, understanding the nuanced perceptions of teachers and students, and exploring how practices align with preparatory goals for Education 5.0 . By combining these approaches, the study gains breadth and depth, enabling a robust examination of the complex interplay between ICT, secondary Physics education, and preparedness for tertiary Education 5.0 within a specific context.

A case study design was employed because the research focuses intensely on a single, bounded unit of analysis: Kriste Mambo High School. A case study allows for an in-depth exploration of a contemporary phenomenon (ICT integration in Physics) within its real-life context, particularly when the boundaries between the phenomenon and context are not clearly evident (Yin, 2018). This design is suitable for answering "how" and "why" questions in relation to a specific setting, providing rich insights into the processes and perceptions at this particular school. While acknowledging the limitations regarding generalizability to other schools, the case study provides valuable localized insights that can inform understandings relevant to the broader Zimbabwean educational landscape. The mixed-methods approach was integrated within the case study to gather diverse data types about this specific site.

3.2 Research Approach

The study employed a mixed quantitative and qualitative approach. The quantitative approach involved collecting numerical data through questionnaires. This allowed for the measurement of variables such as the reported frequency of ICT use, perceptions of effectiveness , the ranking of challenges faced, and basic demographic information. Quantitative data provided a structured overview, enabling statistical analysis to identify patterns and trends in ICT use and perceptions across the sampled student body and teaching staff. This approach helped in addressing the "What are the challenges and opportunities?" question by providing scale and prevalence.

The qualitative approach involved collecting non-numerical, descriptive data primarily through interviews and potentially observation. This approach was used to explore the depth of experiences, detailed perceptions, underlying reasons for challenges and opportunities, and nuanced understandings of how current practices contribute to preparedness for tertiary Education 5.0 and align with the heritage-based curriculum. Qualitative data provided rich context and personal insights, complementing the quantitative findings by explaining the "why" behind the numbers and exploring the "how does" and "how can" questions related to the contribution of ICT and proposed strategies. The data from the quantitative and qualitative strands were collected concurrently and analyzed separately, with the findings intended to be integrated during the interpretation and discussion phase to provide a more holistic answer to the research questions.

3.3.1 Study Area and Site

The study was conducted at Kriste Mambo High School, located in Nyanga District, Manicaland Province, Zimbabwe. Kriste Mambo is a secondary school offering Physics as part of its curriculum, and reportedly has commenced some integration of technology in teaching and learning. It was selected as the specific site for this case study due to its accessibility to the researcher and its representation of a typical secondary school in Zimbabwe facing the challenges and opportunities of integrating ICT to meet modern educational demands, including the imperative to prepare students for the national Education 5.0 framework. Studying a single institution allows for focused, in-depth data collection necessary for a comprehensive case study analysis.

3.3.2 Population

The target population for this study comprised all secondary school students studying Physics at Kriste Mambo High School and all Physics teachers teaching at the school during the period of the study.

3.3.3 Sample and Sampling Procedures

Due to the limitations of time and resources inherent in a diploma-level research project, a sample was drawn from the target population. The student sample consisted of 154 pupils aged 14-16 years, drawn from three specific classes studying Physics at Kriste Mambo High School. This constituted a significant portion of the target student population within that age bracket studying the subject. The sampling procedure for students was likely purposive or convenience sampling, focusing on these specific age groups/classes considered relevant for examining the foundation building towards potential A-Level choices and tertiary education readiness.

The teacher sample included all Physics teachers actively teaching Physics to the selected student classes at Kriste Mambo High School during the study period. This constitutes a census sample of the relevant teaching staff, ensuring that the perspectives of all educators directly involved in the subject for the target student group were included. The specific sample sizes and selection procedures were guided by feasibility within the case study approach and the objective of gathering representative data from the key actors in the Physics teaching and learning environment at the school.

3.4 Data Collection Instruments

Three main data collection instruments were used in this study to capture both quantitative and qualitative data. Structured questionnaires comprising a mix of closed-ended (Likert scale questions on frequency of ICT use, perceived helpfulness, perceived challenges with ICT) and open-ended questions (listing specific challenges, describing how ICT helps, ideas for improvement, views on subject choice preparation for university) were administered to the sampled students. Questionnaires are efficient for collecting data from a relatively large number of respondents on standardized topics and can provide quantitative insights into prevalence of certain perceptions or practices.

In addition to student questionnaires, but tailored to the teacher perspective, these included sections on frequency and types of ICT tools used in teaching Physics, perceived benefits and barriers of ICT integration for Education 5.0 preparation, views on curriculum alignment (including heritage aspects) and subject choice guidance using ICT, teacher training needs, and suggestions for improvement. Both closed-ended (Likert scales, ranking) and open-ended questions were used.

Furthermore, semi-structured interviews were conducted with the sampled Physics teachers. Interviews allowed for deeper exploration of complex issues related to ICT integration, pedagogical strategies using technology for complex Physics concepts, personal experiences with challenges and successes, nuanced opinions on preparing students for tertiary Education 5.0, discussions on aligning technology use with the heritage-based curriculum, and detailed insights into how specific subject content is taught with or without ICT to foster skills relevant for future studies. Interviews facilitated probing for elaboration and capturing richer qualitative data than questionnaires alone. An interview guide with key themes was used to ensure consistency, while allowing flexibility for follow-up questions.

Moreover, an observation protocol or checklist was used by the researcher during visits to selected Physics lessons. This protocol focused on documenting observable aspects of ICT use in the classroom, such as the specific tools utilized, teacher demonstration skills, student engagement levels with technology, the type of activities facilitated by ICT, and observed infrastructural constraints. This provided direct evidence to corroborate or contrast with questionnaire and interview data.

