Science Teachers' Information and Communication Technology (ICT) Self-Efficacy and Classroom Technology Integration: The Case of Manicaland Province, Zimbabwe

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Abstract

Computers and the internet are becoming common in learner's everyday life. The learners therefore acquire competencies associated with these digital resources outside the classroom. The way the learners are educated must keep pace with the realities they experience in their lives outside the school environment. The initiatives by Zimbabwe to integrate ICTs in the teaching and learning process is in line with the current learners' digital image. The effort and determination in using information and communication technology (ICT) in teaching and learning is influenced by one's level of computer self-efficacy. The aim of the study was to determine the ICT self-efficacy and practices of Science teachers in Manicaland province of Zimbabwe and to propose a teacher professional development model to enhance Science teachers' self-efficacy to ensure ICT integration in the teaching and learning of science. The self-efficacy theory was developed by Albert Bandura's as a sub-set of a larger theory, the social cognitive theory. This study therefore drew from the social cognitive theory. This study used the mixed research methods and adopted the exploratory sequential design using a descriptive survey. Data was collected in two phases. The initial phase (qualitative) was done to identify challenges and impediments to ICT integration in the teaching and learning of science as perceived by the population members using questionnaires and interviews to collect data. The second phase of the research was carried out to determine the level of teacher ICT self-efficacy and the frequency of use of digital devices in lesson delivery. Generally, the teachers agree that they are not confident in using ICT in teaching and learning, that is they are not computer self-efficacious (computer self-efficacy mean score=39, standard deviation =26.624). The Science teachers in the study sample never or rarely used ICT in the teaching and learning process (mean score=1.97, standard deviation = 0.825). There is a positive but moderate correlation between the Science teachers' ICT self-efficacy and their frequency of using digital teaching methodologies (correlation coefficient of 0.521). The linear relationship between the variables was statistically significant ($p<0.01$). The findings indicate that teachers' ICT professional development needs are not sufficiently addressed in a well-coordinated manner to ensure effective integration of ICT in teaching and learning. This study recommended that an effective monitoring and evaluation mechanism for the ICT integration in education should be put in place and teachers and senior management staff at schools should be professionally developed to ensure ICT integration in teaching and learning. Teachers should integrate technology in classroom practice using available devices. Well-coordinated technology centres should be established. An ICT policy dedicated to education besides the generalised one should be formulated.

Key words: Digital gadgets, Information and Communication Technologies, ICT self-efficacy, Digital teaching methodologies, Professional development, Technology integration.

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Dedication

I dedicate this study to my late father, my late mother, my late brothers Maxwell and Mishack and my late sister, Ruth.

Declaration

I declare that this thesis is my own unaided work. It is being submitted for the degree of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

Sifelani Jabangwe

15th day of March 2022

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List of Acronyms

HUG	Harvard University Guide
ICT	Information and Communication Technology
IRESSE	Integrated Reflection of Experiences and Sources of Self-Efficacy (Model for enhancing teachers' ICT self-efficacy)
IT	Information Technology
MoPSE	Ministry of Primary and Secondary Education
SDG	Sustainable Development Goals
SMS	Short Message Services
SPSS	Statistical Package for Social Scientists
ZimAsset	Zimbabwe Agenda for Sustainable Socio-Economic Transformation

Definition of Key Terms

Self-efficacy: People's beliefs in their capabilities.

ICT self-efficacy: People's (teachers') beliefs in their capabilities to use digital devices in the teaching and learning process.

Technology integration: Infusion of technology in teaching and learning.

Digital teaching methodologies: The use of computers, the internet, radios, televisions, projectors, mobile phones, and any other digital devices as pedagogical tools in teaching and learning.

ICT affordances: Perception of a possible action provided by the properties of ICT pedagogical tools.

Education 3.0: Education that emphasises teaching, researching and community serving.

Education 5.0: Education that emphasises teaching, researching, community serving, innovation and industrialisation. It is a heritage-based philosophy that advocates for education that produces goods and services.

Collective reflection of experiences: This is where individuals mirror their earlier actions and explore them in greater depth to collectively develop new ways of doing things.

Communities of practice (CoPs): Groups of people bound by what they do together mutually engaging in discussions and solving problems to give a standpoint that may guide their choices and practices.

Scenario: Workshop guidelines (framework) that provide a forum for active, equitable and creative discussion on digital teaching methodologies, enabling participants to share and negotiate different views and perspectives on the use of ICT digital tools in teaching and learning.

CHAPTER 1: INTRODUCTION

1.1 Introduction

The study aimed to analyse Science teachers' ICT self-efficacy as defined by Bandura, (1979). He defined self-efficacy as people's beliefs in their capabilities or an individual's beliefs about their ability to successfully complete a task. These beliefs determine the magnitude of effort applied to accomplishing a task (Bandura, 1979)**.** The relationship between the Science teachers' self-efficacy and technology integration in the teaching and learning process was examined. Teo and Joyce (2010) suggested that teachers' choice, effort and determination to use ICT are influenced by their level of computer self-efficacy.

Jang and Chen, (2006) facilitated the development of a Science student teachers' competence model to use ICTs in the teaching and learning process through peer coaching. They developed a training model comprising comprehension, observation, practice, and reflection. This study proposes a model comprising collective reflection of experiences and sources of self-efficacy to enhance Science teachers' ICT self-efficacy. The research using mixed research methods had a qualitative phase (phase 1) followed by a quantitative phase (phase 2) and the proposed model was designed using the findings from these two phases.

The study focused on secondary school Science teachers in Manicaland Province, Zimbabwe. Science is one of the learning areas in the Zimbabwean school curriculum. Science teachers in Zimbabwe teach one or more of the following Science subjects offered in the curriculum: Combined Science, Physical Science, Biology, Chemistry and Physics.

The study is premised on the notion that using technology in the practice of teaching is a function of teachers' perceived beliefs in their capabilities to employ digital teaching methodologies. Teachers who feel uncomfortable using technology as a tool in lesson delivery (Low self-efficacy) are unlikely to integrate it in teaching and learning (Farah, 2011) Self-efficacy beliefs are thus a key to action, that is if a teacher is highly ICT self-efficacious, the teacher is likely to employ digital teaching methodologies.

Information and communication technology (ICT) has several definitions depending on the context in which it is used. Lubuya (2012) defined it as an umbrella term that comprises any communication device or application, encompassing radio, television, cellular phones, computer and network hardware and software and satellite systems. According to Ratheeswari, (2018) ICT refers to technologies that avail access to information.

In this study, digital teaching methodology assumed the use of computers, the internet, radios, televisions, projectors, and mobile phones as tools to allow learners the opportunity to learn. The integration of ICT in the teaching and learning of science enhances desirable educational outcomes resulting in learner exit profiles such as problem solving (Nyambane & Nzuki, 2014) and critical thinking (Thapliyal, Sharma, & Godiyal, 2016)

The use of ICT in teaching and learning must by necessity fit into tried and tested teaching methodologies and learning theories if it is to improve the quality of teaching and learning. The use of ICTs in teaching and learning may activate the stages in Kolb' experiential learning cycle theory, and thus enhance learning (Chiu, 2019). Kolb's theory suggests that learners have four types of abilities, namely concrete experience ability, reflective observation ability, abstract conceptualisation ability, and active experimentation ability (Abdulwahed & Nagy, 2009) Concrete experience involves actually doing an activity; reflective observation ability involves reflecting on performance in an activity; abstract conceptualisation is applying theory to the experience of doing the activity; and active experimentation is considering theory and reflection to guide planning for later experiences. Using ICT with Kolb's experiential learning theory motivates learners since they are connected to it and interested in it, and therefore, able to assimilate and apply the experience under the four stages of Kolb's experiential learning (Chiu, 2019). Experiential learning is an approach where experience is the major resource (Smitiene, Braslaiskiene, & Vismantiene, 2018). Learners have the experience of using digital devices, therefore ICT creates experiential teaching environments (Smitiene, Braslaiskiene, & Vismantiene, 2018) Learners taught experientially score higher than those who are taught through direct instruction (Barker & Robinson, 2016).

The use of ICTs in the teaching and learning process also links the process to real life and may promote learner-centred learning, empowering the learner to direct their own learning with the teacher acting as a guide. The integration of technology in the classroom could bring about a change from traditional teaching methods to more constructivist teaching methods, resulting in enhanced student learning (Matzen & Edmunds, 2007)

Researchers studying constructivist teaching and learning observed that ICTs raises student motivation (Herzig, 2004). In a study on ICTs as a catalyst for change, Matzen and Edmunds (2007) found out that teachers' use of ICTs changes to more constructivist methods. However, they noted that in some instances ICTs can promote more constructivist compatible instruction and in other instances it may simply support existing instruction methods.

According to Nyambane and Nzuki (2014), using ICTs in teaching and learning develops learners' searching skills, assessing information skills, cooperation, communication, and problem solving. These skills are important as they ensure the learner is prepared for the knowledge society. ICTs may make lessons lively and create an interest in science (Lin, et al, 2012). Using the results of the first and second phases of the research (perceived obstacles to the use of technology in the teaching and learning process and efficacy scores and level of technology integration), the final phase of this research was the development of a model to ensure ICT integration in the teaching and learning of science.

1.1.1 Professional development models to enhance ICT integration into teaching and learning

A primary barrier to teachers being confident in using ICT is their lack of training. Therefore, teachers lack expertise and awareness of the possible uses and roles ICT can play in the teaching and learning process (Harrison, 2010). In Ghana, Sarfo, Amankwah, and Konin, (2017) found that senior high school teachers in that country are unlikely to use and integrate computers in their teaching and learning as effectively as expected. They suggested that the teachers need more training and support to enhance their self-efficacy to facilitate teaching and learning.

Participants at a Southern Africa regional meeting on ICT integration in education identified limited teacher capacity as a challenge to ICT integration into teaching and learning (Steukers, 2017). Zindi and Ruparanganda, (2011) recommended that effective staff development programmes must be launched to ensure ICT integration into the teaching and learning process. There is need for professional development activities in the use of ICTs for teaching in multicultural environments and classroom management (Dlamini & Mbatha, 2018).

The results obtained from the initial phases of the research included the needs of the respondents derived from the perceived obstacles to the use of ICTs in the teaching and learning process and the respondents' ICT self-efficacy levels and frequency of ICT use in lesson delivery. These were considered during the design of the proposed model to align it to local needs.

1.2 Background to the Study

Zimbabwe attained independence from Britain in 1980. The advent of independence necessitated the need for educational reforms to align the country's education system to the developmental needs of the new dispensation. The reforms at independence mainly focused on the expansion of the provision of education and redressing the quantitative inequalities that existed in the past. During the pre-independence era, very few black children had access to education whereas education for white children was compulsory (Kanyongo, 2005). However, it later became apparent that the country had to develop technologically, economically, and socially in line with the emergence of a highly competitive global economy and the rapid technological changes. The new thrust therefore had to be a migration from 'educate all' to 'educate all and educate well'. The then president of the Republic of Zimbabwe observed that it was necessary to reform and restructure education so that it became competitive enough to meet the challenges of the 21st century (Nziramasanga, 1999). In 1988, the president of the

Republic of Zimbabwe appointed a commission of inquiry into education and training, known as the Nziramasanga Commission. The commission was appointed to examine the education system and give advice and make recommendations (Nziramasanga, 1999). The commission, among many other recommendations, suggested that school learners should have skills to gather, sift, analyse, and make critical judgement (Nziramasanga, 1999). While the recommendations of the commission were not legally binding, they were supposed to inform policy on education. The National Education Advisory Board, which was appointed by the Minster of Education to advise on educational issues, stated that only some recommendations from the Nziramasanga Commission had been introduced in a haphazard fashion without a clear understanding of the consequences and without the necessary supporting personnel, infrastructure and materials (National Education Advisory Board, 2010).

The mismatch between education and national goals therefore remained despite attempts to redress the anomaly. The government aimed at having a curriculum that met the nation's evolving development aspirations of a better and quality standard of life for the citizenry, focusing on the teaching of science and technology (Ministry of Primary and Secondary Education [MoPSE], 2013).

The Marist International Solidarity Foundation (2011) stated that the curriculum in Zimbabwe's primary and secondary schools lacked relevancy to the development needs of the child. The Marist International Solidarity Foundation is a non-governmental organisation that advocates for children's rights to education. The then president of the Republic of Zimbabwe appeared to agree with the Marist International Solidarity Foundation when he noted that there was a need to transform the structure and curriculum of the country's education system to meet the evolving development aspirations. He further asserted that greater focus should be placed on the teaching of science and technology (Ministry of Primary and Secondary Education [MoPSE], 2013). The president reiterated government commitment to digital teaching methodologies when he was quoted saying,

> "We have now decided to go a gear up and add value to the initial programme (of availing computers to schools) by introducing a new dimension to it, this time, in the form of an e-learning programme" (Kawadza, 2012, 29 March).

Steukers (2017) noted that countries (including Zimbabwe) were making considerable efforts towards technology integration in education and were implementing numerous initiatives with the support from various partners. To transform education, the Zimbabwean Government with the backing of several partners came up with various initiatives that encouraged the use of ICTs in the teaching and learning process. Zimbabwe Vision 2030 and the United Nations Agenda 2030

The African Virtual University Teacher Education Project

Zimbabwe is one of the 10 African countries that were involved in a programme established by the African Virtual University focussing on Mathematics and Science education. The initiative focused on integrating ICTs into and across the teaching of Science and Mathematics, contributing to the development of more and better-quality teachers. It was envisaged that this will be achieved through e-learning methodologies to achieve the following objectives:

- To boost the capacity of teachers in the use of ICTs in the teaching and learning of Science and Mathematics.

- To develop the capacity of teachers to teach ICT as a subject; and
- To ensure that the country has enough Science and Mathematics teachers by increasing access to training through the online, distance and e-learning methodologies (Isaacs, 2007).

The teacher education project was an attempt to ensure ICT integration into teaching and learning.

College Information Technology Enhancement Programme

The College Information Technology Enhancement Programme is supported by the Flemish Office for the Development Co-operation Assistance, a Belgium based non-governmental organisation. The focus of the programme is to ensure that existing ICT infrastructure in teacher training colleges are fully used through staff development strategies that promote ICT-supported teaching and learning (Isaacs, 2007). Isaacs (2007) noted that the Zimbabwean Government leadership showed an interest in and positive attitude toward promoting ICT in education.

This shift from traditional teaching to digital teaching methodologies initiated by external partners did not seem to yield desired results. The institutions seemed not to be able to sustain the change. Musarurwa, (2011) noted that external funded programmes ended with the expiry of the external partnership.

The Presidential Computerisation Programme

To turn around the education sector and to tap the benefits associated with ICT integration in education, the Government of Zimbabwe embarked on a programme named the Presidential

Computerisation Programme. The programme was availed to ensure the availability of computers in disadvantaged schools. Many schools received computers under this initiative (Konyana & Konyana, 2013). This showed that the Zimbabwean Government was keen to avail the digital operational equipment to schools. This initiative was in line with the Nziramasanga recommendations to transform education in line with technological advancements**.** According to Konyana and Konyana (2013), the computerisation programme initiated by the Government of Zimbabwe to ensure the use of ICT in teaching and learning did not yield the desired goals as most of the computers donated to schools remained idle in classrooms.

The National ICT Policies of 2005 and 2016

The growth of ICTs from 1980 when Zimbabwe attained independence changed the economic and educational landscape of the country. After realising the vital nature of ICTs, the Government of Zimbabwe initiated the development of the first National ICT Policy, which was finalised in 2005. According to a World Bank and the Ministry of Educational and Vocational Training in Tanzania synthesis report (2011), the starting point to plan for ICT integration into education is for policy makers to clarify national policy to justify the integration and to provide a road map for technology integration (Hooker, Mwiyeria, & Verma, 2011). The Government of Zimbabwe formulated the policy to ensure ICT integration in the economy and in education. Such policies are expected to set out a shared vision on economic development and social change. The ICT policy therefore authenticates government investment on ICT integration into teaching and learning as an educational innovation. The policy also ensures regulated use of ICTs by giving directions for its use.

Policy statements contained in the document include the following:

1. Equitable access to ICT enabled education in all parts of the country.
2. Facilitate acquisition of appropriate and affordable digital equipment by schools.
3. Promote e-learning; and
4. Embed ICTs in the pedagogy of schools, colleges, and universities (Government of Zimbabwe, 2005)
5. The National ICT Policy therefore references to the promotion of ICTs in education.

The formulation of the policy was informed by the Nziramasanga Commission report of 1999 and the Harvard University e-readiness survey (Isaacs, 2007). The e-readiness was measured using the Harvard University Guide (HUG), an internationally recognised model. The model uses a four-point scale where 1 is a *low state of readiness* and 4 is the *ideal state of readiness*. One of the attributes that contributes to the overall score of a country is networked learning, which seeks to establish how well the education system integrates ICTs into teaching and learning. According to the HUG model, Zimbabwe was not e-ready, with an overall score of 0.4 out of a possible score of 4.0 (Zimbabwe Information and Communication Technology Policy Framework, 2005)

ICT policies are also supposed to be a springboard for the integration of ICT into teaching and learning. However, the policy did not bring about significant pedagogical transformation in the Zimbabwean classrooms. Farrell and Isaacs (2007) noted that the development of ICT policies does not always lead to implementation and results on the ground. Du Toit, (2015) posited that the establishment of policy measures is a prerequisite for effective ICT integration into national education systems, but further suggests that the introduction of ICT policies is not enough to result in ICT integration in teaching and learning. The European Commission Joint Research Centre (2009) noted that interest in the use of digital teaching methodologies appeared to be increasing even in the most challenging settings in developing countries; however, there is a disconnection between the rationales presented and the implementation on the ground.

The 2005 policy was reviewed in 2016, leading to the second ICT policy (2016). The second policy was necessary because the ICT sector is dynamic. Reviewing ICT policies is therefore imperative so that Zimbabwe does not lag. One of the overall objectives stated in the policy document is to enable and foster access to the use ICT in education. The policy document indicated a significant increase to the number of internet users and a large increase in mobile phones users.

The 2016 policy document acknowledges the following challenges faced by the ICT sector in Zimbabwe:

- Insufficient communications infrastructure; and
- Electricity problems: The national grid does not cover all parts of the country and there are regular power outages (Ministry of Information Communication Technology Postal and Courier Services, 2016).

Although Zimbabwe has an ICT policy, it does not have a specific national policy on ICT in education (Isaacs, 2007). A specific education ICT policy will give a detailed road map for ICT integration in education.

The Zimbabwe Agenda for Sustainable Socio-Economic Transformation

In 2013, the Zimbabwean Government formulated an economic plan known as the Zimbabwe Agenda for Sustainable Socio-Economic Transformation (ZimAsset). The aim of the plan was to stimulate accelerated and sustainable economic growth (ZimAsset document, 2013). The ZimAsset document cited improved standards of education through e-learning, computer literate pupils and innovative school graduates as some of the indicators of the success of the national blueprint (ZimAsset document, 2013, p.90).

The above initiatives and policy statements had very little impact on the education system in Zimbabwe. The education system remained irrelevant and unable to meet the country's developmental needs. These sentiments were implied in the president's statement at the opening of the 8th session of the Parliament of Zimbabwe (2013) when he observed that there was need to transform the structure and curriculum of the country's education system to adequately meet the evolving development aspiration of the nation (MoPSE, 2013)

The Primary and Secondary Schools Curriculum Review (2015–2022): The Competency Based Curriculum

In response to the government's call to transform the structure and curriculum of the education system to meet the nation's evolving development aspirations, some of the Nziramasanga Commission recommendations were finally used when MoPSE reviewed the primary and secondary school curriculum in 2014. The revised curriculum advocated for competence-based learning. O'Sullivan and Bruce, (2014) emphasised that competence-based learning pays attention to learners' learning styles. Zimbabwean learners' digital orientation therefore demanded the use of digital teaching methodologies. Competence-based learning is a departure from benchmarking achievement by the ability to recall key concepts and memorised sequences. The reviewed curriculum therefore advocated for the use of ICTs in teaching. One of the aims of competence-based learning is to foster lifelong learning in line with the opportunities and challenges of the knowledge society (MoPSE, 2014). The framework singled out embracing ICT's and e-learning as one of the means to achieve this.