3.5 Data Collection Procedures

The data collection process followed a systematic sequence. Formal permission was sought from the Bindura University of Science Education for ethical clearance. Following this, formal permission was obtained from the Head of Kriste Mambo High School to conduct research within the institution. The purpose and nature of the study were explained clearly to the school administration, the Physics teachers, and the students in the selected classes. Voluntary participation was emphasized. Written informed consent was obtained from the teachers and parents/guardians of the minor students (aged 14-16). Assent was also obtained from the students themselves, ensuring they understood and agreed to participate. Participants were informed of their right to withdraw from the study at any time without penalty and guaranteed anonymity and confidentiality. Student questionnaires were administered collectively to the three sampled classes, preferably during a non-Physics lesson time supervised by the researcher and a nominated school staff member to answer any queries. Teacher questionnaires were distributed to the Physics teachers with instructions for completion within a specified timeframe.

In addition semi-structured interviews were arranged individually with participating Physics teachers at a time and location convenient to them (staffroom, empty classroom after hours), ensuring privacy and minimal disruption. Interviews were audio-recorded with the explicit permission of the participants, and notes were also taken. Arranged visits were made to a predetermined number of Physics lessons utilizing ICT (or intended to use ICT). The researcher used the observation protocol to record observations during the lessons, taking care not to interfere with the teaching and learning process. The collected data (completed questionnaires, audio recordings, interview transcripts, observation notes) were securely stored to maintain confidentiality, accessible only to the researcher. Audio recordings were transcribed shortly after interviews were completed.

3.6 Data Presentation and Analysis

Data analysis commenced after data collection was completed. Quantitative data from the questionnaires was cleaned, coded, and entered into a software package (Microsoft Excel). Descriptive statistics were calculated to summarize the data. These included frequencies, percentages (percentage of students reporting using specific tools, percentage of teachers facing a particular challenge), means, and standard deviations (average perception score on ICT effectiveness). Findings were presented using tables, graphs, and charts (bar charts for frequency, pie charts for proportions) to visually display the distributions and trends.

Qualitative data from the interviews and observation notes was transcribed verbatim (interviews) and organized. The analysis involved thematic analysis, a method for identifying, analyzing, and reporting patterns (themes) within data. This involved reading through the data repeatedly (familiarization), generating initial codes from interesting features, searching for themes by grouping codes, reviewing themes to ensure they fit the coded extracts and the overall dataset, defining and naming the themes, and producing the final report of the analysis (Braun & Clarke, 2006). Emergent themes were related to the research questions, such as specific types of ICT tools used, perceived impacts on learning and preparation for Education 5.0, detailed barriers to implementation (infrastructural, pedagogical), perceived alignment with heritage-based approaches, and suggestions for future improvements. Representative quotes from participants were selected to illustrate the identified themes in the final reporting.

The findings from the quantitative and qualitative analyses were integrated during the discussion phase. This involved comparing and contrasting the results from the two data types to provide a more nuanced and comprehensive answer to each research question. For example, quantitative data on the frequency of using simulation software might be combined with qualitative data from interviews explaining how teachers and students perceive these simulations aiding understanding of complex concepts for future studies. Or, quantitative data on ranked challenges could be enriched by qualitative interview data detailing the specific reasons why those challenges are significant barriers to preparing students for a technology-driven tertiary environment.

3.7 Validity, Reliability and Trustworthiness

Ensuring the quality of the research findings was critical. Reliability was addressed by ensuring that questionnaire questions were clearly worded, unambiguous, and consistently understood by respondents. Pilot testing the questionnaires on a small group not included in the main sample helped identify and rectify any reliability issues in wording or structure. Validity (specifically content validity) was addressed by ensuring that the questionnaire items were derived directly from the research objectives and questions, and covered relevant aspects of ICT use in Physics, perceptions, challenges, and preparedness for Education 5.0

Credibility was pursued through triangulation, by using multiple data sources (student questionnaires, teacher questionnaires, teacher interviews and observations where applicable) to corroborate findings on key themes. Member checking (presenting preliminary findings to participants for validation) was considered but may be challenging due to logistical constraints for a diploma project. Researcher reflexivity (awareness of the researcher's own biases and assumptions) was maintained throughout the data collection and analysis process. Transferability is inherently limited in a single case study. However, rich, detailed descriptions of the context (Kriste Mambo School), participants, and findings ("thick description") were compiled to enable readers to judge the extent to which the findings might be applicable to similar settings.

Dependability was addressed by maintaining a clear audit trail of the research process, including raw data, coding decisions, and analysis steps, which could potentially be audited by an external party. Using a consistent interview guide and observation protocol also enhanced dependability. Confirmability was sought by grounding findings in the data, ensuring interpretations could be traced back to participant responses and observations, and minimizing researcher bias in the presentation of findings.

3.8 Ethical Considerations

Adherence to ethical principles was paramount throughout the research. As detailed in the procedures, comprehensive information about the study was provided, and written informed consent/assent was obtained from all participants and relevant guardians/authorities before data collection began. Participation was voluntary, and participants were informed of their right to withdraw at any stage without reprisal. Measures were taken to protect the identity of all participants and the school. Participants were assigned pseudonyms or coded identifiers in all records and reporting. Collected data was kept confidential, stored securely, and accessible only to the researcher. School identity might be implied due to the case study nature but aggregated data and quotes were presented in a manner that protected individual anonymity.

The study was designed to provide potential benefits (informing school practice, contributing knowledge) while minimizing any potential harm or discomfort to participants. Steps were taken to avoid disrupting school activities excessively. The study explored existing practices and perceptions and did not involve interventions that could pose risks. Formal permission was obtained from the university's ethical review board and the school head before the commencement of data collection.