MoPSE had been reviewing and developing syllabuses over the years, but no comprehensive curriculum review had taken place since the 1980s. Society's needs are constantly changing, and therefore, the curriculum must be constantly reviewed so that it remains relevant to the country's needs. Shittu and Shittu (2014) asserted that the use of ICT in teaching and learning supports the development of skills for sustainable economic development and social transformation.

It was therefore essential to develop a curriculum that reflect the Zimbabwean context and is consistent with international trends and standards in the 21st century. The curriculum review process was therefore a worthwhile development. The curriculum framework was intended to guide learning for the period 2015 to 2022. The framework proposed technological transformations in the education system (MoPSE, 2013). Among other exit profiles of the graduates of the education system, the blueprint listed critical thinking and problem-solving skills. Digital teaching methodologies are effective to ensure critical thinking and problem-solving skills (Meenakshi, 2013). Teaching and learning strategies that may enhance pedagogical integration of ICT include those which emphasise the development of learners' critical-thinking and problem-solving skills and inquiry-based learning (Barak, Nissim, & Ben-Zvi, 2011)

Education 5.0

In response to the government's thrust to transform the structure of the education system, the Ministry of Higher and Tertiary Education, Innovation Science and Technology Development, who is responsible for training teachers, advocated for a departure from the then education 3.0, which emphasised teaching, research and community serving, to education 5.0 whose pillars are teaching, research, community serving, innovation and industrialisation. It advocated for an education that produces goods and services guided by the heritage-based philosophy. This dovetailed well with the MoPSE's competence-based curriculum. Teachers were therefore expected to facilitate learning rather than to be in total control of it. Teachers must tap into the power of technology for lesson delivery for competence-based learning and heritage-based education 5.0 to yield the required results. The use of ICTs in lesson delivery creates a learner-centred environment and motivates learners.

Vision 2030: Towards a prosperous and empowered upper middle-income society by 2030

The Government of Zimbabwe's Vision 2030 sought to transform Zimbabwe to an upper middle-class economy by 2030. Vision 2030 embeds ICT across all national development strategies to enable development that increases investment in ICT development to ensure universal access by 2030. The government's vision envisages that Zimbabwe have internet access at village level. It pledged to invest in state-of-the-art education facilities to achieve quality education (Government of Zimbabwe, 2018). It was therefore imperative that the learners are not left behind by the technology rush. Teachers must by necessity embrace digital teaching methodologies so that learners can enjoy the benefits of ICT integration into teaching and learning.

The United Nations Agenda 2030: Sustainable Development Goals

The Sustainable Development Goals (SDGs) were adopted by the United Nations in 2015. These goals, also known as Global Goals, was a call of action to all nations to eradicate poverty, protect the planet, and guarantee that by 2030 all people of the world enjoy peace and prosperity. Zimbabwe and the other nations pledged to the following:

- To provide all-encompassing and equitable quality education at all levels (SDG 4);
- To ensure that all people, irrespective of sex, age, race, ethnicity, and persons with disabilities, migrants, indigenous peoples, children, and youth, particularly those who are vulnerable, have access to lifelong learning opportunities so that they gain the knowledge and skills necessary to exploit opportunities and to participate fully in the social order.
- To provide children with a nurturing environment to fully realise their rights and abilities so that our countries reap the demographic dividend through nonviolent schools and unified communities and families.
- To guarantee all-encompassing and equitable quality education and promote lifelong learning opportunities for all; and
- To build and upgrade education infrastructure that are child, disability, and gender sensitive and provide safe, nonviolent, inclusive and effective learning

environments for all. (United Nations Department of Economic and Social Affairs, 2015).

The Government of Zimbabwe signed the Qingdao Declaration 2015, committing itself to achieve SDG 4 by 2030. The country is therefore in line with the international obligation to achieve universal access to ICT in education. The government undertook a review of the progress of implementing the SDGs in 2019. This section summarises the progress report for SDG 4 (Government of Zimbabwe, 2020). Gaps and emerging issues requiring policy makers' attention were highlighted in the report. The report is significant to this study as it brings to the fore the country's progress in implementing the SDGs, situates government support on ICT integration into teaching and learning, and gives statistical data that may reveal schools' preparedness to embrace digital teaching methodologies.

Table 1.1 sourced from the report shows the distribution of schools with and without electricity.

Table 1.1 Access to electricity, 2016–2018

Year	**% of schools with electricity**	**% of schools without electricity**
2016	59.40	40.60
2017	68.90	31.10
2018	59.40	28.53

Source: Progress Review Report (Government of Zimbabwe, 2020)

Table 1.1 shows that the percentage of secondary schools with electricity fell from 68.9% in 2017 to 59.4% in 2018. This could be due to fact that more schools were constructed, especially in rural areas, and were not electrified. Most of the schools without electricity are rural day secondary schools. The state of electricity distribution portrayed in table 1.1 which reveals the national situation is comparable to state of electricity distribution in the area under study which was reported to be 25.12% of school without electricity (MoPSE, 2019). However, according to the Minister of Energy and Power Development, the government continues its efforts to electrify rural secondary schools, The minister revealed that in 2020, 70% of rural secondary schools were electrified under the rural electrification programme (Mupanedemo, 2020).

Electricity is key to the use of digital ICT tools. If the government want to effectively implement SDG 4, rural electrification should be prioritised so that learners are not left behind in technological developments.

According to the literature (Khalid, Abdulla, & Binimlas, 2009), (Zindi & Ruparanganda, 2011), (Bhatia & Ilyas, 2010), one of the barriers to ICT integration into education is lack of digital devices in schools. The schools must source learning materials like ICTs from their coffers without government support. Most rural schools, however, benefitted from the Presidential Computerisation Programme. The programme was availed to ensure the availability of computers in disadvantaged schools. Table 1.2 shows schools with and without computers across the period 2016–2018.

Table 1.2 Percentage of schools with and without computers from 2016 to 2018

Year	**% of schools with computers for learners**	**% of schools without computers for learners**
2016	49.69	50.31
2017	51.81	48.20
2018	71.68	28.32

Source: Progress Review Report (Government of Zimbabwe, 2020)

According to MoPSE, (2019) the area under study, that is Manicaland had 70.97% of its schools with computers. The high percentage of schools with computers is expected to translate to ICTs being used more often for teaching and learning. However, on the contrary, literature reported that most teachers do not use digital teaching methodologies, irrespective of the presence of ICT gadgets in their schools (Ghavifekr, Kunjappan, Ramasamy, & Antony, 2016), (Ogbomo, 2011), (Raman & Hamida, 2014), (Salechi & Salechi, 2012). One of this study's objectives was to determine the frequency of use of pedagogical ICT tools by teachers in Manicaland. Lack of internet connectivity is also a barrier to effective ICT integration into education. The review report on progress made to achieve SDG 4 showed that a small percentage of the secondary schools in Zimbabwe had internet connectivity (Table 1.3).

Table 1.3 Schools with and without internet connectivity in 2018

Year	**% of schools with internet connectivity**	**% of schools without internet connectivity**
2018	36.67	60.33

Source: Progress Review Report (Government of Zimbabwe, 2020)

The report shows significant strides towards achieving SDG 4 by the Government of Zimbabwe. However, accelerated implementation is needed if the education system is not to be outpaced by technological advancements.

Is the provision of computers to schools, the existence of an ICT policy and the review of the existing curriculum and other initiatives enough to ensure full and effective implementation of digital teaching methodologies? According to Konyana and Konyana (2013), the computerisation programme initiated by the Government of Zimbabwe to ensure the use of ICT in teaching and learning did not yield the desired goals as most of the computers donated to schools remained idle in classrooms. Mundy, Kupczynski, and Kee, (2012) conducted a study in the USA and noted that many schools were equipped with the latest instructional technologies, but most teachers only used the computers for administrative work and most learners do not use ICTs in the learning process. Classroom change will not begin by simply providing more computers (Chaaban & Ellili-Cherif, 2017). Therefore, providing ICT tools is not enough to guarantee educational transformation. Digital devices by themselves may have little or no impact on the teaching and learning process if teachers do not know how to effectively use ICTs. If they are not used, ICTs just becomes a drain on school finances.

Science teachers must therefore be prepared to embrace and fully exploit the potential of the digital teaching methodologies. Teachers must be prepared to handle learner-centred teaching methodologies by embracing digital teaching methods. A key factor for the effective integration of ICTs into the teaching and learning process is the teacher. Having digital gadgets without the initiative to use them is certainly a waste of resources (O'Sullivan & Bruce, 2014)

Computer self-efficacy can be used as an indicator of the likelihood of teachers integrating ICTs into teaching and learning (Teo & Joyce, 2010). People who doubt their capabilities (low self-efficacy) shy away from difficult tasks that they view as personal threats. Computer self-efficacy has been identified as one of the factors that play a role in teachers' decisions to integrate ICT into teaching and learning (Teo, 2009). Yamamoto and Yamaguchi (2016) suggested that increasing teachers' self-efficacy allows them to be creative, leading to better teaching practices and them taking responsibility for student learning. Farah (2011) asserted that it is important to address teachers' technology self-efficacy and identify interventions to influence it. Lubuya (2012) noted that education systems around the world are advocating for the pedagogical integration of ICT into education.

Learners the world over are increasingly going digital. Zimbabwe is not spared this wave of digitalisation. Computers and the internet are becoming very common in learners' everyday lives, and a logical conclusion is that learners acquire competencies associated with these digital gadgets outside the classroom. The pupils' image is thus becoming digitally oriented. The way we educate our leaners must keep pace with the realities they experience in their lives outside the school. It is therefore important to consider the digital image of learners in classroom practices. The initiatives in Zimbabwe to integrate ICTs into the teaching and learning process is in line with the current learners' digital image. This research proposed a staff development model to enhance Science teachers' ICT self-efficacy in the rapidly evolving digital landscape to prepare them to integrate ICT into their teaching.

Considering the above literature and the Government of Zimbabwe's policy on the use of ICTs in teaching and learning, at what level are the Science teachers' ICT self-efficacy? Do they believe in their own ability to perform actions necessary to reap the gains associated with digital teaching methodologies? To what extent do teachers integrate ICTs into the teaching and learning process? Is there a relationship between teachers' computer self-efficacy and the integration of ICTs into the teaching and learning process? This research tried to answer these questions.

Research on ICT integration in Zimbabwe has focused on factors such as ICT integration obstacles, challenges, perceived competencies, opportunities, and integration at different levels (Konyana & Konyana, 2013; Mandina, 2015; Musarurwa, 2016). This study therefore focused on an internal factor that is related to ICT integration: Science teachers' self-efficacy.

1.3 Statement of the Research Problem

Educational institutions the world over is expected to deliver quality education. OECD, (2012) observed that the highest performing education systems are those that emphasise both equity with quality. Teaching is not mechanical, but an art and its success depends on how the teacher executes the art. Educational efforts that may lead to the success of the art include teaching methods, infrastructure, government support and institutional backing. Teachers are key in the success of educational endeavours as they blend the educational components, such as teaching methods, infrastructure, government support and institutional backing, to create a conducive environment for lesson (Bandura, 1993).

In Zimbabwe, the integration of ICT into teaching and learning is very low (Kangara, Gocha, Tsokota, & Marovha, 2022) and therefore, the country's education sector is missing out on the benefits of ICTs. Steukers (2017) noted that ICT integration into education has been a policy concern in many countries, Zimbabwe included. Magodora, Mapuwei, Basira, Chagwiza, Masanganise and Mutangi (2016) noted that teachers faced constraints which militated against the integration of ICT in their teaching. of mathematics. In a survey carried out using the HUG, it was found out that Zimbabwe is not e-ready, with an overall score of 0.4 out of a possible score of 4.0 (Zimbabwe Information and Communication Technology Policy Framework, 2005). One of the attributes that contributes to the overall score of a country is networked learning, which seeks to establish how well the education system integrates ICTs into teaching, and learning (Zimbabwe Information and Communication Technology Policy Framework, 2005). The other attributes considered when using the survey were availability of ICTs, affordability of the ICT equipment, usage, and barriers to access of the digital equipment.

When ICTs are used appropriately, they can enhance the teaching and learning process. Hennessy, Harrison, and Wamakote, (2010) claimed that there is significant evidence to support the notion that if ICTs are used properly for explicit purposes in specific settings, they can enhance the teaching and learning process.

During the supervision and assessment of college student teachers in Manicaland Province, the researcher observed that the integration of ICT into teaching and learning was not very visible in these schools. The researcher therefore observed that most Science teachers in Manicaland do not use ICTs in teaching and learning, although there have been workshops on the use of

ICT in teaching and learning for the teachers in the province. In most of these schools, computers, internet facilities, digital cameras, radios, and televisions are available, and teachers and some learners own smart phones. The availability of the digital equipment, the image of the learner (digital oriented) and the ICT staff development workshops do not seem to stimulate digital teaching methodologies in the schools that were part of this study. Hennessy, Harrison, and Wamakote, (2010) observed that the pedagogical and technical expertise of teachers are critical if the benefits of ICTs in the teaching and learning process are to be realised.

This study focused on the observations made by the researcher on the use of ICTs in lesson delivery by Science teachers in Manicaland Province, and hence these teachers constituted the study population.

1.4 Significance of the Study

The anticipated benefits of the study are that it may inform curriculum developers about Science teachers' readiness to employ relevant 21st century teaching methodologies. ICT use in teaching and learning which encourages participatory learning leading to problem solving skills and critical thinking is a relevant 21st century teaching methodology (Plaza, 2021) Science teachers' level of efficacy in using digital teaching methodologies may shed light on their professional development needs. The study may also inform educational curriculum developers on the actual use of digital teaching methodologies on the ground. The Curriculum Development and Technical Services Department, the Ministries of Education and the schools can then come up with plausible interventions if need be. The learners will benefit if ICTs are used in the practice of teaching and the model proposed in this research may be used to increase the level of ICT integration in the teaching and learning of Science by enhancing teacher's ICT self-efficacy.

1.5 Research Setting

There are 296 registered secondary schools in the seven districts of Manicaland Province, and 28 of these are independent schools (MoPSE Curriculum Framework, 2015–2022). Schools sponsor the procurement of teaching and learning resources and at times receive donations. A case in point was the distribution of computers to schools, courtesy of the presidential national computerisation programme. Several disadvantaged schools across the country received computers under this initiative.

Private schools have more teaching and learning resources. Their computer laboratories are well equipped with ICT gadgets and the gadgets are well-maintained and accessible to all teachers. The teachers and learners can access the internet most of the time.

Government and church-run secondary schools have equipped computer laboratories. Most of the rural secondary day schools have very few ICT gadgets, and these are normally housed in a classroom turned computer laboratory. This study drew participants from all the types of schools mentioned above.

Each of the seven administrative districts in the province has a district inspector who superintends the administrative and teaching and learning processes in the districts. There are about 800 Science teachers in these schools.

1.6 Research Assumptions

The best technology is the one you have, already use, and can afford (Trucano, 2013). The researcher therefore made the following assumptions while conducting the research:

- All teaching environments in the area under study have some digital devices for pedagogical use; and therefore,
- These schools have the capacity to employ digital teaching methodologies.

1.7 Aim of the Study

The aim of the study was to determine the ICT self-efficacy of Science teachers and determine the relationship between the ICT self-efficacy and technology integration in teaching and learning in Manicaland Province of Zimbabwe and to propose a model to enhance Science teachers' self-efficacy to ensure ICT integration in the teaching and learning of Science.

1.8 Objectives of the Study

This study had the following research objectives:

- To establish Science teachers' perceived obstacles and constraints to ICT integration in the teaching and learning of Science;
- To determine the frequency of ICT use by Science teachers in Manicaland Province of Zimbabwe;

- To determine the level of ICT self-efficacy of Science teachers in Manicaland Province of Zimbabwe by measuring their ICT self-efficacy scores;
- To determine the relationship between teachers' ICT self-efficacy and frequency of ICT use; and
- To propose a professional development model to enhance Science teachers' ICT self-efficacy.

1.9 Research Questions

The research sought to answer the following questions:

1. What are the Science teachers' perceived obstacles and constraints to ICT integration into the teaching and learning of Science?
2. What is the level of computer self-efficacy of Science teachers in Manicaland Province of Zimbabwe?
3. How often do the teachers employ digital teaching methodologies in classroom practice?
4. Does the teacher's ICT self-efficacy affect frequency of ICT use in the classroom?

Researcher developed the following hypotheses for the quantitative phase using Pearson regression coefficient to answer research question 4:

- H_0: There is no correlation between teachers' ICT self-efficacy and their frequency of technology use in teaching and learning.

- H_1: There is a correlation between teachers' ICT self-efficacy and their frequency of technology use in teaching and learning.

1.10 Summary

Science teachers' ICT self-efficacy and technology integration into teaching and learning was the focus of this study. The study was instituted on the view that ICT use in teaching and learning is related to teachers' perceived beliefs in their capabilities to use ICT in teaching and learning. A staff development model to enhance ICT use in teaching and learning were developed. The Zimbabwe education system metamorphosised elitist education to education for all, emphasising quantity. Efforts to infuse quality into the education system saw creation of the Nziramasanga Commission into education and training, the formulation of an ICT policy, which among other pronouncements advocated for the integration of ICT into teaching and learning, the Presidential Computerisation Programme and the review of the primary and secondary education curriculum and its harmonisation with the teacher education curriculum. Despite these efforts by the government and other stakeholders, research on the effective use of ICT in teaching and learning and the researcher's observations revealed that classroom ICT integration is very low in Zimbabwe. It is this background that prompted this study.

1.11 Outline of Chapters

Chapter 2 presents the theoretical framework from which the study drew. A review of related literature is included to provide a foundation of knowledge on the study area, identify prior scholarship, and acknowledge another research.

Chapter 3 presents and justifies the research methods appropriate for the study. It discusses the data collection instruments used to collect data on Science teachers' ICT self-efficacy, barriers to ICT integration, and use of ICT tools in pedagogy.

Chapter 4 summarises the collected qualitative data in tables, charts and participant excerpts and answers and qualitative research questions.

Chapter 5 summarises the collected quantitative data in tables, charts, and statistical test results to answer the quantitative research questions.

Chapter 6 summarises the study and interprets the results.

Chapter 7 presents the proposed model, fulfilling one of the objectives of this study, which was to propose a professional development model to enhance Science teachers' ICT self-efficacy.

Chapter 8 presents the conclusion, makes recommendations, and discusses further research areas for future studies.

CHAPTER 2: REVIEW OF RELATED LITERATURE

2.1 Introduction

The background to the study in the previous chapter revealed that after Zimbabwe attained independence in 1980, its primary focus in education was to correct the quantitative disparities. It emerged later that there had to be a migration from 'educate all' to 'educate all and educate well'. This was implied in the president of Zimbabwe's statement at the opening of 8th session of parliament of Zimbabwe where he emphasised the need for the education curriculum to undergo transformation so that it addresses the evolving developmental aspirations of the nation (Ministry of Primary and Secondary Education, 2013)**.**

Nziramasanga, (1999) observed that the Zimbabwean government realised that there was need to reform and restructure education so that it became competitive enough to meet the challenges of the 21st century. After the government realised how vital ICTs are, it developed the first National ICT Policy, which was finalised in 2005. The 2005 policy was reviewed and led to the second ICT policy in 2016. The policy, among other pronouncements, advocated for the use of ICT in education. It was also noted in the background that there was a mismatch between the goals of the government and what was happening in the schools. The use of digital teaching methodologies was on the average very minimal. Teo and Joyce, (2010) augured that computer self-efficacy could be used as an indicator of the likelihood of the teachers' ICT integration into teaching and learning. The following discussion presents the theoretical framework from which the study drew and reviews the literature that establishes the basis for the study.

2.2 Theoretical Framework

Levin, Culkin, & Perrotto, (2001) posited that the self-efficacy theory was developed by Albert Bandura as a sub-set of a larger theory, the social cognitive theory. This study therefore drew from the social cognitive theory. According to the theory, human operations are a result of personal factors (cognition, affects, and biological events), behaviours, and environmental influences. The social cognitive theory is premised on the view that self-influences impact the choice and creation of one's environment. A major component of the social cognitive theory is self-efficacy. According to the theory, high self-efficacy enhances human achievement. Self-efficacy controls how people feel, think, motivate themselves and behave. Self-efficacy is about an individual's own perceptions about their ability and is connected to motivation (Kazan & EL-Daou, 2016). This implies that the ICT self-efficacy of the study respondents that is the Science teachers will influence their actions and motivate or demotivate them to employ digital teaching methodologies. People with strong self-efficacy believe in their competences to achieve challenging tasks and are motivated to keep on going, even when there are obstacles. On the other hand, those with low self-efficacy doubt their own capabilities and give up easily (Kazan & EL-Daou, 2016). Computer self-efficacy therefore is a measure of an individual's judgement of their abilities to use a computer. Nevid, (2009) noted that the social cognitive theory suggests that individuals do not simply respond to environmental influences but that they actively seek and interpret information.

The self-efficacy theory suggests that self-efficacy influences individuals' behaviour. Teo and Joyce (2010) claimed that individuals' choices, efforts, and perseverance in using computer technology are influenced by their level of computer self-efficacy. Self-efficacy is therefore what an individual believes concerning their capabilities. Such beliefs have diverse effects through cognitive, motivational, affective, and decisional processes (Benight & Bandura, 2004). Schunk and Pagares, (2009) concurred and explained that self-efficacy is a key factor that determines individuals' motivation, learning, self-regulation, and achievement. Self-efficacy determines the level and quality of effort individuals put into an activity, that is, how productively that effort is deployed. Therefore, higher perceived self-efficacy leads to various motivated efforts and improved performances (Bandura, et al, 2001). Teachers who are highly ICT efficacious will realise the learning opportunities (affordances) offered by ICTs. The study was therefore premised on the notion that using ICTs in the teaching and learning process is a function of teachers' perceived beliefs in their capabilities to employ digital teaching methodologies.

According to Bandura's social cognitive theory, cognitive, behavioural, personal, and environmental factors interrelate to shape behaviour and to motivate individuals (Crothers, Hughes, & Morine, 2008). Crothers, Hughes, and Morine, (2008) claimed that human functioning is the result of the interaction of all three of these factors. The social cognitive theory is made up of the following processes: Goal realisation, self-observation, self-evaluation, self-reaction, and self-efficacy. According to Redmond, (2010) these processes are interrelated and all of them influence motivation and goal attainment. Self-efficacy determines whether individuals view a situation optimistically or pessimistically. This research analysed Manicaland Science teachers' ICT self-efficacy by drawing on Bandura's social cognitive theory. The theory provided a framework to explain self-efficacy in terms of an individual's behaviour or actions.

Research on ICT integration in Zimbabwe have focused mainly on factors such as ICT integration, policies, constraints, and teacher competencies (Chigori & Zvavahera, 2018; Dube Scott, 2017; Isaacs, 2007; Konyana & Konyana, 2013; Mandina, 2015; Mandoga, Matswetu, & Mhishi, 2013; Zindi & Ruparanganda, 2011). This study assessed an internal factor that is related to ICT integration: Science teachers' computer self-efficacy. The study focused on Science teachers in Manicaland Province of Zimbabwe.

2.3 ICT adoption in education

When ICT is used in lesson delivery, the computer or any other digital device offers affordances or learning opportunities. Teaching and learning must therefore be structured in such a way that learners exploit the learning opportunities offered by the digital devices. These opportunities are shaped by past experiences and context but in the teaching and learning process may have to be signposted by the teacher. Hammond (2009) posited that affordances result from real, physical, and symbolic properties of objects and provides both opportunities and constraints, and in the context of ICT these are relative to desirable approaches for teaching and learning. Hammond, (2009) claimed that when teachers do not directly perceive the affordances of ICT relative to objectives such as creativity, analysis, and authentic learning, they are unlikely to embrace ICT in teaching and learning.

Bobsin, Petrini, and Pozzebon, (2018) defined ICT affordances as the technology potential emanating from goal-oriented behaviour that turn into concrete action, and they exit in context and in practice.

Gibson, (1979) defined an affordance as what an environment offers an animal (in this case a human being). It is the relationship between an object and what it offers an animal in terms of its needs (Hammond, 2009). Hammond (2009) explained the term affordances as the perception of a possible action provided by the properties of the object. When ICT is used in lesson delivery, the computer (or any other digital device) is the object that offers the affordances or learning opportunities. A digital device can therefore be seen as a solution looking for a pedagogical problem. Therefore, teachers must strategize their teaching in such a way that learners exploit the learning opportunities offered by the digital devices. According to McGrenere & Ho, (2000) affordances have three fundamental properties, but only two are relevant for this study. The first property is that an affordance exists relative to the action capabilities of a specific actor. In the teaching and learning process, the action capabilities of the teacher relative to ICT tools (affordance) are key if the intended benefits of digital teaching methodologies are to be realised. Onwuagboke and Ukegbu, (2010) posited that the power of ICT depends on teachers' ability to use the tools to create a rich, collaborative learning environment for the learners. Teachers will be able to exploit this power of ICT if they are able to perceive the usability of the digital teaching tools in the practice of teaching. Onwuagoke and Ukegbu (2010) further stated that ensuring that teachers are well prepared to use the ICT tools for learning is a challenge for ICT integration. If teachers are ill prepared to use digital tools in teaching and learning, then these ICT tools will not exist as affordances to the actors (the teachers). Enhancing teachers' ICT self-efficacy can therefore help the teachers to see the opportunities (affordances) offered by ICT to improve learner performance.

The second property is that the presence of an affordance is independent of the actor's ability to perceive it. This implies that an affordance can exist without an actor noticing its existence.

This can be said about some classroom practitioners who do not perceive the teaching and learning opportunities offered by ICT tools.

ICT conveys information by transmitting data in text, voice, picture, and video using phones, televisions, and computers. Learners use mobile phones in their everyday lives to transmit data in the form of voice, text, and pictures. This scenario provides teachers with an opportunity to use mobile phones in the teaching-learning process.

There are now more communication modes besides the traditional ones of reading, speaking, and writing coherently, included social media. Hence teachers need to harness the now ubiquitous digital media in teaching and learning. Jimoyiannis, (2012) suggested that robust ICTs, like social media and other interactive learning tools, should be integrated so that teachers create their own strategies and e-tools that facilitate the learning process.

To deal with issues of ethics and responsibility in the use of ICTs, mechanisms to ensure that learners navigate social media like Facebook, WhatsApp, Instagram, and Skype responsibly should be put in place. This is necessary to build trust with the major stakeholders in the teaching and learning process. Teachers should help learners assess and select trustworthy information and sources of information. Alexeyeva, (2004) suggested that the learners should be issued with clear instructions on how to behave online. Schools therefore have the responsibility to ensure learners behave well in cyber space. Digital learning tools must achieve the set national syllabus objectives and not divert learners’ focus and attention.

The use of ICT facilitates the de-institutionalisation of learning. Teachers and their learners can communicate away from the classroom, avoiding the restrictions of timetabling. For digital teaching methodologies to yield the documented benefits, the use of digital pedagogical tools needs to be combined with an understanding of how learners learn and how skills can be developed. Bates & Sangra, (2011) argued that there is increasing pressure from learners themselves, who are digitally oriented, to revolutionise teaching methodologies and move it onto the 21st century digital era. Ratheeswari, (2018) claimed that ICT use in the classroom is vital to give learners the opportunity to learn and to apply 21st century skills and it allows teaching to be presented attractively. Governments and schools can provide the ICT infrastructure to ensure effective integration of ICTs into teaching and learning, but the responsibility and power for change lies within the teachers themselves (Bates, 2015).

According to Ratheeswari, (2018) ICT is influencing all facets of human life, and have had a significant influence in the workplace, business, and education. It has changed teaching methods and learning approaches because it gives the learners the opportunity to apply 21st century skills and it helps teachers perform their role as creators of pedagogical environments. The importance of ICT integration into teaching and learning cannot be ignored since learners have become digitally oriented. The rapid technological advancement the world over has rendered access to information through ICTs virtually unlimited. Repositories of information are readily accessible with internet connectivity, necessitating a shift in teachers' role from being the sole source knowledge to a facilitator of learning.

Tezci, (2009) posited that ICT integration into teaching and learning is the usage of technology for educational processes like transacting curricular content and learners using digital devices to do authentic tasks. Technology integration typically include using digital devices for teaching and learning (Hew & Brush, 2007). Ndlovu & Moll, (2016) considered ICTs as part of teaching and not as simply supplements and that integration involves infusing the ICTs to effectively enhance the practice of teaching. The integration of ICT into classroom practices involves active, collaborative learning through learners' engagement in ICT-based learning environments. (Tezci, 2009).

Steukers, (2017) observed that digital teaching methodologies can improve lesson delivery by enhancing the quality of learning and supporting lifelong learning. The integration of technology in education is recognised in the Global Development Agenda under SDG 9 on innovation and SDG 4 on education.

Chindaro (2014) stated that ICT can be used to make teaching more effective. Teachers must support learners learning using digital devices since the learners' environment is technology imbued and workplaces are technology driven. However, ICT integration into education is affected by teachers' beliefs in their capabilities to use digital media forms in the practice of teaching. Hatlevic and Hatlevic, (2018) claimed that research showed that self-efficacy plays a pivotal role in how teachers master the art of teaching. They found a strong association between teachers' self-efficacy and their use of ICT in teaching. The teachers' motivation to integrate technology in the teaching and learning process and abandoning traditional forms of pedagogy are influenced by their belief in their capability to use the ICT tools in teaching (Hatlevic & Hatlevic, 2018).

The European Commission Joint Research Centre, 2009 observed that when ICTs are used in education, it motivates learners and enhance efficiency in educational practices. It is therefore imperative that teachers use ICT in teaching and learning. According to a Hooker, Mwiyeria, and Verma, (2011) in a World Bank and the Ministry of Educational and Vocational Training in Tanzania synthesis report, the global shift towards knowledge-based economies requires a change in how learning is viewed and requires an understanding of how text-based and digital-based classrooms can be used to facilitate learner-centred methodologies. Such methodologies allow learners to take greater responsibility for their learning. ICT has the potential to increase the richness and breadth of learning and can support higher order thinking in learners, including analysis and synthesis (Okorafor & Okorafor, 2011).

The Permanent Secretary in the Ministry of Primary and Secondary Education acknowledged that the Zimbabwean Government's focus was to prepare learners for the 21st century, emphasising the development of critical skills and competencies. She noted that there is increasing acknowledgement that content mastery knowledge on its own is not adequate as a learner exit attribute and that the development of higher-order thinking skills and competencies must be emphasised (MoPSE, 2014). Graduates for the 21st century market need strong academic qualifications but also need employability skills in an information driven economy that requires skill sets that enable them to live and work competitively in the global village. Sarfo, Amankwah, and Konin, (2017) claimed that computer technology can improve teaching for the development of 21st century competencies. Trucano, (2005) asserted that digital teaching methodologies enhance 21st century skills.

Any educational innovation geared to impart 21st century critical skills and competencies must consider the fact that society is dynamic, requiring lifelong learning. The learners therefore must be afforded the opportunity to learn to learn. MoPSE (2014) stated that ICTs and e-learning must be embraced as an intervention to foster lifelong learning.

Various benefits of ICT integration into the teaching and learning process have been documented. Lavonen, (2008) cited the following benefits of using ICTs in Science education:

- Learning becomes active, constructive, contextual, co-operative, self-regulated and reflective.
- It increases interest and is motivating.
- It affords access to quality and relevant resources; and
- It enables visualisation of complex images, enhancing understanding of scientific concepts.

Uiba and Kikas, (2008) asserted that the use of ICTs in teaching and learning has changed teachers' perceptions about their roles, increased learners' motivation to learn, enabled more collaboration and brought about the opportunity to vary teaching methods. Dube and Scott (2017) cited the following as benefits of using digital teaching methodologies in teaching and learning:

1. ICTs engage and empower learners.

2. They encourage creativity and peer learning.
3. They develop better literacy and communication skills in learners; and
4. They enable learners to keep abreast with current technologies.

The benefits of digital teaching methodologies are well documented (Abdullar, 2016; Aldoobie, 2015; Bailey & Mentz, 2013; Bates ,2015; Ghavifekr & Rosdy, 2015); Mandina, 2015). E-learning is beneficial to both teachers and learners because it offers new opportunities to enrich their teaching and learning experience (Pacific Policy Research Centre, 2010). The Pacific Research Centre supports programmes and organisations that transform educational outcomes across Hawaii and the greater Pacific. Pedro (2009) asserted that technologies demonstrate educational value. They offer powerful learning opportunities. Krause, Pietzner, Dori, and Eilks, (2017) noted that in Germany preservice teachers' imagination for using ICT in Chemistry teaching is rather limited. Their teaching mainly focuses on visualisation aids, and student-centred strategies are rarely applied in the teaching and learning process. The literature therefore suggests that digital teaching methodologies are necessary to improve classroom practice.

ICT integration into teaching and learning is affected by many factors, but chief among them is the willingness of the teacher to use digital teaching methodologies. Bitner and Bitner (2002) claimed that school related factors, such as poor planning and access to digital devices, are not the main factors to the success or failure of ICT use in teaching and learning, but that the effective use of digital teaching methodologies usually lies with the teachers. The teachers' choice on what, when and how to integrate ICT into teaching and learning depends on, among other factors, their self-efficacy beliefs. The effective use of ICT can only be analysed with the knowledge of users of the tool or a context where it is used. The effectiveness of the ICT tool depends on the pedagogical orientation of teachers and their beliefs about the usability of the ICT tools in teaching and learning (Lavonen, 2008).

Vijayalakshmi, (2021) posited that ICTs when used in teaching and learning, develop higher order cognitive skills which are important to solve complex real-world problems and learners are engaged in an active role of self-directed learning thus providing flexibility in the learning process.

Adhikari and Parsons (2012) carried out a baseline study on ICT integration in education and listed the following positive findings:

- Learners were able to gather information from several sources without difficulty.
- When using ICT for teaching and learning, learners could only carry one device instead of many books.
- There was an improvement in learner engagement in learning activities.
- Learners could use the digital pedagogical devices any time and anyway.
- Learners could engage in other activities like taking photos and video recording learning activities.

However, Adhikari and Parsons (2012) also noted the following negative findings:

- The use of digital learning tools distracted the learning process and led to a lack of control in the classroom.
- Problems of internet connectivity disrupted the learning process.
- Some learners spend most of their time on activities divorced from learning.

- Teachers focused on one specific digital device for teaching and learning, and some were reluctant to abandon their traditional teaching methodologies.

The positives listed above seem to outweigh the negatives since digital teaching and learning tools can be used in teaching and learning even without internet connectivity. This view is supported by Yunus, Nordin, Salehi, Sun, and Embi, (2013) who claimed that the disadvantages of using ICT in classroom practice can be overcome easily and Ghavifekr and Rosdy, (2015) who concluded that ICT use in teaching and learning is an effective teaching methodology. Measures like close monitoring can be used to ensure that learners do not engage in activities not related to learning. If teachers are well developed, they may embrace blended learning, which is using digital pedagogical tools and complementing it with their traditional teaching methodologies.

Kangara, Gocha, Tsokota, and Marovha, (2022) concluded that the degree of readiness for secondary schools to integrate ICTs in their teaching and learning was largely limited. Charalambos and Glass, (2007) asserted that teachers tend to imitate their own teachers and teach as they were taught. If teacher educators do not use ICTs to teach student teachers content and pedagogy, the chances are high that the products of the system (the teachers) will not employ digital teaching methodologies. They also observed that in rural areas, donated computers are being used to perform administrative work, such as typing and storing administrative and financial records. Most of the rural schools that received donated computers had not been capacitated to fully use the new technology for the benefit of the learners, teachers, and community. Based on research in sub-Saharan Africa, which includes Zimbabwe. Zimbabwe's education sector was therefore missing out on the benefits of ICT. Hennessy, Harrison, and Wamakote, (2010) noted that many teachers are intimidated by technology and are very comfortable with their established teaching styles. Farah (2011) asserted that it is important to address teachers' technology self-efficacy and identify interventions to influence it. This study sought to determine Science teachers' ICT self-efficacy and to propose a model to enhance it. A crucial dimension in teaching is teachers' self-efficacy. Zeb & Nawaz, (2016) asserted that confident teachers believe they can modify actions and demonstrate this belief through their attitude.

Harrison, (2010) suggested that if used properly and for explicit purposes in specific circumstances, technology can be an effective tool to support teaching and learning. Most researchers agreed that digital teaching methodologies are the way forward in the 21st century since learners have become increasingly digitally dependent. Pedro (2009) noted that the lives of the current learners depend mainly on technology. Their social practices are moulded by digital media. He also acknowledged that digital media is likely to influence the ways learners face their own education. Starkey, (2010)observed that the introduction of digital technologies is influencing ideas about knowledge and teaching theory and beliefs about teaching in the digital age. Zimbabwean learners are also caught up in the digital generational trend. Every generation has its distinctive generational 'consciousness', which depends on the pace of social change (Erstad, 2010). Cornu, (2010) suggested that it is impossible to currently teach or learn in the same way as a hundred years ago because of the rapid changes brought by ICT. These changes have a strong effect on knowledge, teaching, and learning.

Rural learners in Zimbabwe (those at rural day secondary schools) are also catching up with digital equipment such as mobile phones, some with chatting facilities and internet connectivity. These schools also have computers (a few though and donated in most cases). Therefore, these schools must embrace digital teaching methodologies in classroom practices.

Aremu and Fasan, (2011) claimed that teachers' computer self-efficacy influences computer uses in classroom teaching. According to Klopfer, (2010) good lesson delivery is possible in the absence of technologies but there will be a sharp disconnect between the way learners are taught in the classroom and their everyday experiences. The 21st century classroom by necessity requires the use of participatory approaches since learners are exposed to a lot of information sources. If the technology outside the classroom is not taken aboard then in the researcher's opinion, classroom practice may be surpassed by learners' worldviews.

Shittu and Shittu, (2014) emphasised that teaching and learning using technology help stimulate workplace experiences, preparing learners for the labour market. The rate of the technological change is ever increasing, and subsequently, there are huge changes in the economy, in the way we communicate and relate to each other, and increasingly, in the way learners learn (Bates, 2015). Jukes, McCain, and Crockett, (2010) concluded that educational institutions must keep abreast or else they will be rendered irrelevant.

Science teachers must make scientific concepts accessible to learners, and more emphasis must be placed on the understanding and application of scientific concepts. Teachers are therefore expected to design the best itinerary to help pupils reach the desired destination, which is understanding and applying scientific concepts. Effective Science teaching can be achieved with the use of ICT pedagogical tools, which can enhance learners' understanding of Science concepts. Isman, Yaratan, and Caner,(2007) claimed that ICT tools can change an abstract concept to concrete, making it easy to understand.

Professional development programmes where teachers collaborate with others, reflect on their classroom practice, and receive support and feedback have been shown to lead to effective professional growth (Huffman, 2006). ICT in the 21^{st} century has moulded learners who are technology savvy. Abdullar,(2016) observed that the learners interact with technology from a very young age, and teachers therefore are expected to change the learning setting by integrating ICTs into classroom practices to satisfy the requirements of the learners, allowing learners to relate with tools they are already familiar with.

The aims of the Zimbabwean O Level syllabus include the following:

- Promote critical-thinking, creativity and problem-solving skills that apply in the learner's everyday life.
- Participate in the technological development of the country.

Science learners who are relevant in the 21^{st} century must therefore be critical learners, have problem-solving skills and be able to analyse and evaluate data, solve novel problems, be innovative and be able to create new valuable ideas. Meenakshi, (2013 observed that the use of pedagogical ICT tools in teaching and learning is effective to ensure critical-thinking and problem-solving skills. When ICT pedagogical tools are used properly and effectively in the teaching and learning of Science, learners actively engage in the construction of knowledge and their thinking and problem-solving skills improve (Trowbridge, Bybee, & Powell, 2008).