3.9 Chapter Summary

This chapter has detailed the methodological blueprint guiding this research study. A mixed-methods case study design was chosen to provide a comprehensive investigation of ICT's role in secondary Physics education at Kriste Mambo High School as preparation for tertiary Education 5.0. The chosen approach involves both quantitative and qualitative data collection through questionnaires and interviews (and potentially observation) from a sample of students and all relevant Physics teachers. Procedures for data collection and analysis, integrating findings from both strands, were outlined. Measures to ensure the validity, reliability, and trustworthiness of the findings, alongside strict adherence to ethical considerations, were described. The methodology outlined here provides a solid foundation for collecting and interpreting the data necessary to answer the research questions and meet the study's objectives, contributing valuable insights into the preparatory phase for Education 5.0 in Zimbabwean secondary schools.

CHAPTER FOUR: DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.0 Introduction

This chapter presents, analyses, and discusses the data collected from Kriste Mambo High School concerning the contribution of Information and Communication Technology (ICT) to Physics teaching and learning, specifically in the context of preparing students for tertiary Education 5.0. The data were gathered using mixed methods, including questionnaires administered to sampled students and Physics teachers, and semi-structured interviews conducted with Physics teachers. The presentation and analysis are structured according to the research questions outlined in Chapter 1, incorporating quantitative summaries and qualitative insights. The analysis involves interpreting these findings and linking them back to the relevant literature reviewed in Chapter 2, aiming to provide a comprehensive understanding of the role of ICT in secondary Physics education at Kriste Mambo High School in fostering preparedness for Education 5.0.

4.1 Overview of Participants

The study included all Physics teachers at Kriste Mambo High School involved in teaching the sampled student population and a sample of students from Form 3 and Form 4 studying Physics. Demographic data for the participants were collected to provide context for the findings.

4.1.1 Demographic Data of Teachers

Table 4.1.1: Demographic Data of Physics Teachers (N=5)

Characteristic	Frequency (n)	Percentage (%)
Gender		
Male	3	60.0
Female	2	40.0

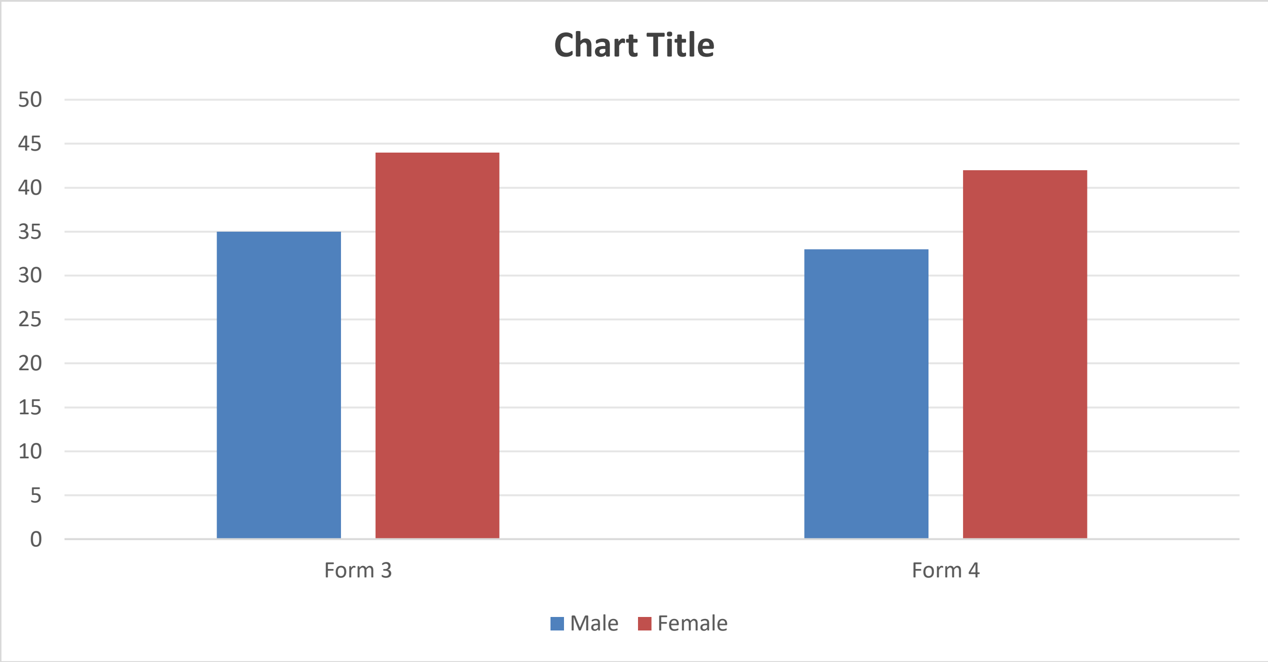
Age Range (Years)		
25-35	1	20.0
36-45	3	60.0
46-55	1	20.0
Highest Qualification		
Diploma in Education	1	20.0
Bachelor's Degree	3	60.0
Master's Degree	1	20.0
Years of Teaching Physics		
1-5	1	20.0
6-10	2	40.0
>10	2	40.0

As shown in Table 4.1.1, the majority of Physics teachers at Kriste Mambo High School participating in the study were male (60%), within the age range of 36-45 years (60%), and held a Bachelor's Degree as their highest qualification (60%). A notable portion had over 6 years of experience teaching Physics (80%). This demographic profile suggests a teaching staff with a mix of experience levels, potentially influencing their adoption and integration of ICT in their practice.

4.1.2 Demographic Data of Students

The study included a sample of 154 students from Form 3 (aged 14-15) and Form 4 (aged 14-18) studying Physics. The distribution of students by form and gender is presented in Figure 4.1.1.

Figure 4.1.1: Distribution of Student Participants by Form and Gender (N=154)



The sampled student population was drawn from both Form 3 (approx. 51.3%) and Form 4 (approx. 48.7%) Physics classes, ensuring perspectives from different stages of their secondary Physics journey. The gender split was approximately 44.16% male and 55.84% female, providing a balanced view across genders. All students in the sample fall within the age range of 14-18 years, which is crucial for assessing the preparatory phase for tertiary education.