It is therefore imperative that Science teachers use digital teaching methodologies. The learners must not lose out on the benefits of ICT pedagogical tools. Abdullar, (2016) argued that in today's globalised and technological driven world learning environments can be virtual, online, or remote.

2.4 The Digital Divide

The digital divide describes the gap between individuals who can readily access ICT and have the skills to use it and those who cannot access ICT and have no skills to use ICTs (Samia, 2007). Steukers, (2017) stated that participants at a Southern Africa regional meeting on ICT integration in classroom practice identified the ICT divide within countries as a challenge to ICT integration into teaching and learning). There is this digital divide between urban and rural schools in Manicaland. It should be noted, however, that some private and church schools in rural areas are moderately digitally equipped.

Mandoga, Matswetu, and Mhishi, (2013) noted that some of the challenges that Zimbabwean schools face are related to the high costs of purchasing and maintaining computers. The European Commission Joint Research Centre (2009) cited high costs, poor infrastructure, inadequate human resource capacity and insufficient policy frameworks as the barriers to the use of digital teaching methodologies (Gordon, 2009). While in Manicaland some schools have a fair number of computers, some have a few, and in most cases, these are reserved for the Computer Science subject and not for pedagogical use. The digital devices readily available in these schools are mobile phones, some with cameras and most with chatting facilities (short message services [SMS] and/or WhatsApp). Most of these rural schools do have some computers, courtesy of the Presidential Computerisation Programme. Mandoga, Matswetu, and Mhishi, (2013) noted that to tap the empowering benefits of ICT, the Government of Zimbabwe embarked on a massive drive to turn around the education sector by providing computers to many rural schools.

Lominé and Buckhingham (2009) posited that the rationale for using ICT must be anchored in pedagogy rather than the availability of the tools. Pedagogical considerations must reflect on learners' learning styles or needs. The use of any ICT tool in teaching and learning should be informed by the intended learning outcomes and the cost implications for the learners, teachers, and the school.

The pedagogical revolution prompted by technology must not leave some learners behind under the guise of the digital divide. The available digital tools must be exploited so that all learners benefit. Using any available digital tools has the potential to transcend any barrier and space in the provision of quality education. Quality instruction becomes accessible to all learners, including those affected by the digital divide. No learners, irrespective of geographical location, should lose out on the documented benefits of digital teaching methodologies. It is this researcher's submission that no learner should be left behind.

Educators and learners, like all members of the current (and future) generations, are living in a digital era characterised by technological creativity. The education system must not allow the opportunity to capitalise on digital teaching methodologies to slip away. While some critics are sceptical about the use of ICT in teaching and learning in technological poor environments, there seem to be no practical alternative to digital teaching methodologies as all learners, irrespective of geographical location, are technological oriented.

Hennessy, Harrison, and Wamakote, (2010) suggested that tteachers in technological poor environments, as is common in sub-Saharan Africa, must be supported so that they use ICTs for lesson delivery. The initiatives must be anchored on the provision of technological solutions rather than an interest in the physical technologies. Therefore, this study determined Science teachers' ICT self-efficacy, examined the relationship between Science teachers' self-efficacy and ICT integration into the teaching and learning process, and created a model to enhance teachers' ICT self-efficacy, irrespective of whether or not their teaching space is technology rich. The assumption is that all teaching environments in Manicaland have some digital devices for pedagogical use and that efforts are being made by the government and other partners to digitally equip all schools.

Qureshi (2013) studied the impact of leadership on the meaningful use of ICT and found that in some schools with limited resources, school heads tried to plan the teachers' lessons in such a way that the limited resources were used efficiently. Timetables were made in such a way that a maximum number of teachers could use the available digital equipment. Literature on the use of some digital tools readily available in all schools is reviewed in the following sections.

2.5 Cost-Effective and Readily Available Digital Tools

Steukers, (2017) noted that at a Southern Africa regional meeting organised by the UNESCO Regional Office for Southern Africa, the participants suggested that it is necessary to explore mobile learning as a strategy to enhance technology integration in teaching and learning. Zimbabwe was represented at the meeting. Mobile learning is the use of mobile devices as pedagogical tools. Kozma, (2011) asserted that mobile technology represents a significant opening for ICT advancement in developing countries as they provide media rich content on the web.

2.5.1 SMSs as a teaching and learning tool

SMSs are a component of mobile learning. Lominé and Buckhingham, (2009) cited the following as the advantages of using SMSs as a pedagogical tool:

- It has short texts (about 70 characters), so users (teachers and learners) express themselves concisely.
- Texts use little memory (no sounds, images, or videos), keeping costs down.
- No technical training is required for the teachers or the learners since SMSs are simply an imported and adapted tool that is already being used in society ().
- Learners learn at any place at any time.

Lominé and Buckhingham (2009) explained how SMSs can be used in higher arts education, and their suggestions can also be applied to Science education, the focus of this study. The researchers further argued that SMSs are a flexible learning tool and not subject specific. SMSs can be used for direct teaching as an interactive media where communication can be between the teacher and learners or between learners (questions and answers, sharing views or information, giving learning activities and/or instructions to the learners). SMSs can also be teacher related where the teacher gives personalised support to the learners, send them motivational messages, and gives feedback. Teachers can also use SMSs for general communication, such as sending reminders (key dates, homework, deadlines, cancelled or rescheduled classes) to learners. Small bites of educational content can be sent to learners via SMS (Burston, 2011).

Mellow, (2005) emphasised what he coined push, pull and interactive modes, which can be used to send educational content. The push mode involves the teacher sending educational content by SMS to learners; the pull mode involves learners requesting specific educational content; and the interactive mode is where the teacher pushes educational questions, or the learner pulls the questions and answers, and feedback are exchanged between the learners and teachers.

SMSs have the following disadvantages when used as a teaching and learning tool:

- SMSs have a limited number of characters that can be sent as one message (Mothana, Gasaymer, & Aldalala, 2013)
- SMSs cannot be used to send sounds, images, or videos (Leung, 2007) and

- SMSs do not enable group communication (Bouhnic & Deshen, 2014).

The advantages of using this technology as a teaching and learning tool outweigh these disadvantages.

2.5.2 WhatsApp as a teaching and learning tool

According to Bouhnic and Deshen (2014), WhatsApp is a smartphone application for instant messaging, and has a variety of functions, such as text messaging, attached images, audio files, video files and links to web addresses. WhatsApp enables communication between individuals or groups. Learning environments can therefore use this technology. According to Riyanto, (2013) WhatsApp cannot only be used for socialisation with friends but also for study purposes. Learners are familiar with this messaging application and most use it daily. If educators use this technology in the practice of teaching, they link with learners through a messaging application they use every day. Teachers would not waste time teaching the learners the skills to use the application. This methodology is therefore not divorced from learners' everyday life. Bouhnic and Deshen (2014) concurred when they claimed that WhatsApp chat groups can nurture the social atmosphere. Social incidences of conversation and debate afford learners the opportunity to learn.

Keskin and Metcalf (2011) noted that there is potential to improve learning using mobile devices as they are portable, universal, easily accessible, and popular. Fattah, (2015) asserted that the portability and accessibility of mobile devices have made their use in educational settings attractive. They also claimed that this social network (mobile phones) has availed new opportunities for teacher-learner interaction and collaboration. Social incidences of conversation and debate afford learners the opportunity to learn.

The WhatsApp platform has a group chats feature, and this can be used to create learning groups. Bouhnic and Deshen (2014) singled out the following as the uses of class WhatsApp groups:

- Dialogue creation.
- A learning platform.
- Communicating with learners.
- Nurturing the social atmosphere.
- Provides faster and continuous communication with learners.
- Teachers can keep in touch with learners outside the classroom, and thus, assignments can be administered to learners after learning hours; and
- Audio and video lessons can be created and send to learners, and learning is enhanced since learners can listen to the lesson repeatedly.

Rambe and Chipunza, (2013) discovered that learners claimed that WhatsApp allowed them to express themselves without a restricting environment, leading to high participation. Bouhnic and Deshen (2014) asserted that participants stated that WhatsApp as a teaching and learning tool has the following advantages: It is simple to operate, economic, readily available, and immediate. The educational advantages also included the creation of an enjoyable learning environment and an in-depth acquaintance with other learners. Academic advantages indicated were accessibility of learning materials, teacher availability and learning beyond class time.

Sweeny (2010) claimed that when WhatsApp is used to administer assignments, learners take these assignments more seriously to impress other learners.

Bouhnic and Deshen (2014) listed the following as challenges of using WhatsApp as a teaching and learning tool:

- Some learners may not have smartphones.
- Teachers maybe flooded with irrelevant and nonsensical messages from learners.
- Language used by some learners may not be compatible with other learners; and
- Learners may assume that their teachers are available 24/7, and therefore, communicate at odd hours.

Sweeny (2010) pointed out that instant messaging led to learners overlooking vowels and punctuation in their write ups. Bouhnic and Deshen (2014) posited that when WhatsApp is used as a learning tool, leaners use non-formal language, leading to teachers feeling challenged by leaners' manner of expression.

The many advantages of using WhatsApp in education outweigh the disadvantages. The most attractive advantage is that it can be used for educational communication with learners using a phone, which is very familiar and popular and is relatively cost effective. It can therefore be used effectively in technology poor environments.

2.5.3 Use of a digital camera as a teaching and learning tool

Jeff, (2013), claimed that the camera is a cheap and easy-to-use pedagogical tool. Triacca (2017) noted that teachers do not have to be experienced or specialised photographers to be able to use cameras in lesson delivery. Photographs can be used by learners to construct knowledge. Learners in Manicaland have access to mobile phones with cameras, and therefore, they already acquired the skills that are instrumental to classroom practice. The schools have the capacity to buy cameras for pedagogical use. Once cameras are available, everything else is free, and thus, the use of a camera is cost effective. Jeff (2015) claimed that use of a camera is an alternative pedagogical tool that even the most financially strapped school can afford. He further suggested that the use of cameras in teaching and learning makes learning learner-centred, project based, collaborative, multimodal and critical. The other advantage of using the camera as a media form is that the learner makes the media by taking pictures. Jeff (2015) observed that when learners are actively involved in creating learning photographs, the learning process becomes empowering. Visuals can be used to make concepts clear and situated and learners can focus on relevant elements (Triacca, 2017).

The literature therefore supported the researcher's assertion that all schools in Manicaland has the capacity to employ ICTs in teaching and learning. The availability of computers (a few in some schools) also makes it possible for the teachers to use other digital teaching methodologies not reviewed, including PowerPoint presentations, simulations, the virtual laboratory, and the internet.

2.6 Learning Theories and ICT Integration into Teaching and Learning

Matzen and Edmunds (2014) observed that when digital teaching methodologies are placed in the context of a specific instructional practice, teachers may use the methodologies to support the demonstrated instructional practice. Learning is a continuous process in human beings and can be formal or informal. Best practices in the teaching and learning process for the 21st century require teachers to be facilitators of learning by giving learners the opportunity to learn. A set of precise skills such as critical thinking and problem solving need to be the exit profiles of learners leaving the education system. For effective and efficient learning to take place, a scientific approach to the choice of teaching methodologies and media forms must be used.

To ensure learning takes place in any instructional endeavour, it is vital to explore the way learners receive, arrange, and retain information in long-term memory, and this has led to several learning theories. Learning theories are handy in instructional design that results in effective lesson delivery. Digital teaching methodologies must be matched to a theory of learning. The two theories that this study focused on are the constructivist learning theory and Kolb's experiential learning theory.

2.6.1 Constructivism

Constructivism is largely credited to Jean Piaget who articulated how learners internalise knowledge. He explained that learners construct new knowledge from their experiences through a process he coined accommodation and assimilation. Learners reconcile new concepts with previous experiences probably by changing their world views or by completely discarding the new information as irrelevant. Aldoobie, (2015) listed the following as points that explain the constructivist theory:

- A learner works in their mind to build knowledge; thus, knowledge is not transmitted to them.
- Experience and prior knowledge are used to explain new knowledge.
- The learning process is active and dynamic.
- Learning is a social process and related to learners’ community.
- Learning is a combination of comprehending concepts and possessing prior knowledge or experience, which act as a springboard for new knowledge.
- Learning takes place when learners practice; and
- Learners do not learn isolated facts but cause and relationships.

The constructivist theory therefore prescribes that the teacher should endeavour to allow the learners the opportunity to learn by building the knowledge and not reproducing knowledge during lesson delivery. Aldoobie, (2015) observed that learners can construct knowledge through discussions, cooperation, and social experience. The emphasis should be on critical-thinking and problem-solving skills. Effective lesson delivery is achieved through learner active participatory methodologies that involve problem-solving enquiry-based learning activities. Okorafor and Okorafor (2011) posited that this can be achieved using suitable media, and they singled out ICTs. They noted that constructivist pedagogical strategies demand the appropriate use of ICTs. Interaction with simulations, learner-learner and teacher-learner collaboration and undertaking collective learning activities facilitate knowledge construction. Active collaboration among peers is supported using collaborative technologies (Okorafor & Okorafor, 2011). Aldoobie (2015) posited that constructivism is one of the best learning theories that deal with any change that occurs in the educational environment. He further argued that randomly using ICTs in teaching may not result in the intended educational outcomes. A scientific approach in the use of ICTs in teaching and learning is key if the benefits of digital teaching methodologies are to be realised.

ICTs can be used as teaching and learning tools, and it works to integrate ICTs into education along with constructivism. The interactive nature of ICTs makes them suitable for use by teachers to allow collaborative learning, giving the learners the opportunity to learn. Learners can discuss and exchange views, allowing them to bring up their prior experiences and enriching their knowledge through meaningful discussions; hence, constructivism.

2.6.2 Kolb's experiential learning theory

The theory on experiential learning was introduced by Kolb, (1984) and has been acknowledged as an effective pedagogical model. The theory is underlined by the constructivist view on knowledge construction. Abdulwahed and Nagy (2009) concurred when they stated that Kolb's theory provides a clear mechanism of the strategy of teaching and learning underscored by the constructivist view. Experiential learning focuses on how learners gain knowledge through experiences. Through experiences, learners can construct a sense of understanding of what goes on around them. Zhou and Brown (2015) claimed that educators harness the power of experience in computer-based interventions. According to the theory on experiential learning, learners should have the following four types of abilities:

- Concrete experiences
- Reflective observation

- Abstract conceptualisation
- Active experimentation.

Optimal learning is possible when learners have an adequate balance of the four stages. The four stages lead to two phases of knowledge construction, namely the prehension dimension and the transformation dimension. Figure 2.1 summarises the theory.

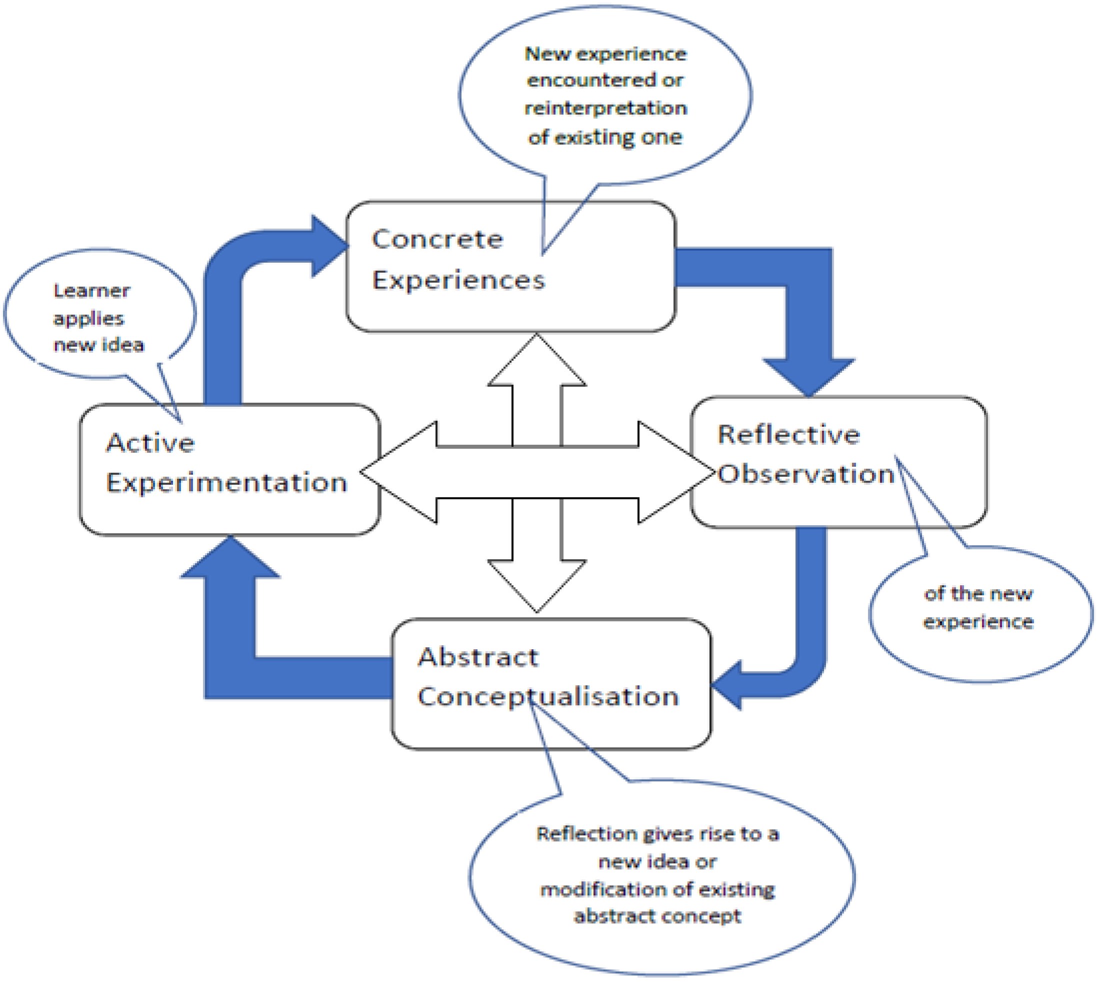

Figure 2.1 A summary of Kolb's experiential learning theory (adapted from Abdulwahed & Nagy, 2009).

According to the theory, optimal learning traverses the cycle demonstrated in Figure 2.1. Abdulwahed and Nagy (2009) noted that often learners may not do well in laboratory sessions because of poor activation of the prehension dimension. According to the learning theory demonstrated in Figure 2.1, learners should first detect and depict knowledge. This study advocated for the use of ICT in teaching and learning. Abdulwahed and Nagy (2009) observed that the introduction of a virtual lab in the pre-lab preparation led to a significant improvement in the conceptual understanding of the learners. ICT can be combined with concrete experience and abstract conceptualisation to trigger the grasping dimension (prehension mode) of the experiential learning theory cycle, and this leads to the activation of the transformation dimension (Abdulwahed & Nagy, 2009). Digital teaching methodologies could therefore be handy to activate the dimensions in Kolb's learning model. It should be noted, however, that computer simulations cannot replace hands-on activities. ICTs are teaching and learning tools that compliments other teaching and learning media forms. The National Research Council, (2009) noted that some schools may undertake digital trips and learning does take place during these trips, but the learners are only be exposed to what is considered important in the media. On an actual trip, learners encounter experiences that engage all their senses. It is therefore advisable to use blended learning as a strategy for teaching and learning.

Marshal and Robinson, (2019) studied the effects of Kolb's experiential learning model on successful intelligence in secondary agriculture learners and concluded that learners who receive experiential learning obtained higher domain specific creativity scores and scored well in practical use of knowledge. They recommended blended learning. This study advocates for blended learning, and therefore it was necessary to explore teachers' self-efficacy and propose a model to enhance it to ensure technology integration in teaching and learning.

2.7 Self-Efficacy

Self-efficacy is a psychological theory that attempts to explain the cause of individuals' choices to pursue a specific activity and the magnitude of effort devoted to the activity. Bandura (2006) described teacher self-efficacy as teachers' beliefs in their own ability to plan, organise and carry out activities that are required to accomplish stated educational outcomes. Sarfo, Amankwah, and Konin, (2017) described self-efficacy as individuals' confidence or beliefs. Cheraghi and Dasta (2015) defined self-efficacy in teaching and learning as the role of an individual's competences to bring about desired changes in learners' performances and achievements.

2.8 Teachers' ICT Self-Efficacy

Wadmany, (2011) asserted that teacher related factors have the most influence on ICT integration into education. The choice to use digital teaching methodologies in classroom practice is determined by teachers' skills and self-efficacy beliefs, among other variables (Bitner & Bitner, 2002). Teachers' ICT self-efficacy influences computer use for classroom teaching (Aremu & Fasan, 2012; Ertmer, 2006). Kazan and EL-Daou, (2016) noted that teachers' perception on whether they can effectively use technology in the practice of teaching have a bearing on their ability to do so. What teachers think about themselves in relation to ICT use in classroom practice often depend on their attitude towards the effective use of digital teaching methodologies. According to Zindi & Ruparanganda, (2011), one of the major barriers to ICT integration into teaching and learning met by Zimbabwean Science and Mathematics teachers is lack of confidence (). The willingness to use digital teaching methodologies may therefore largely depend on teachers' self-efficacy. Teachers are the key implementers of ICT integration and need to embrace a domain of knowledge that combines ICT with subject content and applicable teaching and learning approaches (Lubuya, 2012). Kazan and EL-Daou (2016) found that teachers' self-efficacy and learners' academic performance are correlated. They concluded that as teachers' self-efficacy positively increases, learners' academic performance also increases. What then is the level of ICT self-efficacy of the Science teachers in Manicaland? The research sought to answer this question.

Jones (2004) conducted a study in the UK and found that lack of personal confidence (self-efficacy) is a key barrier to ICT integration into the teaching and learning process. They also cited lack of awareness of the benefits of digital tools as a barrier. Teachers' choices to use an innovation in teaching and learning depend on how they value the innovation and how effective they expect the implementation of the innovation to be (expectancy-value model). The expectancy-value theory is grounded on the realisation that innovations are more likely to be adopted if the perceived value of the innovation or expectancy of success is high.2

Sangkawetai, Koul, and Neanchaleay, (2016) conducted a study to predict teachers' ICT integration in the classroom and found that the frequency of using digital teaching methodologies in teaching and learning is positively related to ICT self-efficacy. They also found that self-efficacy toward ICT integration is the strongest predictor for ICT use in teaching and learning. According to Achura and Villardon (2012), self-efficacy accounts for a mental construct that links knowledge and action, meaning is self-efficacy affects the practice of teaching.

It should be noted, however, that although ICT self-efficacy enhances the quality of teaching and learning, it does not guarantee on its own the effective practice of teaching. Achura and Villardon (2012) concurred when they observed that despite the notion that teachers' self-efficacy beliefs are relevant in teaching, that alone does not guarantee effective teaching. The researchers listed knowledge, training, and teaching skills as other essential factors that promote student learning. Onyia and Onyia, (2011) sought to determine whether a significant correlation exists between perception of self-efficacy and technology implementation in the teaching and learning process among teachers, and they found that there is a positive correlation between teacher self-efficacy and the integration of technology.

Qasem and Viswanathappa (2016) noted that student performance can be improved by using ICT and that it can change the nature of core subject practice and pedagogy. They further pointed out that this can only be achieved with proper guidance. Yamamoto and Yamaguchi (2016) concluded that if teachers believe they are competent (higher self-efficacy), they are willing to make extra effort to generate innovative lessons using ICTs. The success of educational transformation requires the development of positive teacher attitudes. Procurement of many and relevant digital devices neither guarantees improved instruction nor creates a more effective learning environment. Okorafor & Okorafor, (2011) stressed that the benefits of using ICT in Science teaching and learning can only be realised if teachers develop a positive attitude and appropriate competencies for ICT use in learning.

2.9 Sources of Self-Efficacy

According to Bandura (2006), the most effective ways to create a strong sense of efficacy are through:

- Mastery of experiences,
- Experiences provided by social models,
- Verbal persuasion, and
- Social persuasion.

The sources of efficacy are discussed separately but practically in the following subsections, but these sources influence each other and can be used concurrently. This research used collective reflection of experiences and Bandura's sources of self-efficacy as a model to ensure ICT integration into teaching and learning. Individuals who have high self-efficacy persist longer in the face of difficulties and are resilient in the face of failure (Artino, 2012).

Mastery of experiences

Experience influences individuals' ability to perform a given task. If someone performed well at a task previously, they are more likely to feel competent and perform well at an associated task (Bandura, 1977). Efficacy beliefs can therefore originate from experience. Experience is the knowledge gained when one is involved in an event or exposed to it. Confidence is built in individuals if they are successful in an activity. A group of Science teachers with low ICT self-efficacy can therefore be guided through activities they are likely to succeed at. Bandura, (1999) posited that people's self-efficacy can be enhanced by creating an environment that help them perform an activity successfully and have tasks assigned to them. The tasks can be broken down into manageable steps. Breaking down the activities into manageable tasks reduce the time it takes to accomplish them. The activities can then be performed together with identified individuals who are highly efficacious. Similar tasks are then done individually to ensure that coping successes stem from personal efficacy. Once people develop self-efficacy, they can withstand difficulties without adverse effects (Bandura, 1999). Prior task-based achievement on an activity motivates one to tackle similar but more complex future activities. Akhtar, (2008) argued a resilient sense of self-efficacy requires experience in surmounting constraints through effort. Schunk and Usher (2012) posited that, accomplishments experienced for which one has real evidence of success are the most dependable sources of efficacy, and thus, mastery of experience can be used as a source of self-efficacy. Zeb & Nawaz, (2015) argued that one very important source of self-efficacy is performance outcomes, where positive and negative experiences can impact the ability of an individual to perform a specific task.

Social models

People can develop high self-efficacy through other people's performances. Watching someone in a similar position perform and succeed can increase someone's self-efficacy (Bandura, 1977). If colleagues successfully perform an activity in the presence of those with difficulties performing the same activity, the success motivates those who are less competent, enhancing their self-efficacy. Watching people who have the same status as ourselves succeed raises our self-efficacy beliefs (Akhtar, 2008). Modelling is therefore an effective way to raise efficacy. If activities are modelled to show people how to cope with tasks perceived to be difficult, their self-efficacy beliefs are raised. The people modelling the activities provide relative information that can be used to benchmark someone's own capabilities. Social models are therefore instrumental to raise self-efficacy. Individuals can attain high or low self-efficacy through other people's performances. Zeb and Nawaz, (2015) asserted that a person's self-efficacy can be increased if the individual observes someone similar in status succeed.

Verbal persuasion

According to Redmond (2010), an individual's level of self-efficacy can also be enhanced through encouragement pertaining to their performance or ability to perform. Schunk and Usher, (2012) argued that positive verbal persuasion results in individuals exerting more effort, leading to a greater chance of success. If people are persuaded that they can perform an activity, they are more likely to put and sustain effort to master the activity. Verbal persuasion, however, may have little effect on adults. Bandura (1997) also noted the limitations of verbal persuasion and posited that it generates speculative expectations that focus on ability rather than effort. Verbal persuasion can therefore be used to complement the other sources of self-efficacy. Zeb and Nawaz, (2015) claimed that individuals can be made to believe that they can successfully achieve a task using encouragement.

2.10 Collective Reflection of Experiences

Reflection is a process in which individuals mirror their previous actions and explore them in greater depth, in other words, it is examining previous experiences. Beck and Jamissen, (2011) observed that exploring and curiosity about one's experiences lead to focused learning Reflective practice therefore creates opportunities for learning from experience. Reflecting on previous actions help individuals perceive themselves as instrumental, individually, and collectively, in setting programmes for ICT use in classroom practice (Phelps, Ellis, & Hase, 2001).

Beck and Jamissen (2005) created a project in which they added a reflective approach to a technology roll-out and the teachers involved reported that they developed a sense of mastery over technology and gained a more differentiated understanding of using ICT in teaching and learning. Their study was based on Paulo Freire's argument that there is a close relationship between reflection and activism. They claimed that that if action is required, then reflection is also necessary. The current study proposes a model that uses teachers' collective reflection of their experiences in ICT use as a tool for teaching and learning. This provides a springboard to increase Science teachers' ICT self-efficacy and their ICT adoption in teaching practices.

Analysis of teachers' descriptions of their experiences provide insights into how collaboration is significant, the importance of a shared understanding and a change in mind-set about teaching methodologies. These insights can be used to structure professional development (Kelly & Cherkowski, 2015).

2.11 Enhancing ICT Self-Efficacy

Hennessy, Harrison, &and Wamakote, (2010) observed that efforts to introduce ICTs into schools in sub-Saharan Africa have to a large extend been unsuccessful because of the top-down nature of the programmes and because little attention has been given to teacher involvement. The target population for this study is included in this assertion as Zimbabwe is in sub-Saharan Africa.

Steukers, (2017) noted that participants at a Southern Africa regional meeting acknowledged that inadequate teacher capacity was a challenge to technology integration into teaching and learning. In this digital era, teachers are expected to create ICT pedagogical environments and to present their teaching attractively to allow learners the opportunity to learn. Efforts should therefore be directed towards empowering teachers to enable them to use digital teaching methodologies. Staff development must therefore be tailor-made so that it enables teachers to use technology to enhance the quality of teaching and learning. Charalambos & Glass, (2007) cited lack of teacher professional development as one factor that may hinder the use of ICT in teaching and learning. Garces & Granada, (2016) argued that teacher professional development involves teachers engaging to change some of their pedagogical practices and map out new ways to meet their needs and interests in their contexts. This research's proposed staff development model fits well into the action research staff development model. This is supported by Hathorn & Dillon, (2018) when he posited that action research provides quality professional development where teachers are provided with opportunities to collaborate and share best practices. The proposed approach will allow teachers to jointly reflect on their experiences of using digital teaching methodologies in lesson delivery. The Science teachers will share and interrogate their practices regarding the use of ICT in the teaching-learning process. Garces & Granada, (2016) asserted that when teachers share what works and reflects on their practice, it leads to positive gains in their development.

Effective professional development to guarantee ICT integration into teaching and learning should provide teachers with techniques that enable them to use ICT in teaching and learning. It should be experiential, designed and directed by teachers, encompass reflection and collaboration, be participant driven, and involve teachers in concrete tasks (Downes, et al., 2001) The model proposed by this research addresses the above issues.

Hennessy, Harrison, and Wamakote, (2010) created the following list of features of successful programmes for teacher education in ICT use from their synthesis of research literature on teachers' use of ICTs in schools in sub-Saharan Africa:

- ICT integrated into subject teaching instead of simply introducing it as a discreate subject.
- Developing teacher confidence in ICT use.
- Developing an awareness of the potential of ICT to enhance teaching and learning through a hands-on workshop approach.
- Offering active learning opportunities for teachers that are sustainable and collaborative; and
- Locally developed programmes that are curricular relevant.

The strategy proposed in this study develops teachers use of digital teaching methodologies and enhance their ICT self-efficacy, and it is expected to use interactive and participatory methods rather than transmission-based methods.

Communities of Practice

This study proposed a professional development model to enhance Science teachers' ICT self-efficacy. Working groups in the form of CoPs are suggested to allow joint exploration of ideas and sharing of experiences in the use of digital tools in classroom practice. Teachers will mutually engage in discussions on best practices and challenges associated with digital teaching methodologies.

CoPs are groups of people who share a common concern or desire. The members enter the group of their own accord. They come together and collaboratively explore the concerns and ideas to grow their practice. Mercieca, (2017) suggested that CoPs are a form of social learning. The Science teachers in this study shared a common concern about the use of ICTs in lesson delivery. They could therefore come together in a group to perform a common activity and workshop to enhance their ICT self-efficacy. Haradhan (2017) defined CoP as an assembly of individuals who participate to perform a common activity with the aim of performing jobs properly. The proposed workshop framework infuses collaborative engagement among the Science teachers. In the group they will reflect on their practices using digital teaching methodologies, collaboratively and practically learn how to use other digital tools and evaluate the workshop activities. CoPs play an important role in sharing knowledge and generating value for the members and the organisation.

According to Haradhan (2017), CoPs have three features, namely domain, community, and practice. In this study, the domain is the teaching methods, the community are the Science teachers, and the practice is teaching and learning using digital pedagogical tools. Haradhan, (2017) posited that the group of people constituting a CoP shares a desire, a worry, or a set of problems regarding a particular topic, and they interact to expand their knowledge and expertise and learn how to do things better. Most CoPs have a natural life cycle. Whenever they are no longer fit for purpose, they fold up. They should be sustained, and their effectiveness improved (Bates, 2015). Wenger, McDermont, and Snyder, (2020) suggested that those in charge should do the following to ensure the sustenance and continued effectiveness of the CoP:

- Shift the focus to new needs, remaining within the domain of interest.
- Encourage the discussion of new viewpoints and ideas.
- Encourage participation from active members and those on the periphery, ensuring that all members are fully engaged.
- Emphasise value by discussing what members value most.
- Consider common concerns and perspectives and introduce thought-provoking perspectives for discussion; and
- Create a rhythm by regular scheduling of activities and making sure members are willing to collaborate.

Technology is ever changing, and therefore, new needs requiring professional development will continue to crop up; hence, the need to sustain CoPs. Discussing emerging digital teaching methodologies should be encouraged.

2.12 Summary

Most of the reviewed studies on ICT integration in Zimbabwe focused on factors such as ICT integration obstacles, challenges, perceived competencies, opportunities, and integration at different levels Konyana & Konyana, (2013); Mandina, (2015); Musarurwa, (2016); Zinyeka, (2012); Hepp (2004) claimed that only focussing on such factors will not produce meaningful results. This study therefore focused on an internal factor that the literature revealed has a significant effect on ICT integration, teachers’ ICT self-efficacy.

This study drew from the social cognitive theory premised on the view that self-influences impact the choice and creation of one’s environment, and that a major component of the social cognitive theory is self-efficacy, which enhances human achievement.

According to the literature review, the use of ICT tools in teaching and learning supports lifelong learning, makes teaching more effective, involves active and collaborative learning through student engagement, motivates learners, and instils in learners problem-solving and critical-thinking skills. Teachers therefore should use digital teaching methodologies for effective teaching and learning. The choice to employ digital teaching methodologies in classroom practice, however, depends on teachers’ ICT self-efficacy, among other variables. Most of the Science teachers in Zimbabwe do not use ICT tools in teaching and learning.

It was also noted in literature reviewed that to ensure technology integration in the teaching and learning process, effective professional development programmes should be launched. This study therefore proposes that the Science teachers’ ICT self-efficacy should be enhanced to achieve effective ICT integration in teaching and learning. Professional development programmes where teachers collaborate with others, reflect on their classroom practice, and receive support and feedback have been shown to lead to effective professional growth. The study therefore proposes a professional development model to enhance Science teachers’ ICT self-efficacy.

A gap was therefore identified in the literature reviewed, and this prompted the researcher to carry out this study whose aims were to find out to what extent Science teachers in the Manicaland Province of Zimbabwe integrate technology in the teaching and learning process, to determine the Science teachers' ICT self-efficacy, to discover if there is relationship between teachers' computer self-efficacy and the integration of ICT into the teaching and learning process, and to propose a professional development model to enhance teachers' ICT self-efficacy.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

The previous chapter reviewed the literature related to the study. Many researchers concurred that ICT integration into teaching and learning make teaching more effective, motivates learners, ensures desirable learner exit profiles like problem-solving and critical-thinking skills, and supports lifelong learning, among other benefits.

This chapter describes the research approach, research design, methodological research, research paradigm, target population, sample and sampling procedure, and the research instruments.

3.2 Research Approach

This study took advantage of the in-depth nature of qualitative findings and the generalizability of quantitative findings by using mixed methods research. Mixed methods research involves the collection and analysis of both quantitative and qualitative data in one research study. EL-Daou, (2015) stated that concurrent qualitative and quantitative data would enrich research on computer self-efficacy for teachers. More specifically, she recommended follow-up interviews with teachers, which would assist in obtaining more detailed data on the qualitative portion of a study of this nature. Mixed methods research data is collected alongside each other or sequentially and integrated at some stage in the research process (Creswell J. , 2014) Data to explore Science teachers' ICT self-efficacy and ICT integration into the teaching and learning of Science in Manicaland was collected sequentially. Mixed methods research has the advantage of showing results that otherwise may have been missed by a single method, and it also minimises the limitations of both. This form of inquiry is premised on the notion that a combination of qualitative and quantitative approaches provides a more complete understanding of a research problem than either qualitative or quantitative alone (Hanson, et al, 2005).

3.3 Research Design

This study adopted the exploratory sequential design using a descriptive survey. Data was collected in two phases. The initial phase (qualitative) was done to identify challenges and impediments to ICT integration in the teaching and learning of Science as perceived by the population members. The second phase of the research was carried out to determine the level of teachers' ICT self-efficacy and the frequency of use of digital devices in lesson delivery. To determine Science teachers' perceived obstacles and constraints to ICT integration in teaching and learning (phase 1) and explore their ICT self-efficacy and ICT integration into the teaching and learning of Science (phase 2) in Manicaland Province, a descriptive survey method was adopted. A descriptive survey design is a study carried out to describe the tendencies, attitudes, or opinions of individuals in a sample selected from a population by means of data collection tools (Creswell, 2012). A descriptive survey research design was chosen because the study was conducted to investigate Science teachers' levels of self-efficacy beliefs, their frequency at which they use ICT teaching tools, and their readiness to integrate ICT in lesson delivery. Surveys are used to learn about people's beliefs, values, demographics, opinions, and other types of information (Creswell, 2012)

3.4 Methodological Research

There are three basic mixed methods designs, namely convergent parallel, explanatory sequential and exploratory sequential designs (Creswell, 2014). These are discussed in the following subsection.

3.4.1 Convergent parallel

This approach involves the collection of both quantitative and qualitative data, and the data is analysed separately. The results are then compared to see whether they confirm each other. This design is premised on the assumption that qualitative and quantitative data provide different types of information. In this design, there are competing arguments on the size of the sample in qualitative data collection as opposed to that in the quantitative data collection. Some researchers use the same sample size for both qualitative and quantitative data. Using this approach implies that the qualitative sample will be increased limiting the amount of data collected from an individual (Creswell, 2014). Some researchers as is the practice use a smaller sample size for qualitative data collection and a bigger sample for the quantitative research arguing that qualitative methods allow the researcher to gain a deeper insights and quantitative methods allows for generalisation to the population thus each provides an adequate count irrespective of different sample sizes (Creswell J., 2014).

In the convergent parallel design individuals in the qualitative sample are included in the quantitative sample. The data collected concurrently from the qualitative phase and that from the quantitative phase is analysed separately, and results compared to determine whether they confirm each other (Creswell, 2014).

3.4.1 Explanatory sequential

The explanatory sequential mixed methods approach is carried out in two stages. Quantitative data is collected first, analysed and then used to map out the qualitative phase. Respondents and questionnaire items for the qualitative stage are based on the results of the quantitative phase. Quantitative data and the qualitative data are analysed separately (Creswell, 2014).

3.4.3 Exploratory sequential

This approach starts with the qualitative phase followed by the quantitative phase, which is the reverse of the explanatory sequential approach. The researcher begins by gathering and analysing the qualitative data. The findings are then used in the quantitative phase. The design starts with an exploratory phase followed by instrument development. The developed instrument is then administered to a sample of a population. Qualitative data is therefore used to develop a scale. New variables can also be developed from the qualitative data. Different samples for the qualitative and quantitative phases can be used but both samples can be drawn from the same population, making sure that the individuals for both samples are not the same (Creswell, 2014). Figure 3.1 summaries the three basic mixed methods design.