4.2 Current Use of ICT in Physics Teaching and Learning at Kriste Mambo High School

This section addresses the first research question: How does the use of ICT in Physics teaching and learning at Kriste Mambo High School contribute to equipping students with foundational skills required for tertiary Education 5.0? Findings on the types and frequency of ICT tools used, and their perceived impact on skill development are presented.

4.2.1 Frequency of ICT Use in Physics Lessons

Teachers were asked about the frequency with which they use various ICT tools in their Physics lessons.

Table 4.2.1: Teacher Reported Frequency of ICT Tool Use in Physics Lessons (N=5)

Frequency/ ICT Tool	**Never (0%)**	**Rarely (1-2 times/term) (20%)**	**Sometimes (monthly) (40%)**	**Often (weekly) (60%)**	**Very Often (daily) (80%)**
Projector/Digital Display	1	0	1	2	1
School Computer Lab access	3	1	1	0	0
Personal Teacher Laptop	0	0	1	2	2
Educational Software/Simulations	4	1	0	0	0
Online Videos (YouTube etc.)	1	1	1	2	0
Learning Management System (Google Classroom)	5	0	0	0	0
Teacher-Student WhatsApp/SMS	0	0	1	2	2
Student Personal Devices (laptops, tablets, phones in class)	3	1	1	0	0

Table 4.2.1 indicates varied levels of ICT usage. While personal teacher laptops and communication tools like WhatsApp are relatively often used, dedicated school computer labs and educational software or simulations are rarely or never used in Physics lessons. This suggests that basic ICT infrastructure might exist or is personally owned, but specialized tools relevant for practical science visualization are largely absent or underutilized. Learning Management Systems appear unused. Student responses on the frequency teachers use ICT tools mirrored these trends, with mentions primarily focused on teachers using projectors or sometimes showing videos. Accessing computer labs for Physics-specific tasks was reported as infrequent by students.

4.2.2 Perceived Contribution of ICT to Skill Development for Education 5.0

Both teachers and students were asked how existing ICT use in Physics contributed to developing skills important for tertiary Education 5.0, such as research, critical thinking, problem-solving, and digital literacy. Teachers provided a range of insights during interviews. One teacher stated, "Using the projector and online videos, I could show complex diagrams or real-world examples much better than drawing on the board. The students grasped concepts faster. This visual literacy was definitely useful for understanding things in university." Another teacher added, "Sometimes I tried to give them research tasks using their phones at home, like finding definitions or simple applications. This helped a bit with basic research skills, but we couldn't really supervise or ensure they found reliable information, which is what's needed for serious research at tertiary level." A third teacher reflected, "We talked about using simulations, saying, 'imagine we could see the atoms moving like this!' They understood the idea of simulations, but they weren't actually getting the hands-on experience with them. That practical digital skill for modeling wasn't being built here."

Students also offered their perspectives through questionnaires and focus group discussions. One focus-group participant said, "Watching videos on gravity on the projector made it easier to understand than just the teacher talking. It's like the physics became real." A Form 4 male respondent noted, "When we had to find stuff for School-Based Projects on our phones, it helped us learn how to search. You need to master these skills for university—finding research papers and things." Another student, a Form 3 female, stated, "Using computers sometimes for other subjects showed us how to make presentations. Physics needs clear graphs, so using Excel might help later."

These findings suggested that the current use of ICT at Kriste Mambo High School contributed primarily to enhancing conceptual understanding through visual tools such as projectors and videos. It also helped to foster basic digital literacy and information retrieval skills through the use of laptops, internet searches, and basic office software. However, the limited access to specialized physics software and simulations significantly constrained the development of more advanced skills that are essential for the pillars of Education 5.0—particularly innovation, research, and industrialization. These pillars often require hands-on experience with modeling, data analysis, and virtual experimentation, which were not yet fully supported in the school's ICT environment.

4.3 Challenges and Opportunities in ICT Implementation for Education 5.0 Preparation

This section addresses the second research question: What are the challenges encountered and opportunities presented by using ICT in secondary Physics education at Kriste Mambo High School specifically regarding the preparation of students for tertiary Education 5.0?

4.3.1 Challenges Faced by Teachers and Students

Both teachers and students identified several barriers to effective ICT integration. Table 4.3.1 summarizes teacher perspectives on the magnitude of key challenges identified.

Table 4.3.1: Teachers' Perceived Magnitude of ICT Integration Challenges (N=5, Scale 1-5)

Challenge Category	**Mean Score**	**Description**
Inadequate ICT Infrastructure	4.8	Lack of functional computers, unreliable internet, insufficient projectors/labs.
Lack of Teacher	3.6	Teachers needing more training on how to integrate

Training/Skills		ICT effectively into Physics pedagogy.
Limited Access to Relevant Software	4.9	Absence of physics simulations, virtual labs, data analysis tools.
Power Supply Issues	4.5	Frequent power cuts affecting usability of electrical equipment.
Time Constraints	3.2	Insufficient time in crowded curriculum/timetable to plan and implement ICT-based lessons.
School Policies/Management Support	2.1	Generally supportive environment, policies don't explicitly restrict but may not actively promote specific ICT use in Physics.
Student Access to Devices	3.9	Many students lacking personal devices or data for out-of-classroom digital learning tasks.

Interviews provided deeper insight into these challenges. One teacher explained that "infrastructure is the biggest problem, the computer lab exists, but getting time there is nearly impossible, and we don't have the physics software anyway. Even our personal laptops are useless if there's no power, which happens often." Another noted "we know we should be using simulations—it's in the heritage-based curriculum guides now—but finding and learning how to use them for teaching rather than just showing a video takes specific training that we haven't had." Students echoed these concerns. A Form 4 female respondent pointed out that "my parents don't have a smartphone or laptop, and data is expensive. It's hard to do the research the teacher asks for at home like some other students. The computers at school are for Computer Science only." These testimonies underscored the urgent need for reliable infrastructure, targeted training on pedagogical use of technology, and equitable access to devices and data.

4.3.2 Opportunities Presented by ICT Use for Education 5.0 Preparation

Despite the challenges, teachers and students identified significant opportunities offered by ICT, particularly for fostering the skills needed in tertiary Education 5.0. Teachers explained that, with proper virtual lab software, they could have performed all the experiments that were often skipped due to a lack of chemicals or equipment. This practical exposure was seen as essential for students aspiring to study science or engineering at university or polytechnic, aligning closely with the industrialization and research principles of Education 5.0.

Furthermore, teachers noted that online resources opened up a world beyond the textbook. Students were able to explore cutting-edge physics concepts, understand connections to industry and potential careers, and broaden their perspectives—helping them see why learning physics was relevant to their future education and professional goals. In addition, the teaching of basic coding skills related to physics, or the use of data loggers for simple experiments, directly built the technical competencies required for university-level science courses. Even using spreadsheets to analyze data from basic experiments laid the groundwork for more advanced data analysis and problem-solving skills.

Student perspectives echoed these insights. One focus-group participant suggested that increased use of tablets in class—paired with online whiteboards—could have enabled small groups to collaborate more effectively. This collaborative approach made learning more engaging and supported peer-to-peer knowledge sharing, which is a key aspect of Education 5.0’s emphasis on teamwork. Another student respondent proposed that seeing real-life physics applications from Zimbabwean industries online made the subject feel more relevant and current. By linking the curriculum to real-world examples and career pathways, students were more motivated to pursue physics at the tertiary level and contribute to heritage-based industrialization.

Overall, while the implementation of ICT remained basic and was challenged by various limitations, there was clear recognition of its potential to address resource gaps, provide practical exposure, expand learning beyond the standard curriculum, encourage collaboration, and develop essential digital and technical skills required for the research, innovation, and industrialization pillars of tertiary Education 5.0.

4.4 Strategies for Improving ICT Use for Education 5.0 Preparation and Equitable Access

This section addresses the fourth research question: What strategies can be recommended to improve the use of ICT in Physics teaching and learning at Kriste Mambo High School to better prepare students for tertiary Education 5.0 and ensure equitable access to this preparation? Findings on proposed strategies by teachers and students are presented.

Teachers and students offered practical suggestions. Table 4.4.1 summarizes teacher recommendations for addressing the identified challenges.

Table 4.4.1: Teacher Recommended Strategies for Improving ICT Integration (N=5)

Recommended Strategy	**Strongly Agree/Agree (%)**	**Neutral (%)**	**Disagree/Strongly Disagree (%)**
Provide reliable internet access	100.0	0.0	0.0
Procure more computers & projectors	100.0	0.0	0.0
Provide relevant Physics software/simulations	100.0	0.0	0.0
Ensure consistent power supply/backup	100.0	0.0	0.0
Provide targeted ICT pedagogical training for Physics teachers	100.0	0.0	0.0
Allow students to use personal	60.0	20.0	20.0

devices (managed)			
Establish school policy actively promoting ICT in Physics	80.0	20.0	0.0
Dedicate technical support staff for ICT	100.0	0.0	0.0

Teacher interviews elaborated on how these strategies will be crucial for Education 5.0 preparedness. One teacher explained that “without proper internet and working computers in the Physics lab, students cannot practice data logging or use online tools effectively. This isn't just about basic IT; it's about the specific tools for the subject needed for university. Investment is key,” emphasizing the need for targeted resources. Another teacher highlighted that “training isn't just about how to switch on a computer. It's about how to teach wave motion or electricity using simulation, how to get students analyzing experimental data from the virtual lab, how to manage a blended lesson. This pedagogy linked to tech is what prepares them for 5.0,” underscoring the importance of pedagogical training specific to Physics. A third teacher noted that “even if only a few students have phones, allowing controlled use with cheap data packages for accessing school-approved resources or doing group discussions is a way to bridge the gap now. Equity for 5.0 prep means everyone needs some digital exposure,” thus advocating strategies for equitable access.

Student recommendations further highlighted the need for improved access. One focus-group participant remarked, “We need more computers that we can use for Physics, not just for Computer Science. And free Wi-Fi at school! We can research better.” A Form 3 male respondent suggested, “Maybe the school can get codes for us to use learning apps that are too expensive for our parents—like the virtual experiment ones the teacher showed us pictures of,” pointing to the necessity of affordable, subject-specific software. Together, these findings will strongly advocate for fundamental improvements in ICT infrastructure, reliable power supply, and access to subject-specific software. They will call for targeted teacher professional development focused on integrating pedagogy with technology and for dedicated technical support to maintain and expand these resources. Strategies for leveraging existing student-owned devices alongside school-provided equipment will be seen as crucial for improving equitable access. Finally, there will be a clear desire for the school and the Ministry to actively support and guide this integration through robust policies and appropriate resource allocation. By aligning investments, training, and policy frameworks, stakeholders will ensure that both teachers and students are effectively prepared for the technological environment and skill demands of tertiary Education 5.0.

4.5 Discussion of Findings

This section synthesizes the findings presented above, interpreting them in relation to the study's objectives, research questions, and the existing literature, particularly concerning preparation for tertiary Education 5.0. The study at Kriste Mambo High School reveals a foundational, yet limited, level of ICT integration in Physics teaching, primarily utilizing basic tools like projectors and teacher laptops for visualization and some basic online research. This aligns with some challenges highlighted in the literature, such as inadequate infrastructure and lack of access to advanced resources (Bingimlas, 2009; Mwambela et al., 2019). While existing ICT use contributes positively to conceptual understanding (Rahmatullah et al., 2022; Dori et al., 2013) and basic digital literacy – skills beneficial for any future study – it appears insufficient for fully developing the research, innovation, and problem-solving competencies emphasized in tertiary Education 5.0 (Mopse, 2018; Muzira & Bondai, 2020). The underutilization of simulations, virtual labs, and data analysis tools directly hinders the cultivation of practical digital skills essential for STEM fields aligned with Education 5.0's industrialization goals.