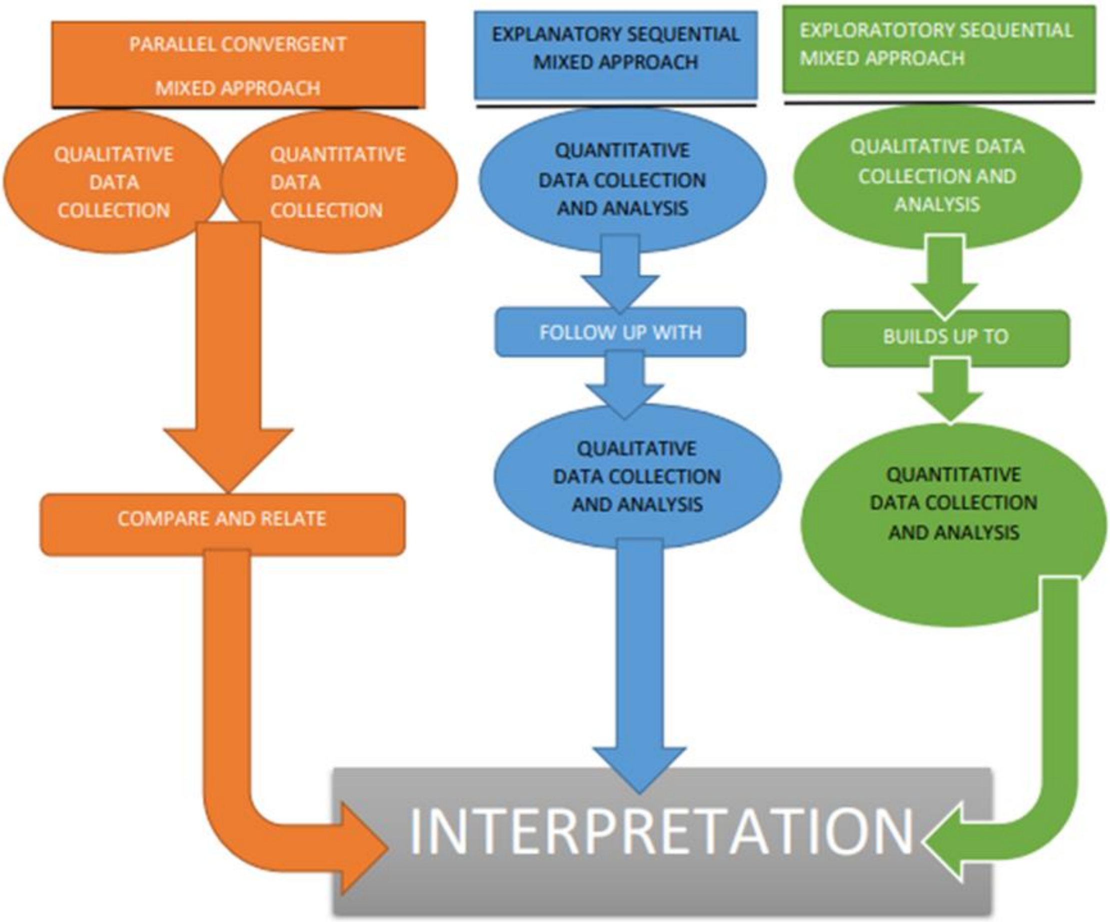

Figure 3.1 The three basic mixed methods design

This study adopted the exploratory sequential design using a descriptive survey. Data was collected in two phases. The initial phase (qualitative) was done to identify challenges and impediments to ICT integration in the teaching and learning of Science as perceived by the respondents. The second phase of the research was carried out to determine the level of teachers' ICT self-efficacy and the frequency of use of digital devices in lesson delivery. Figure 3.2 is a summary of the exploratory sequential design used for this study.

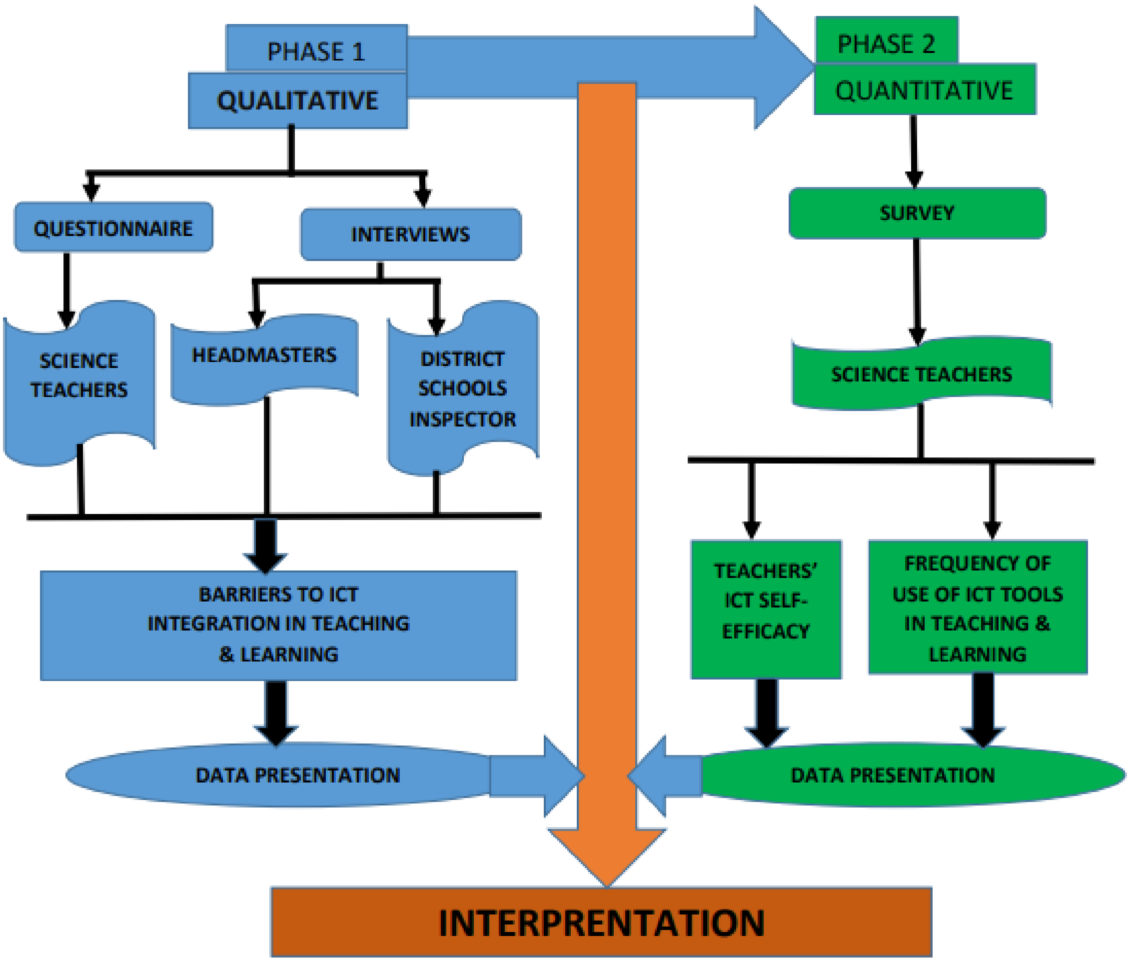

Figure 3.2 Exploratory sequential design flowchart for the study

Figure 3.2 summarises the research design adopted for this study. The qualitative method (the blue section of the figure) was the first phase of the research. Barriers to ICT integration in teaching and learning were solicited through the two pathways shown in the blue section of the figure, namely questionnaires administered to the Science teachers and interviews with the headmasters and a District Schools Inspector. The collected data was presented and analysed, leading to the quantitative phase of the research (the orange section). A descriptive survey was administered to the Science teachers to obtain numeric trends regarding their frequency of use of digital pedagogical tools and their ICT self-efficacy so that the researcher would generalize findings to the population. According to Creswell,2014, a survey design affords a quantitative description of trends of a population by considering a sample drawn from the population and the sample results can be generalized. The researcher then interviewed headmasters and a district schools inspector to enable an in-depth analysis on institutional and government support of ICT integration in education.

The Science teachers in the initial qualitative stage were asked to respond to questionnaire items on things that made it difficult for them to integrate ICTs into the teaching and learning process. The identified challenges were then used to modify the efficacy questionnaire items on Science teachers' ICT self-efficacy for the quantitative stage.

For the quantitative phase, survey questionnaires were administered to the Science teachers to determine their frequency of use of ICT tools in teaching and learning and their ICT self-efficacy. The collected data was presented and analysed. The analysed data from both the qualitative and the quantitative phases was then interpreted.

3.5 Philosophical Foundations/Research Paradigm

The choice of the mixed methods research was founded on an explicitly theoretical lens, which combined positivism and constructivism to bring about complementarity and development. Pragmatism can combine these two philosophies. According to Creswell, (2014) complementarity is when one method is used to elaborate on the results from the other method, while development is used when the results from one method develops or informs the other method. The results of the first phase of the study, which is perceived obstacles to ICT integration, were used to modify an instrument to measure the teachers' ICT self-efficacy. The results from the two stages were used to propose a staff development model to ensure ICT integration in the teaching and learning of Science in the province. Pragmatism was the philosophical foundation on which this study was built. For the mixed methods research, pragmatism ensures the use of multiple methods in a single study (Hanson, et al, 2005). The pragmatist research philosophy agrees that there are multiple ways of interpreting the world and that no single point of view can ever give the entire picture, and therefore, the philosophy can combine positivist and constructivist positions in single research (Collins, 2010). A quantitative approach entails a positivist paradigm belief, and a qualitative approach implies beliefs associated with a constructivist paradigm standpoint (Armitage, 2007). To explore Science teachers' self-efficacy and ICT integration into the teaching and learning of Science, the researcher therefore used pragmatism as the theoretical lens.

3.6 Population

The respondents for this study were drawn from secondary schools in Manicaland Province of Zimbabwe. The study was on Science teachers' self-efficacy and classroom ICT integration,

and therefore, the target population was about 800 Science teachers, 290 headmasters and seven district inspectors. Form 1–6 teachers participated in the study.

3.7 Sample and Sampling Technique

Sampling is the procedure of choosing a representative sample from the target population (Kamangar & Islami, 2013). Each of the seven administrative districts in the province has a district inspector who superintends the administrative and teaching and learning processes in the districts. Convenience sampling was used to select the district from where the district school's inspector would come from. The district inspector was selected to enunciate the

MoPSE policy on the use of digital teaching methodologies and the ministry expectations on the use of the methodologies. Convenience sampling is the selection of the most accessible or available participants (Umair, 2018). Convenience sampling is non-probability sampling. The procedure does not guarantee that all elements in the target population will have an equal chance to be included in the study (Etikan & Bala, 2017). The district inspector who participated in the study was stationed in the district where the researcher’s workstation is situated, making him the most accessible participant.

The first phase of the study was qualitative, and 35 Science teachers participated in this phase. The schools from where the respondents were selected entered the study by stratified and convenient sampling techniques. At the schools, respondents were then randomly sampled. Stratified sampling divides the target population into sub-groups that are individually homogenous, and respondents were randomly selected from each of the stratum to generate a sample (Etikan & Bala, 2017). About two schools were conveniently selected from each of the seven administrative districts where respondents were then randomly selected. At each of the seven out of the fourteen schools selected, two Science teachers were randomly selected and at the remaining seven selected schools, three Science teachers were randomly selected. The districts constituted the strata. The respondents were randomly selected from the schools visited by the researcher when he was on teaching practice supervision. The researcher’s workmates also helped distribute the research questionnaires to the school not visited by him. The teachers at these schools were most accessible and available. Five respondents in this sample were from private schools.

The four headmasters interviewed were selected by stratified and convenient sampling. The four closest districts to the researcher's workstation were conveniently selected and one headmaster from each of these strata at a school close to the researcher's station was conveniently chosen.

To avoid sampling errors in the second quantitative phase, the sample size was obtained from tabulated values calculated using a statistical sampling formula,

$$n = \frac{p(100-p)z^2}{E^2}$$

where:

- n is the sample size
- p is the percentage occurrence of a state (variance or heterogeneity of the population)
- E is the percentage maximum error
- z is the level of confidence level (Taherdoost, 2017).

For this study, p was estimated to be 50%. If an estimate of 50% is used as p, it results in the maximisation of variance producing the maximum sample size (Bartlett et al., 2001). E, the margin of error that is the risk the researcher was willing to accept was pegged at 5%. Therefore, 95% confidence was used for the calculation of the sample size. The z-value at this confidence level is 2.57. The sample size calculated from these values and tabulated in Table 3.1 is 260. This study used a sample of 270 respondents.

Table 3.1 Sample size based on desired accuracy with confidence level of 95%

		Margin of error: 5	Margin of error: 3	Margin of error: 1
Row	**Population**	**Sample size**	**Sample size**	**Sample size**
1	50	44	48	50
2	75	63	70	74
3	100	79	91	99
4	150	108	132	148
5	200	132	168	196
6	250	151	203	248
7	300	168	234	291
8	400	196	291	384
9	500	217	340	475
10	600	234	384	565
11	700	248	423	652
12	800	260	457	738

Source: Taherdoost (2017)

Table 3.1 was used to determine the sample size. The first column shows the population. For this study, the target population was 800 Science teachers. This population (row) 12 tallies with sample size of 260 (column 3) at 5% margin of error. For this study, a sample of 270 respondents was used.

3.8 The Instruments for Data Collection

The data collection tools for phase 1 of this study were two interview guides (one for headmasters and one for the District Schools Inspector), and a questionnaire with open- and close-ended items. A survey was used for phase 2 of the study. The data collection tools played a vital role in investigating the research questions.

3.8.1 Interviews

The vision of the government in general and headmasters may determine the success or failure of ICT integration into teaching and learning. Qureshi (2013) observed that leaders are critical in the effective implementation of ICT in the classroom. A district schools inspector in the province and three headmasters were therefore interviewed to determine the level of support afforded to the integration of ICT in the teaching and learning of Science by the government and the institutions. The successful integration of ICT in the classroom depends on the teacher, the learner and the headmaster's attitude towards the utility of digital teaching methodologies (Mhlongo, Dlamini, & Khoza, 2017).

According to Opdenakker, (2006) face-to-face interviews have the following advantages:

- Social signals such as voice, intonation, and body language of the interviewee can yield extra information.
- There is no time delay between question and answer; thus, interviewee responses are given as a first reaction without extended reflection.
- Interviews can be recorded, making the interview report more accurate.

Face-to-face interviews also offer flexibility in that questions can be explained, and responses can be probed. In this study the face-to-face interviews were conducted, and they were recorded using a mobile phone and later transcribed into text.

The disadvantages of using face-to-face interviews as a research tool, among others, are related to time and cost. The interviewer must meet transport costs and more time is needed to travel to and from the location of the interviews. To mitigate against the transport costs challenges, the researcher used convenient and stratified sampling to select the interviewees. Those closest to the interviewer's workstation were considered. The other disadvantage related to time is that more time is required to transcribe the recordings.

To minimise biases due to asking different participants same question differently, the researcher used a research interview schedule and did not deviate from the interview items on it. The purpose of the interviews was to answer the following research question: What are Science teachers' perceived obstacles/constraints to ICT integration into the teaching and learning of Science? A framework to answer the research question was designed with the following themes:

- Institutional support towards integration of ICT in teaching and learning
- Learners' responsible use of ICT devices
- Challenges encountered in the effort to integrate ICT in classroom practice

Long periods of work during transcription were avoided to reduce possible transcription errors due to fatigue. Reducing errors and bias was imperative to strengthen the validity and reliability of the study. Nigel, Fox, & Hunn, (2002) agreed that reducing interrogation errors, interpretation errors and recording errors strengthen the validity and reliability of the study.

3.8.2 Questionnaires

Techers in phase one of the study were asked to respond to questionnaire items on things that made it difficult for them to integrate ICTs into the teaching and learning process. Perceived efficacy should be measured against levels of task domains that represent gradations of challenges to successful performance (Bandura, 2006). The questionnaire had items that were open ended, allowing respondents the freedom to express their views. The respondents were also given a list of possible factors and asked to indicate whether these adversely affected their use of ICT in teaching and learning. The responses were given on a three-point Likert scale (*not at all*, *partially* and *a lot*). The identified challenges were then used to modify the efficacy questionnaire items on Science teachers' ICT self-efficacy. Self-efficacy reflects the level of difficulty individuals believe they can surmount. If there are no challenges, the activity becomes easy to perform and everyone is highly efficacious (Bandura, 2006).

The second phase of the study was a survey that was used to generalise the results to the population. Surveys are appropriate for gathering information on specific topics and allow the researcher to get numerical data from the target population. The survey employed questionnaires to determine the self-efficacy of study sample in phase 2. According to Young T, (2016) questionnaires are most common way of conducting surveys. This study sought to determine whether science teachers are currently using ICT tools in classroom practice and whether they would employ digital teaching methodologies hence questionnaires were the most appropriate instrument to use. Young T, (2016) posited that questionnaires can be used to determine respondents' future intentions and reporting on behaviors. Questionnaires were also appropriate since the study sought to collect large data sets Mathers, Fox, and Hunn, (2007) asserted that questionnaires can be used to gather large datasets relatively easily.

Structured questionnaires were used to determine self-efficacy and practices of Science teachers in Manicaland with regards to digital teaching methodologies. The questionnaires were divided into three sections. The first section was on demographic information, such as gender, age, teaching experience and experience with the use of a computer.

In the second section (to measure self-efficacy), respondents were presented with questionnaire items representing different levels of task demands and were asked to rate the strength of their capability to perform the activities. This ensured content validity. Self-efficacy questionnaire items should be expressed in terms of what the participant can do (for example: I can/cannot use a computer for lesson delivery) since it is concerned with perceived capabilities (Bandura, 2006). Questionnaire items for the survey were presented in three steps where respondents would rate their strength in performing ICT pedagogical tasks through a range from *cannot do*, *moderately certain can do* to *highly certain can do*. For purposes of quantifying the survey results, each of the survey items had three choices, ranging in 50-unit intervals on a 100-point scale from 0 (*cannot do*) through 50 (*moderately certain can do*) to 100 (*highly certain can do*), as suggested by Bandura (2006). The 100-point scale was chosen because it is more sensitive. Scales that use only a few steps should be avoided because they are less sensitive and less reliable (Bandura, 2006). An efficacy scale with 0–100 response format is a stronger predictor of performance than one with a five-interval scale (Pajares, Hartley, & Valiante, 2001).

Bandura (2006) dismissed the idea of an all-purpose measure of perceived self-efficacy. He claimed that such a measure has limited explanatory and predictive value and concluded that self-efficacy scales must be linked to the object of interest. The self-efficacy scale for this study was developed by the researcher based on the objectives of the study and the literature reviewed. It was adapted from Bandura's (2006) self-efficacy scale and from the computer self-efficacy scale developed by (Teo & Kor, 2010).

The third section used a five-point Likert scale to measure frequency of computer use by the target population in the teaching and learning of Science. The questionnaires (the survey, the five-point Likert scale items on efficacy questionnaire) were pilot tested to ensure the clarity of items to the target population. The results of the pilot test were used to determine the reliability of the survey scale using Cronbach's alpha reliability test.

To triangulate the data, four headmasters and a district schools inspector were interviewed to validate the findings on the frequency of ICT use in the teaching and learning process and institutional and government support. Figure 3.3 shows the triangulation of the data sources for this study.

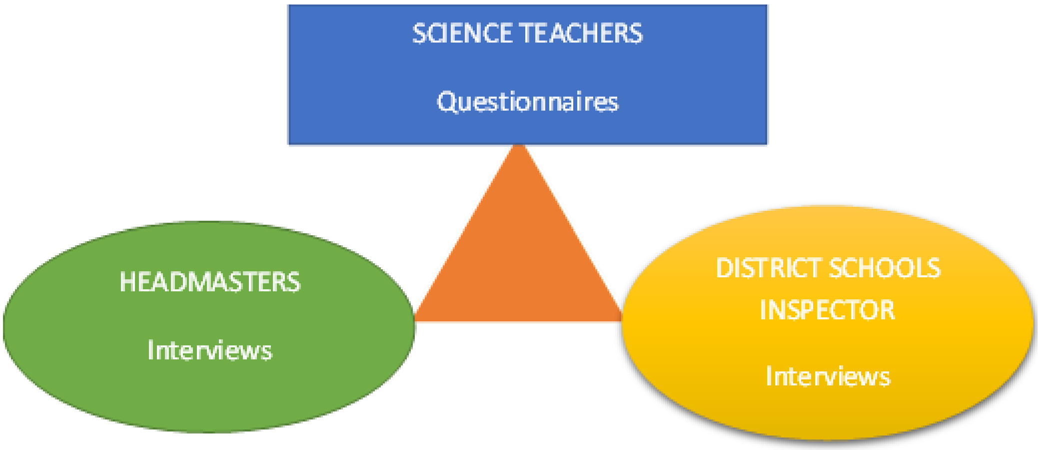

Figure 3.3 Triangulation of data sources

Figure 3.3 demonstrates that the Science teachers were the main source of data for this study. Data were obtained from the Science teachers using questionnaires. Headmasters and a District Schools Inspector were interviewed to triangulate the data obtained from the Science teachers. Data triangulation takes account of matters such as periods of time, space, and people (Noble & Heale, 2019). In this study, data was gathered from different groups of stake holders, that is teachers, headmasters and district school's inspector to answer the same research question. The aspects of data triangulated was the perceived barriers to ICT integration in education.

3.9 Data Analysis Techniques

3.9.1 Science teachers' questionnaire

A framework of research question 1: What are the Science teachers' perceived obstacles and constraints to ICT integration into the teaching and learning of Science?

Using the questionnaire items on the obstacles and constraints faced by Science teachers in integrating ICT into teaching and learning, a framework of the research question and the evolving themes was constructed based on the one used by Qureshi (2013)

Table 3.2 A framework of research question 1

Research Question	Themes	Questionnaire Item
What are the Science teachers' perceived obstacles and constraints into ICT integration in the teaching and learning of Science?	1. Teacher appreciation of ICT integration	What do you think about ICT integration into the teaching and learning of Science?
	2. Barriers to ICT	Does your school have a deliberate strategy on ICT integration into teaching and learning? Does the school administration support ICT integration into the teaching and learning of Science? Of the available gadgets, which ones have you ever used in lesson delivery? What are the available functional ICT gadgets at your school?
	3. Other barriers to ICT integration	What other constraints have you encountered in the use of ICT in lesson delivery?

The data from the questionnaire was put under the themes in Table 3.2 and analysed. Other emerging themes from the data were also considered and analysed.

Questionnaire item 2.8, a three-point Likert scale item designed to also answer research question 1, was quantitatively analysed to ensure validity. The responses were entered into

SPSS and descriptive statistics were generated. Combining quantitative and qualitative data enabled the researcher to compare, contrast and relate results to gain deeper insights.

3.9.2 Science teachers' questionnaire (self-efficacy): Descriptive statistics

The data collected using the questionnaire on teachers' ICT self-efficacy in the second phase of the study was analysed using descriptive statistics, measuring frequencies, means and standard deviations. The data was entered into SPSS for analysis.

3.9.3 Headmasters and District School Inspector interviews

The qualitative data from the interview transcripts were entered into NVivo, a qualitative research programme, and coded**.** Codes were pre-determined, and themes were generated from the codes.

3.9.4 Science teachers' questionnaires (self-efficacy and technology): Pearson's product moment correlation coefficient

The relationship between teacher self-efficacy and ICT use in the classroom was analysed using Pearson's product moment correlation coefficient. Pearson's correlation measures the following:

- The existence of a linear relation between two variables
- The p-value and the strength of the relationship

- The coefficient r between -1 and +1.

Pearson's product moment correlation explores the linear relationship between two variables. If a linear relationship exists between the variables, then when one of the variables increases, the other must also increase in step or if one decreases, the other must also decrease in step (positive correlation); or when one variable increases, the other must decrease in step (negative correlation). The relationship between the two variables was measured by correlation. The data was entered into SPSS and a scatter plot was drawn to show any trends in the relationship. If the scatter plot predicts a linear relationship, then the correlation coefficient is calculated (Gilchrist & Samuels, 2014). Table 3.3 shows how the value of Pearson's correlation moment coefficient was interpreted.

Table 3.3 Pearson's correlation moment coefficient interpretation

Correlation coefficient, r	**Interpretation**	**Correlation coefficient, r**	**Interpretation**
0.9 to 1.0	Very high positive	-0.9 to -1.0	Very high negative
0.7 to 0.9	High positive	-0.7 to -0.9	High negative
0.5 to 0.7	Moderate positive	-0.5 to -0.9	Moderate negative
0.3 to 0.5	Low positive	-0.3 to -0.5	Low negative
00 to 0.3	Negligible	00 to -0.3	Negligible

Adapted from Mukaka (2012)

The values in Table 3.3 (columns 1 and 3) indicate the strength of the association between two variables. The variables considered in this study were the science teachers' self-efficacy scores and the frequency of ICT use in teaching and learning. The closer the value of the Pearson correlation coefficient to either +1 or -1 the stronger the association. +1 depicts a positive relationship, meaning that as one of the variables increases the other also increases in step. -1 represents a negative relationship, meaning that as one variable increases the other decreases in step. This study sought to determine the relationship between Science teachers' ICT self-efficacy and the frequency of using ICT tools in teaching and learning to answer the research question: Is there a relationship between teacher ICT self-efficacy scores and frequency of ICT use in the classroom?

3.10 Staff Development Model

The findings from the study were used to modify the proposed model to enhance Science teachers' ICT self-efficacy. A staff development implementation scenario was then developed.

3.11 Validity and Reliability

Reliability is the extent to which results are consistent over time and represent the whole target population, and validity is about whether the research measures what it purports to measure (Joppe, 2000, cited in Zohrabi, 2013). Content validity is when different elements, skills and behaviours are sufficiently and effectively measured (Zohrabi, 2013). In this study, two PhD holders were asked to review the Science teachers' questionnaire, and on their recommendations one question was reworded and another one discarded.

Internal validity is the degree to which the researcher observes and measures what is supposed to be measured. The questionnaire items were developed from the research objectives and research questions. The following three methods to ensure internal validity suggested by Zohrabi, (2013) were considered:

1. Triangulation: Data was collected through interviews and questionnaires using open- and closed-ended questions.
2. Peer examination: non-participants reviewed the data and findings and commented.
3. Researcher bias: The researcher collected, analysed, and interpreted the data impartially and was non-judgemental throughout the research process. Ethical considerations were adhered to, and the findings are reported honestly.

Merriam, (1998) suggested that the reliability of results can be ensured in the following ways:

- The researcher’s position: For this study, the significance of the study, the research design and the participants are described in detail. The processes and phases of the study are explicitly explained.
- Triangulation: Different data collection procedures and different sources were used to obtain data. The researcher also used closed- and open-ended questionnaires and interviews.
- Audit trail: Data collection, analysis, formulation of themes and the results are described in detail. The detailed information should help to replicate the research, and hence, boosts its reliability.

The internal consistency of the survey was determined by entering the data into SPSS and computing the Cronbach alpha coefficient, α. Table 3.4 shows the rule used to interpret α.

Table 3.4 The rule used to interpret α

Cronbach's alpha (α)	**Internal consistence**
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

The table shows the assessment of a measure of reliability of the survey scale (Cronbach α). $\alpha = 0$ shows that the scale items are entirely independent from one another; therefore, they are not correlated, and hence, not reliable. $\alpha = 1$ shows that items have a high covariance, meaning that they measure the same underlying concept.

3.12 Ethical Considerations

The Canterbury Christ Church University (2014) listed the following reasons why studies on human beings require ethical considerations:

- To protect the rights of the participants.
- To minimise the risk, psychological discomfort, harm, or danger from the research procedures.
- To protect the reputation of the university where the researcher is a student; and

- To minimise the likelihood of claims of negligence against the researcher and the university.

This research therefore conformed to informed consent and ethics principles to protect the participants, the university where the researcher is enrolled, and the researcher himself. In that regard, data collection for this research only started after the researcher applied to the University of Witwatersrand ethics committee for ethics approval. The study's ethical credibility and approval was granted (see Appendix A).

Data was collected in secondary schools, which falls under the Ministry of Primary and Secondary Schools. The head of the ministry is the Permanent Secretary, and therefore, he was contacted to seek permission to carry out the study in the targeted schools in Zimbabwe (see Appendix B). The permission was granted (see Appendix C).

The target population were secondary school teachers in Manicaland Province. A provincial director represents the Permanent Secretary in the province and oversees all educational endeavours in the province. Permission was sought to carry out the study in Manicaland from the Provincial Education Director, and it was it was granted (see Appendix D).

Permission to carry out the research in the districts was sought from and granted by the District Schools Inspector (see Appendix E). The District Schools Inspector also completed a consent form (see Appendix F)

Permission to gain access to each of the schools was requested from each of the headmasters. The headmasters also completed a consent form (see Appendix G). The teachers were issued with a letter explaining what the research is about, its purpose, the prospective respondents and what participation entailed (Appendix I). Participants and ministry officials were assured that the names of the research participants and the identity of the schools and districts would be always kept confidential and that data gathered in this study would be treated with the strictest confidentiality and presented only in summary without names or affiliations. Participants were also assured that the choice not to participate would not have any consequences and that they could withdraw their participation at any time during the project without any penalty.

Data collection only began after all ethics protocols were observed. Issues of consent and confidentiality were therefore addressed.

3.13 Summary

This study took advantage of the in-depth nature of qualitative findings and the generalizability of quantitative findings and used mixed research methods. Data was collected in two phases, and therefore, the study used the exploratory sequential design using a descriptive survey. The choice of the mixed methods research was founded on an explicitly theoretical lens that is pragmatism, which combines positivism and constructivism to bring about complementarity and development.

The data collection tools used in this study were two interview guides (one for headmasters and one for the District Schools Inspector), a questionnaire with open- and closed-ended items for the Science teachers who participated in phase 1 of the study, and a survey for the phase 2 of the study.

CHAPTER 4: PHASE 1 DATA PRESENTATION AND ANALYSIS

4.1 Introduction

This chapter presents and analyses the qualitative data for the first phase of the study.

4.2 Data Collected

This section summarizes the data collected in phase one of the research and describes the respondents and return rates. It should be noted at the outset that the proposed number of participants for the headmaster interviews was affected by lockdowns due to the Covid-19 pandemic. The onset of the lockdown coincided with the process of data collection. Schools closed and teachers were not at their workstations. For the first part of phase 1 of the study, however, the return rate was 100% as the data was collected before the lockdown period. This stage was qualitative, and 35 questionnaires were distributed and returned. The study had proposed to interview four headmasters but, in the field, only three were interviewed. Table 4.1 shows the respondents of the study for phase 1.

Table 4.1 Study respondents

Study phase	Description of target population	Instrument	Sample initially proposed	Returned/ achieved	Return rate
1 Qualitative	Science secondary school teachers in Manicaland Province	Questionnaires	35	35	100%

Study phase	Description of target population	Instrument	Sample initially proposed	Returned/ achieved	Return rate
	District Schools Inspector	Interview schedule	1	1	100%
	Headmasters	Interview schedules	4	3	75.0%

4.3 Demographic Data

The demographic data collected from respondents is presented in this section.

Table 4.2 Gender

Gender	Frequency	Percentage (%)
Male	28	80
Female	7	20

Table 4.3 shows that most of the teachers in the sample are above 40 years old.

Table 4.3 Age of the respondents

Age/years	Frequency	Percentage (%)
18 to 20	0	0
21 to 30	4	11
31 to 40	10	29
Above 40	21	60

Table 4.4 shows that 57% of the teachers sampled have been in the teaching field for more than 11 years.

Table 4.4 Work experience

Work experience/years	Frequency	Percentage (%)
1 year and below	2	6
2–10	13	37
11–20	7	20
21 and above	13	37

Table 4.5 shows that most of the sampled teachers (80%) have less than 10 years' experience using a computer, 17% has less than one-year experience with a computer, and 20% has worked with a computer for more than 10 years.

Table 4.5 Experience using a computer

Experience with using a computer	Frequency	Percentage (%)
1 year and below	6	17
2–10	22	63
11–20	5	14
21 and above	2	6

4.4 Findings from the open-ended questions from the questionnaire

This section presents and analyses data for the open-ended items to answer the following research question: What are the Science teachers' perceived obstacles and constraints to ICT integration into the teaching and learning of Science?

The instrument used to solicit data to answer the research question was a questionnaire with nine open-ended questionnaire items and nine closed-ended questions. This section focuses on the open-ended questionnaire item responses, but where an overlap of responses was observed, reference is made to such responses from the closed-ended questionnaire item responses.

The following are the first two questionnaire items:

1. What do you think about ICT integration into the teaching and learning of Science?
2. What is your opinion on the notion that "the efficiency of the learning process can be increased through the use of ICT"?

Questionnaire items 1 and 2 sought to determine the likelihood that the respondents (if all other obstacles are dealt with) would use ICT in the teaching and learning process. This study referred to the expectancy-value model to predict whether the respondents see value in the pedagogical innovation and expects it to be successful. Rogers' diffusion of innovation model was also used to predict at what level of the innovation-decision process spectrum the respondents were. According to Rogers (2003), the innovation-decision process involves seeking and processing information to minimise uncertainty on the advantages and disadvantages of an innovation. The process follows the following five steps:

1. Knowledge
2. Persuasion
3. Decision
4. Implementation
5. Confirmation

Determining where respondents are on the decision-innovation process stages helped to decide on the appropriate professional development model.

The rest of the questionnaire items, listed below, attempted to extract the barriers the respondents felt were hindering the effective integration of ICT in teaching and learning:

- Does your school have a deliberate strategy on ICT integration in teaching and learning? Explain the strategy.
- Does the school administration support ICT integration into the teaching and learning of Science?

- Give details of how the school supports ICT integration into the teaching and learning of Science.
- What are the functional ICT gadgets available at your school?
- Of the available gadgets, which ones have you ever used in lesson delivery.
- What other challenges/obstacles/constraints have you encountered in the use of ICT in lesson delivery?

A reliability analysis was carried out on the survey to determine the Science teachers' self-efficacy comprising 24 items. Table 4.6 shows that Cronbach's alpha showed the survey scale reached an acceptable reliability of $\alpha = 0.805$.

Table 4.6. SPSS output for Cronbach's alpha coefficient, α

Reliability statistics		
Cronbach's alpha	**Cronbach's alpha based on standardised items**	**N of items**
.805	.786	24

A Cronbach's alpha coefficient of 0.805 was acceptable as it shows a high level of internal consistency for the scale used with the sample. The closer the coefficient is to one the greater the internal consistency of the items (Gliem & Gliem, 2003).

Data from the open-ended item responses was entered into NVivo for coding with the following four pre-determine themes which formed the basis of the findings:

1. Teacher appreciation of ICT integration
2. Barriers to ICT integration
    2.1. Institutional/leadership support
        i. School strategy on ICT integration
        ii. Administration support
        iii. Available functional ICT gadgets at the school
3. ICT gadgets normally used by teachers as pedagogical tools
4. Other challenges/barriers/constraints to ICT integration

4.4.1 Teacher appreciation of ICT integration into teaching and learning

The following discussion focuses on how the Science teachers in the study sample perceived the use of ICT in teaching and learning. The research sought to determine whether teachers in the study sample appreciate the benefits of using ICT efficiently and effectively in teaching and learning hence their likelihood to employ digital teaching methodologies. An innovation is more likely to be accepted if its perceived value of success is high (Wozney, 2006).

Thirty-three (94%) of the 35 Science teachers sampled in this study indicated that the use of ICT in teaching and learning increases the efficiency and effectiveness of the learning process. One participant did not answer the question and one claimed that question was irrelevant since they did not have ICT in their department. Below are some responses given by the respondents on the benefits of ICT integration:

> It's the best way to go. Science should incorporate ICT for the betterment of the learners. (Respondent 3)

It helps learners to grasp concepts easily as there is enough resources from ICT. (Respondent 5)

It makes work easier. (Respondents 4, 6, 7, 8, 15, 16, 19 and 23)

Makes work easier and faster. Challenging questions in a lesson can be answered by clicking a button. Record keeping become easier. Schemes can be easily done. (Respondent 7)

It makes work easier, and learners quickly understand the concepts being taught. (Respondent 8)

The use of ICT in teaching and learning provides collaborative learning and it allows both learners and teachers to explore more using ICT. (Respondent 11)

It would be very much useful and of great importance. We cannot do effective Science teaching and learning without ICT. (Respondent 12)

The use of ICT is of more importance in Science. It helps learners to visualise and, they can use audio. Learners can see how some of the experiments are carried out. (Respondent 13)

Motivates the learner. (Respondent 17)

It’s a noble move which makes comprehension of abstract concepts easier to impart to learners. (Respondent 22)

The learning becomes interesting. (Respondent 35)

An NVivo text search showed that “makes work easier” was the most used phrase by the respondents. Shamim & Raihan, (2016) researched on the effectiveness of using ICTs to promote teaching and learning in technical education and found that using digital teaching methodologies made teaching and learning very easy.

The above responses show that the teachers have a strong desire to integrate ICT in the practice of teaching. Khalid et al. (2009) reviewed literature on barriers to the successful integration of ICT into teaching and learning environments and found that teachers have a strong desire to integrate ICT into education. Ndawi et al. (2013) found that teachers generally appreciated the benefits of digital teaching methodologies.

4.4.2 Barriers to ICT integration

Data on the perceived barriers hindering ICT integration into the teaching and learning process are presented and analysed in this section. The main theme of barriers to ICT integration was broken down into the following sub-themes:

- Institutional/leadership support
    - School strategy on ICT integration
    - Administration support
    - Available functional ICT gadgets at the school

4.4.2.1 Institutional/leadership support

The school's management structures are expected to support any pedagogical innovation if its benefits are to be realised. The questionnaire items that follow sought to extract data on the extend of this support. The responses from the respondents are shown in the following subsections.

4.4.2.1.1 School strategy on ICT integration

Respondents were asked to respond to the following question with a 'no' or 'yes': Does your school have a deliberate strategy on ICT integration in teaching and learning? Responses to the above questionnaire item are shown in Figure 4.1.

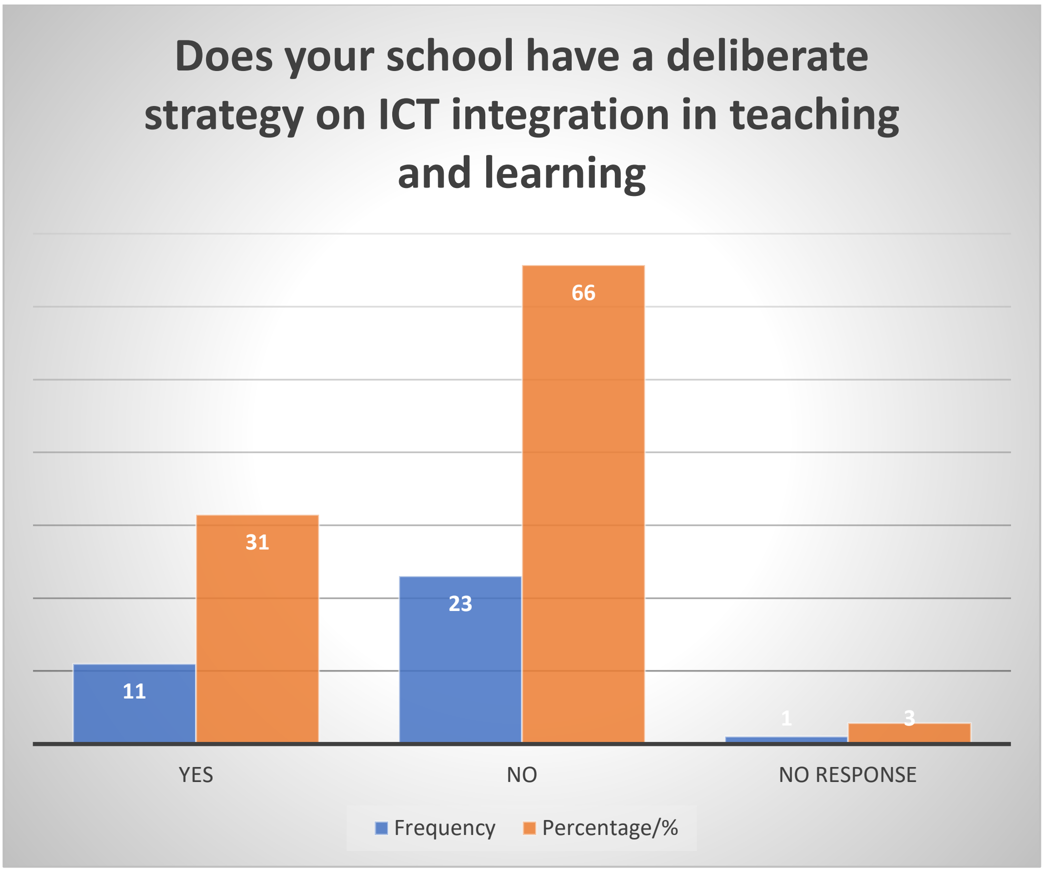

Figure 4.1 School strategy on ICT integration into teaching and learning

Sixty-six percent (66%) of the respondents indicated that there is no deliberate strategy on ICT integration at their schools, 31% of the respondents indicated that a deliberate strategy to integrate ICT in teaching and learning existed at their schools, and one participant did not respond to the questionnaire item.