The challenges identified are significant and interconnected: a critical lack of relevant ICT resources (computers, software, consistent power, internet) forms the primary barrier, compounded by teachers' need for targeted pedagogical training in integrating these tools into Physics lessons for specific learning outcomes. This resonates with challenges noted globally and regionally regarding infrastructure and teacher preparedness (Msafiri et al., 2023; Odhiambo, 2018; Phiri, 2018 in Chapter 2 Literature). The issue of unequal student access to devices further exacerbates the digital divide, threatening the equitable preparation for Education 5.0, a concern raised by various studies (UNESCO, 2023; Howie, 2019 on equity in Chapter 2 Discussion).

Despite these obstacles, there are clear opportunities perceived by both teachers and students. ICT is recognized for its potential to fill resource gaps through virtual experiments, broaden curriculum relevance through online resources, and enhance collaborative learning, all of which align with the principles of Education 5.0. Leveraging ICT, especially through methods that allow controlled use of personal devices, could help overcome limitations in school-provided resources and promote a more learner-centred approach (Petry & Moss, 2019). The potential to showcase real-world Physics applications, possibly linked to Zimbabwean industries as suggested by a student, could also tie into the heritage-based aspect of Education 5.0's industrialization pillar.

The strategies recommended by participants are practical and directly address the identified barriers, emphasizing the urgent need for investment in targeted infrastructure, reliable connectivity, and subject-specific digital resources. Crucially, the call for pedagogical ICT training for Physics teachers highlights the understanding that merely providing tools is insufficient; teachers need the skills to integrate technology effectively to foster the specific higher-order skills and prepare students for the learning methodologies expected in tertiary Education 5.0. Support for equitable access, such as school policies allowing and managing student devices or subsidizing access to educational software/data, is vital to ensure that the preparatory benefits of ICT in Physics are available to all, supporting the inclusive goals of Education 5.0. These recommendations resonate with strategies proposed in the wider literature for effective ICT integration (Blunkrupt, 2021; Howie, 2019 on technical support and collaboration).

This case study underscores the critical role secondary schools play in the national Education 5.0 agenda. Effective preparation requires more than just foundational knowledge; it demands digital fluency, critical problem-solving, and the ability to engage with technology in subject-specific ways. While Kriste Mambo High School has initiated some ICT use, a significant gap exists in leveraging technology to fully equip students with the skills and experiences necessary to thrive in tertiary Education 5.0 programs, particularly those emphasizing research, innovation, and industrialization which often build upon strong Physics backgrounds. Addressing the infrastructural and training challenges identified is paramount to realizing the potential of ICT in secondary Physics education as a crucial preparatory step for Zimbabwe's future-oriented educational framework. Furthermore, aligning Physics curriculum delivery and ICT use to explicitly demonstrate connections to local heritage, innovation, and industrial applications could strengthen the heritage-based element of this preparation.

4.6 Summary

This chapter presented the demographic data of the participants, outlining the profile of Physics teachers and students involved in the study at Kriste Mambo High School. Findings related to the use of ICT in Physics teaching and learning were presented, indicating a foundational level of use but limited adoption of specialized tools. The perceived contribution of ICT to developing skills for Education 5.0, along with the main challenges encountered and opportunities perceived by teachers and students, were detailed with supporting qualitative and quantitative data. Finally, strategies recommended by participants to enhance ICT integration in Physics education and improve preparedness for tertiary Education 5.0, while ensuring equitable access, were discussed and linked to the broader context of Education 5.0 and existing literature. The chapter highlights the need for significant improvements in resources, training, and policy support to maximize the potential of ICT in secondary Physics as a crucial preparatory step for the demands of tertiary Education 5.0 in Zimbabwe.

CHAPTER 5: SUMMARY, CONCLUSION AND RECOMMENDATION

5.0 Introduction

This final chapter consolidates the findings of the study. It begins with a summary of the entire research, recalling the problem investigated and the methodology employed. Subsequently, conclusions are drawn based on the comprehensive analysis and interpretation of the data presented in Chapter 4. These conclusions directly address the research questions and highlight the effectiveness and challenges of using ICT in secondary Physics education at Kriste Mambo High School as a preparatory step for tertiary Education 5.0. Flowing from these conclusions, actionable recommendations are proposed for various stakeholders to enhance current practices. Finally, the chapter suggests areas for future research, building on the limitations of the study and the knowledge gaps identified.

5.1 Summary of the Study

This study was motivated by the imperative to understand how secondary education, particularly Physics enhanced by Information and Communication Technology (ICT), is preparing students for Zimbabwe's trans-formative tertiary Education 5.0 framework. Recognizing that Education 5.0, with its pillars of teaching, research, community service, innovation, and industrialization, demands students equipped with strong foundational knowledge, 21st-century skills, and technological literacy, this research investigated the specific role of ICT in secondary Physics within a local context guided by the heritage-based curriculum. A mixed-methods case study design was employed, focusing on Kriste Mambo High School. The study involved collecting data from Physics teachers and students through questionnaires and semi-structured interviews. The methodological approach aimed to provide both a broad overview and in-depth insights into current ICT practices, perceived effectiveness, existing challenges, potential opportunities, and desired strategies.

Key findings from the data analysis revealed that while there is some basic use of ICT tools like projectors, teacher laptops, and general internet access in Physics teaching at Kriste Mambo High School, the integration of subject-specific software, simulations, and virtual laboratories remains minimal. Current ICT use is primarily seen as beneficial for enhancing conceptual understanding through visualization and supporting basic digital literacy and information retrieval skills. However, the study identified significant barriers hindering more effective ICT integration for advanced skill development aligned with Education 5.0. These challenges predominantly relate to inadequate and unreliable ICT infrastructure (lack of functional computers, internet, and power supply), limited access to relevant Physics software and simulations, and insufficient teacher training focused on the pedagogical integration of ICT specifically in Physics. Additionally, ensuring equitable student access to digital resources, both at school and home, emerged as a crucial concern impacting preparedness for a digitally-reliant future.

Despite these challenges, participants recognized the considerable opportunities offered by ICT. These include the potential to overcome physical resource constraints (e.g., through virtual labs), broaden the relevance of Physics learning by connecting it to real-world applications and industries, and fostering collaborative learning and active participation – skills highly valued in Education 5.0. Teachers and students proposed several strategies for improvement, emphasizing urgent needs such as reliable internet access, procurement of appropriate ICT infrastructure and software for Physics laboratories, consistent power supply, and targeted professional development for Physics teachers focusing on pedagogical ICT integration. Recommendations also included establishing school policies that support the proactive use of ICT and exploring ways to enhance equitable access to digital resources for all students, potentially leveraging personal devices under managed conditions and developing locally relevant online learning materials that resonate with the heritage context.

In summary, the research indicates that while Kriste Mambo High School is beginning to adopt ICT in Physics, the current level and nature of integration are significantly constrained by resource and training limitations. This restricts the school's capacity to fully leverage ICT's potential to equip students with the comprehensive digital and subject-specific skills necessary for successful transition into and contribution within tertiary Education 5.0 programs, particularly those requiring strong foundations in Physics and aligning with the national goals of research, innovation, and industrialization within a heritage-based framework. The findings highlight that effective preparation requires addressing fundamental barriers to ensure ICT becomes a truly transformative tool in secondary Physics education.

5.2 Conclusions

Based on the findings and analysis of the study, the following conclusions are drawn. Firstly, the level of ICT utilization in Physics teaching and learning at Kriste Mambo High School is foundational but limited. While basic tools are occasionally used for presentation and communication, subject-specific software like simulations and virtual laboratories, crucial for interactive and deep conceptual understanding in Physics, are largely underutilized or inaccessible. This low level of integration means that ICT's potential contribution to the "Teaching and Learning" pillar of Education 5.0 at the secondary level is not being fully realized. In addition, existing ICT use primarily contributes to enhancing visualization of abstract Physics concepts and fostering basic digital literacy and information gathering. While these are necessary foundation skills, the limited integration prevents the widespread development of more advanced ICT-dependent competencies such as scientific modeling, data analysis from virtual experiments, digital collaboration on complex problems, and inquiry-based learning that are fundamental to the "Research," "Innovation," and "Industrialization" pillars of tertiary Education 5.0. This limits the extent to which current Physics education at the school actively prepares students for the specific methodological and cognitive demands of higher education within the 5.0 framework and for selecting technical/STEM-related tertiary pathways which build on strong practical and digital Physics skills.

Furthermore, the most significant challenges to effective ICT integration for Education 5.0 preparedness at Kriste Mambo High School are systemic in essence inadequate and unreliable infrastructure (including power and internet), lack of relevant and accessible software, and insufficient targeted pedagogical training for teachers in Physics-specific ICT application. These barriers make it difficult to implement interactive, practical, and research-oriented learning experiences via ICT. However, significant opportunities exist in leveraging ICT to address resource deficiencies (e.g., via virtual labs), broadening subject relevance (linking to local heritage/industries), and promoting essential 21st-century skills, provided these fundamental barriers are addressed through targeted interventions and resource allocation aligned with national educational priorities.

Overcoming the challenges and seizing the opportunities requires a multi-faceted strategic approach involving increased, targeted investment in Physics-specific ICT resources and infrastructure, ensuring reliable power and internet access, providing relevant and sustained professional development for teachers in ICT pedagogical content knowledge for Physics, and establishing clear school/Ministry policies that actively support and promote this integration. Critically, strategies to enhance equitable access to these digital learning resources for all students, regardless of their socio-economic background or access to personal devices, are essential to ensure that preparation for tertiary Education 5.0 via ICT is inclusive and does not exacerbate existing disparities, aligning with the principles of social justice.

In conclusion, Kriste Mambo High School is at the initial stages of leveraging ICT in Physics education. While a willingness exists and the potential benefits for preparing students for tertiary Education 5.0 are recognized, significant systemic barriers currently prevent the deep and equitable integration necessary to cultivate the advanced skills required for the research, innovation, and industrialization goals of Education 5.0 and for empowering students to confidently pursue and excel in related tertiary pathways, including those building upon strong Physics foundations informed by local heritage and technological advancement.

5.3 Recommendations

Based on the findings and conclusions of this study regarding the preparation of secondary students for tertiary Education 5.0 through ICT in Physics at Kriste Mambo High School, the following recommendations are made to relevant stakeholders. The Ministry of Primary and Secondary Education (MoPSE) should prioritize targeted investment in robust and reliable ICT infrastructure specifically for secondary school science laboratories, including functional computers, consistent internet connectivity, and dependable power backup solutions. This should extend beyond general computer labs to discipline-specific facilities where practical application of ICT is vital for developing Education 5.0 skills. Allocate specific budget lines or seek partnerships for procuring licensed Physics-specific educational software, simulations, and virtual laboratory platforms that are aligned with the national curriculum and accessible to schools. Develop and implement comprehensive national policies that not only encourage ICT use but also provide clear guidelines and support structures for the pedagogical integration of ICT in all science subjects, explicitly linking it to the development of skills required for tertiary

Education 5.0 pillars and emphasizing equitable access. Fund and promote specialized, ongoing professional development programs for Physics teachers focusing on developing Technological Pedagogical Content Knowledge (TPACK) in Physics, demonstrating how to effectively use specific ICT tools and methodologies to foster critical thinking, problem-solving, collaboration, and creativity in line with Education 5.0 objectives and the heritage context. Establish mechanisms to encourage the development and use of locally relevant, heritage-based digital learning content and resources for Physics, showcasing connections to Zimbabwean industries and innovation to better prepare students for national development goals within Education 5.0.

To Kriste Mambo High School Administration, they should develop a clear school-level strategy for integrating ICT specifically within the Physics department, outlining objectives for ICT use, required resources, and a plan for implementation that supports preparedness for tertiary Education 5.0. Explore creative solutions for resource allocation and partnerships (e.g., with local businesses, NGOs, or university science departments) to acquire and maintain necessary ICT equipment and software for the Physics lab. Implement policies that facilitate controlled and productive student access to school ICT resources and potentially manage the responsible use of student-owned devices for educational purposes in Physics lessons, ensuring equity and addressing parental concerns. Allocate time and resources for internal teacher support structures, such as peer-to-peer mentoring or workshops led by technologically proficient staff, to encourage the adoption of new ICT tools and pedagogies in Physics. Review the Physics timetable to potentially allow for more dedicated time or flexible scheduling that accommodates ICT-based learning activities, including access to limited resources.

To Physics Teachers at Kriste Mambo High School they should actively participate in professional development opportunities focused on ICT integration in Physics, seeking out and sharing resources and best practices with colleagues. Explore freely available or low-cost Physics simulations, online resources, and data analysis tools that can complement existing teaching methods, even within infrastructural constraints, to introduce students to relevant digital experiences. Incorporate discussions and project ideas in Physics lessons that utilize ICT to research or illustrate connections to local heritage, Zimbabwean scientists, or relevant industries, thereby aligning with the heritage-based industrialization aspect of Education 5.0 and informing student career/tertiary pathway considerations. Advocate to school administration and relevant authorities for the specific ICT resources and training needed to effectively prepare students for tertiary Education 5.0, using evidence of current challenges and desired opportunities.

Universities and Colleges (Tertiary Institutions) should communicate clearly the expected ICT proficiency levels and subject-specific digital skills required for entry into Science and Technology programs aligned with Education 5.0. Consider offering outreach programs or resources to secondary schools to assist teachers in preparing students with the foundational technological skills needed for tertiary-level ICT use in science disciplines. Explore mechanisms for students to receive orientation on utilizing ICT effectively for research, innovation projects, and course work upon entering Education 5.0 programs, recognizing that preparedness levels from secondary schools may vary. By collaboratively implementing these recommendations, stakeholders can significantly enhance the contribution of ICT in secondary Physics education at Kriste Mambo High School, transforming it into a more dynamic, equitable, and effective preparatory phase for students aspiring to thrive within the demands of tertiary Education 5.0 and contribute to Zimbabwe's future.

5.4 Recommendations for Further Research

Based on the findings and limitations of this study, the following areas are recommended for future research. Future researchers should conduct a broader, quantitative study involving a larger sample of secondary schools across different districts (urban, peri-urban, rural) in Zimbabwe to provide a more generalized assessment of ICT integration in Physics education as preparation for Education 5.0. Researchers can undertake a comparative study investigating the specific ICT tools and pedagogical approaches used in high-performing vs. lower-performing secondary schools in Physics and analyze the correlation with student preparedness outcomes for tertiary Education 5.0. In addition conduct an action research study at Kriste Mambo High School focusing on the implementation and evaluation of specific ICT interventions (e.g., introducing a virtual lab software, targeted teacher training) and their direct impact on student engagement, understanding of complex Physics concepts, and development of Education 5.0 relevant skills over a defined period.

Furthermore, explore longitudinally the experiences of Kriste Mambo High School Physics graduates as they transition into tertiary Education 5.0 programs, assessing how their secondary-level preparation in Physics and ICT contributed to their success in higher education and identifying specific gaps experienced. Investigate the feasibility and effectiveness of different models for providing equitable access to ICT resources for secondary school students in the Zimbabwean context, such as school-managed device loan programs, community-based technology centers, or government subsidy schemes, assessing their impact on learning outcomes in subjects like Physics. Conduct research specifically focusing on how ICT is or can be used to integrate the heritage-based curriculum into secondary Physics teaching and learning, exploring effective strategies for connecting abstract scientific concepts to local knowledge systems, materials, or industrial applications, thus enhancing the distinct nature of Zimbabwe's Education 5.0 from an early stage. These suggested studies would build upon the localized insights gained from this case study, contributing further to the body of knowledge on effectively leveraging ICT in secondary science education in Zimbabwe for the holistic preparation of students for the future demands of tertiary Education 5.0.

5.5 Chapter Summary

This final chapter brought the research study to a close by presenting a comprehensive summary of the entire investigation. It briefly restated the research problem concerning the role of ICT in secondary Physics teaching at Kriste Mambo High School in preparing students for tertiary Education 5.0 within a heritage-based curriculum. The chapter then summarized the methodology employed, highlighting the mixed-methods case study design and the data collection tools used. Building upon the detailed analysis presented in Chapter 4, the chapter drew explicit conclusions directly addressing each research question, confirming that while basic ICT use exists, it is limited and significantly constrained by infrastructural deficiencies, lack of targeted training, and equitable access issues. These limitations impede the full realization of ICT's potential to develop the comprehensive skills required for the research, innovation, and industrialization pillars of Education 5.0. The chapter then put forward actionable recommendations tailored for various stakeholders, including the Ministry, school administration, teachers, and tertiary institutions, focusing on necessary investments in resources, specialized pedagogical training, supportive policy development, and strategies to ensure equitable access for all students. Finally, the chapter outlined areas for future research, identifying gaps and potential avenues for further investigation to deepen the understanding of

ICT integration in the preparatory phase for Education 5.0 in Zimbabwe.

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