Insufficient ICT planning and lack of strategies on how to integrate ICT into the teaching and learning process may hinder teachers' efforts to use digital teaching methodologies (Wozney et al., 2006). Most of the respondents' claimed that their schools do not have a strategy for integrating ICT into teaching and learning and this matches the findings by Ndawi, Thomas, and Nyaruwata, (2013), whose research on barriers to effective integration of ICT in Harare secondary schools revealed that schools in Harare, Zimbabwe, had no clear sense of direction on how to embrace ICTs to enhance student learning.

The respondents who felt that their schools had a deliberate strategy to integrate ICT in teaching and learning cited the following as indicators that a strategy exists:

- ICT infrastructure
- ICT tools
- Administration support
- School activities linked to ICT.

The following extracts show their responses:

> Our laboratories have interactive boards which have USB connections and Wi-Fi connections as well. (Respondent 26)
>
> The school is planning to have a projector but now it has Wi-Fi to link us to the outdoor world. (Respondent 12)
>
> It is mandatory for Form ones to bring laptops/tablets to school. (Respondent 7)
>
> The use of cell phones is allowed in the school but there are a few functional computers. (Respondent 5)

> The administration supports the procurement of hardware and software; they approve if ordered. Computers as a subject has been introduced. Thanks to the presidential scheme for equipping schools with such important gadgets. The school is in a process of installing internet. (Respondent 8)

> All junior (Form 1–2) learners must do computer literacy. (Respondent 27)

Staff development workshops on ICT use in teaching are carried out. (Respondent 16)

While some respondents indicated that learners may bring mobile phones to school, it should be noted that at present the Ministry of Education does not allow learners to bring mobile phones to school; however, this issue is still being debated, implying that it may be reversed at some time. This was revealed by the District Schools Inspector when he responded to the following interview question: Explain the Ministry's position regarding learners bringing personally owned digital devices such as laptops or mobile phones to school. The following was his response:

> The ministry, yes, allows learners to provide their own with regards to laptops. However, when it comes to mobile phones, there is still a debate. Something you may be aware, that they may not be allowed to use the mobile phones, particularly during the learning process. However, for the laptops there is not much of a challenge, yes.

The teachers, however, can take advantage of the fact that learners have access to mobile phones that belong to them or to someone they share a home with, and thus use the ICT tool outside normal learning time so that some learners do not miss out on the benefits associated with the use of technology in teaching and learning. Some private schools allow their learners to bring mobile phones to school; hence, some responses above that imply that leaners are allowed to be in possession of mobile phones during learning time. In research carried out in South Africa by Maphalala, (2014) they noted that a considerable number of learners brought mobile phones to school. They also observed that some schools do not have functional policies on learner use of mobile phones and some of the schools have banned the use of mobile phones in their learning areas. The reasons given for such measures were security reasons and lesson disruption. Their study concluded that the benefits of allowing learners to bring mobile phones to school may outweigh the disadvantages. This study subscribes to this conclusion.

The respondents' responses discussed shows that the respondents strongly felt that lack of strategies to integrate ICT in teaching and learning may hinder teachers' efforts to implement ICT in lesson delivery.

4.4.2.1.2 Administration support

Respondents were asked to answer the following question with a 'yes' or 'no': Does the school administration support ICT integration into the teaching and learning of Science. The results are shown in Figure 4.2.

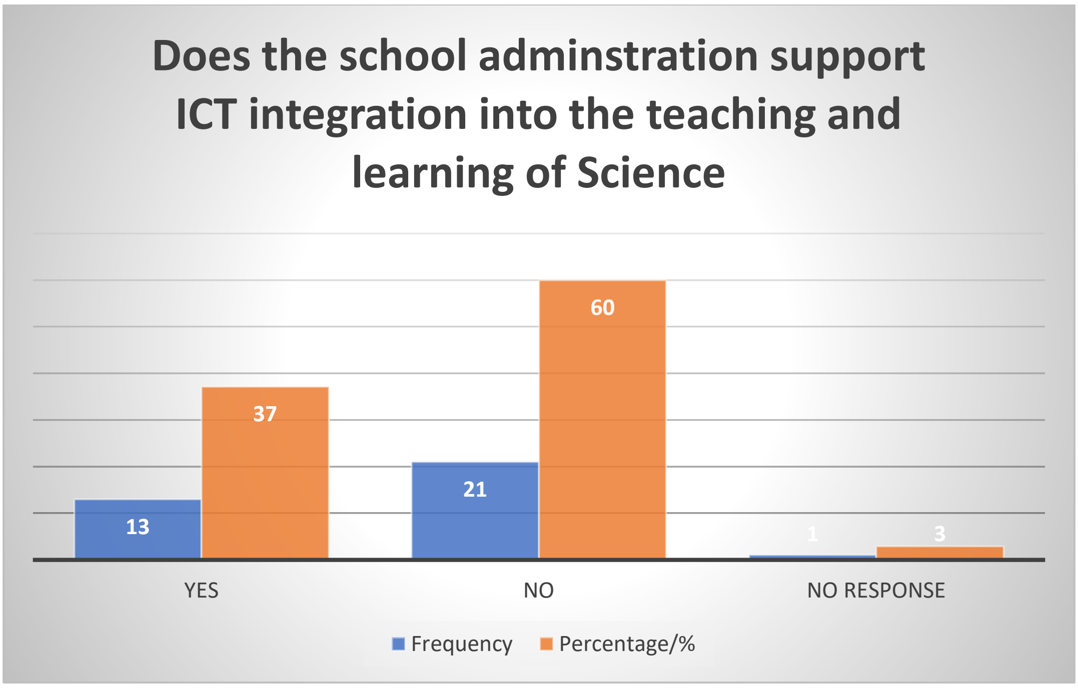

Figure 4.2 School administration support

Sixty percent (60%) of the respondents indicated that the school leadership does not support the integration of ICT into the learning process, 37% indicated that their school leadership supported the use of ICT in teaching and learning, and one participant did not respond to this questionnaire item. In their study on barriers to effective integration of information and technology in Harare schools, Ndawi, Thomas, and Nyaruwata, (2013) found that most teachers in their study sample felt there was no adequate support and encouragement from their schools to use digital teaching methodologies.

Responding to a questionnaire item on challenges encountered in the use of ICT in lesson delivery, one participant claimed that the constraint was an “arrogant headmaster”. The participant did not elaborate on the claim, but this may mean the headmaster was not open to teachers’ ideas on ICT integration. However, in the researcher’s opinion it is obvious that the participant implied that the headmaster did not support ICT integration into teaching and learning.

According to Ogbomo, (2011), school administrators are key in ICT integration into education. He further claimed that several ICT projects were undermined by lack of support from school leadership and that for ICT integration to be effective and sustainable, administrators must be competent in technology use. One of the headmasters interviewed implicitly agreed that he and half of his staff were not computer cultured. Below is an extract of his response when he was asked the following interview question: How does the school ensure that teachers use digital teaching methodologies in the teaching and learning process?

> It's still a challenge, we don't have resources to train them, but there is need to train more than half of our current establishment of 32 qualified teachers. Half of them are okay, but the other half, including me, we were 'born before computers' so definitely there is need to be staff developed.

This was confirmed by one participant whose age range was above 40 years. When he responded to the questionnaire item on obstacles to ICT integration, he said the following: "Knowledge to operate the computer effectively is lacking" (Respondent 31).

Here follow other respondents' responses to the same questionnaire item:

> Lack of interest in integrating ICT in teaching and learning by school authorities. (Respondent 23)

Resistance to change by the admin. (Respondent 17)

Lack of support from school authorities. (Respondent 4)

Lack of interest in integrating ICT in teaching and learning by school authorities. (Respondent 19)

According to the responses discussed above, the respondents felt that lack of support from the administration was a barrier to ICT integration into teaching and learning. The respondents cited the following as the reasons to show that the school authorities did not support the efforts to integrate ICT in the teaching and learning process:

- Administrators' negative attitude towards use of the digital devices
- Lack of skills/competencies on the part of the administrators
- Lack of ICT infrastructure in the schools

4.4.2.1.3 Available functional ICT gadgets at the school

Participant were asked to list the ICT gadgets available in their schools and their responses are shown in Figure 4.3.

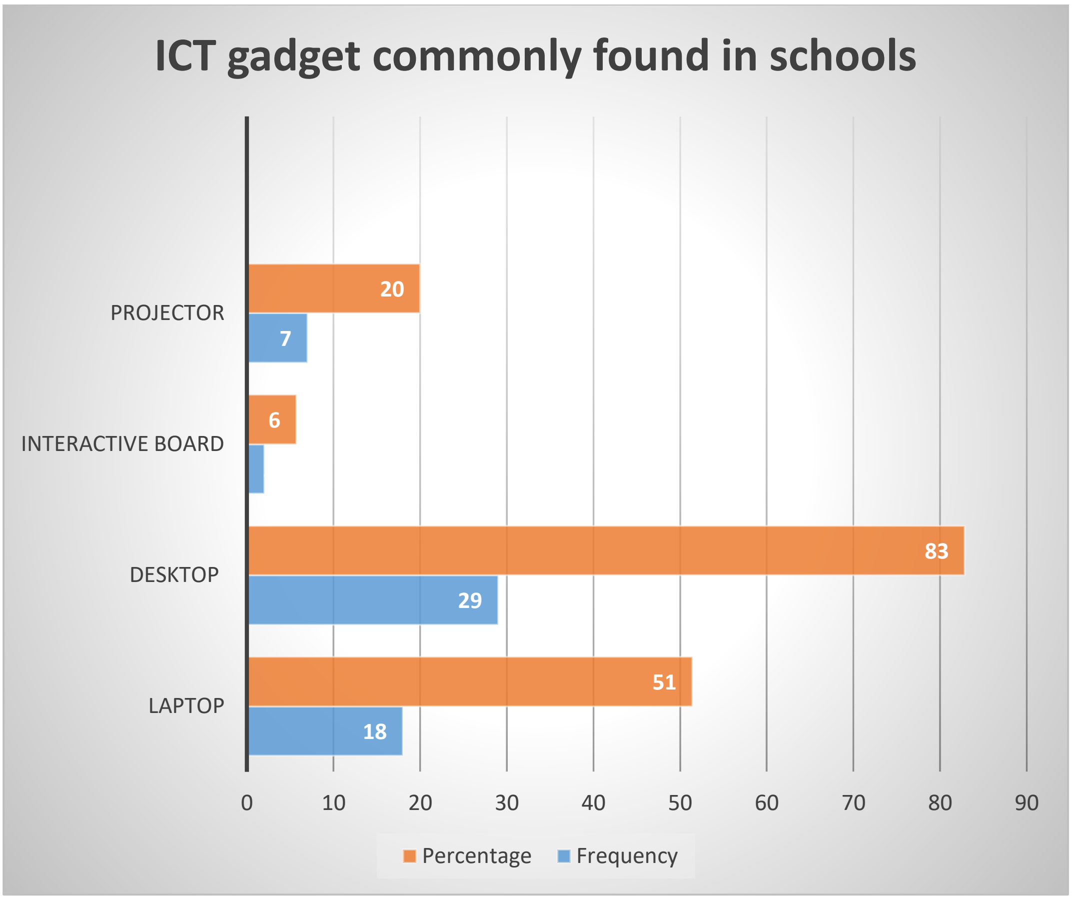

Figure 4.3 ICT gadgets commonly found in schools

Figure 4.3 shows the digital gadgets the respondents listed in available in their schools. Most of the respondents were quick to point out that the gadgets are few and mostly confined to the Computer Science subject area, and thus not accessible to other teachers.

Respondent 1 said that what they had available are “5 desktops at a grade 1 high school”. Grade 1 schools in Zimbabwe have a high enrolment. The response implied a high learner-computer ratio at the school. This statement was echoed by another participant who claimed that “there is competition for the gadgets”. Some respondents claimed that the available gadgets in their schools were not accessible to most teachers, as revealed by the extracts of their responses below:

> Desktops only available at the administration offices and at the Computer Science lab only limited to Computer Science learners. The computers are only available for the computer lessons only. (Respondent 3)
>
> The computers are exclusively for the Computer Science department. (Respondent 2)
>
> The only gadgets in the school are available for teaching and learning of Computer Science as a subject. (Respondent 31)

Ndawi et al. (2013) and Ogbomo (2011) also cited unavailability of ICT tools as a barrier to the successful integration of ICT into teaching and learning. The respondents besides citing the fact that a few ICT gadgets were available in the schools also revealed that the Science teachers had little to no access to the available ICT gadgets

4.4.3 Gadgets available in the school normally used by Science teachers in teaching and learning

Respondents were asked to list which of the gadgets that they indicated were available in their schools had they ever used in teaching and learning. Twenty-five out of the sampled 35 Science teachers indicated that they had never used any of the ICT gadgets available at their schools in lesson delivery. Varied reasons were given but the most common ones were inaccessibility to the usually few digital gadgets at the school and lack of skills on the part of the teacher to employ digital teaching methodologies. Below are some extracts from their responses:

> None now since we do not have electrical power in the classrooms except in the computer lab. (Respondent 10)
>
> None, the few available are exclusively for the Computer Science department. (Respondent 29)
>
> There is competition for the projector, so it's rarely used. None because the computer lab is only available for computer lessons only. (Respondent 31)

The findings paint a gloomy picture with regards to ICT integration into teaching and learning. IT clearly shows that teachers are not employing digital teaching methodologies though their benefits are many and well documented. The teachers articulated most of these benefits in their responses. There seem to be no attempt by the teachers to use ICTs in lesson delivery, even at the schools where functional ICT tools are available, and they do not try to use other available digital tools like the radio, television, mobile phones, and cameras.

4.4.4 Other barriers to ICT integration

Figure 4.4 shows the barriers to ICT integration cited by the respondents. Non-availability of ICT gadgets was cited by 71% of the respondents and 51% indicated that lack of skills by the teacher is a hinderance to successful ICT integration into teaching and learning. Other barriers to ICT integration into teaching and learning cited by the respondents are lack of support by the school administration (31%), unavailability of electricity or power outages (26%), time constraints (11%) and connectivity problems (3%).

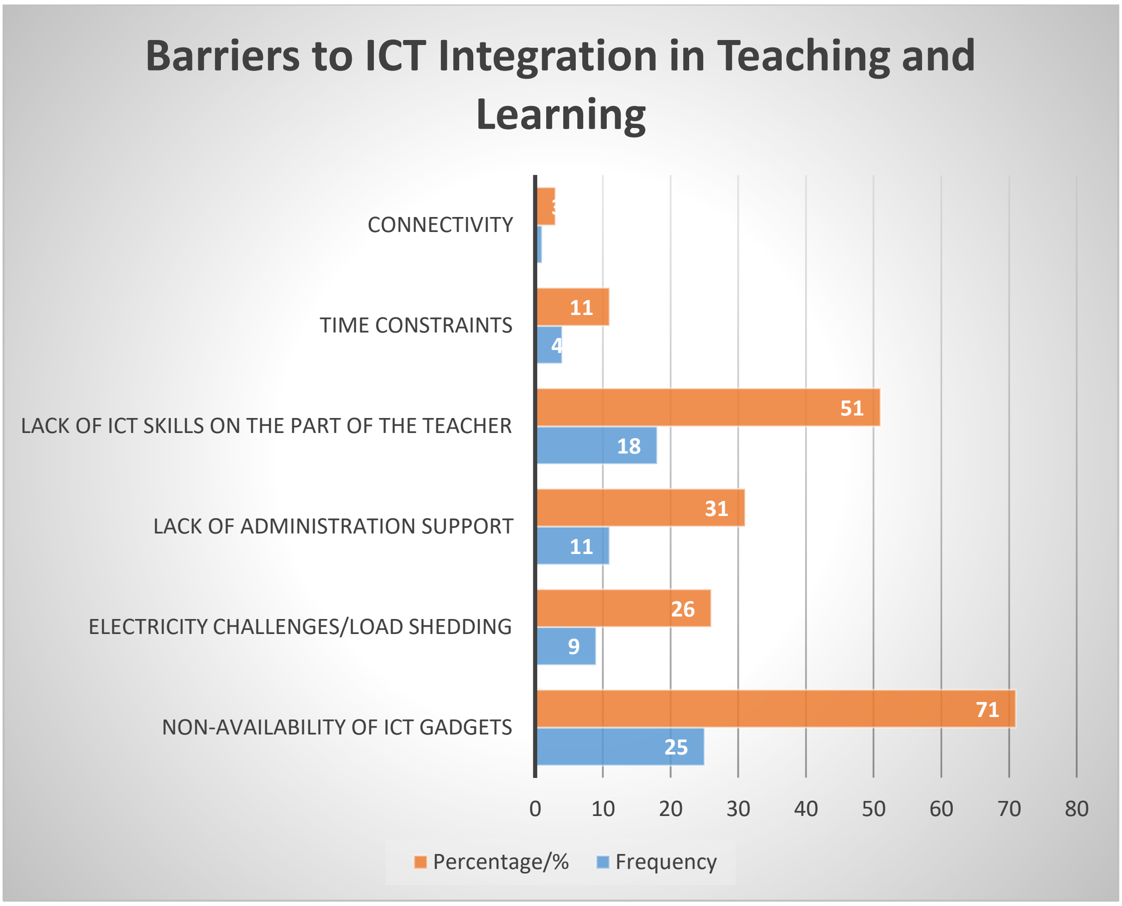

Figure 4.4 Barriers to ICT integration

Some of the respondents' responses are captured below.

Lack of skills in the use of ICT. (Respondent 7)

There is fear by the teachers to embrace new/modern ways of teaching, they stick to the old ways of teaching. (Respondent 35)

Knowledge to operate the computer effectively is lacking. (Respondent 31).

These can be attributed to lack of confidence using ICT tools on the part of the teachers (low self-efficacy). One participant claimed that ICT did not exist in the department, implying no effort at all to integrate ICT into teaching and learning. He said that “We don’t have the ICT tools at all in the Science department” (Respondent 9).

The challenge of non-availability of electricity in some schools and power outages was cited as a barrier to ICT integration into the teaching and learning of Science by 26% of the respondents. However, the Minister of Energy and Power Development revealed that the government is continuing its efforts to electrify rural secondary schools. The minister revealed that 70% of the rural secondary schools were electrified under the rural electrification programme. The government through the Treasury had allocated a significant amount of money for the programme to augment the rural electrification fund levy (Mupanedemo, 2020). The rural electrification levy is 6% levied on electricity sales.

The obstacles alluded to by the study respondents agree with the following obstacles listed and categorised as external variables (Ghavifekr, Kunjappan, Ramasamy, & Antony, 2016):

- Restricted accessibility and connectivity
- Limited ICT facilities
- Lack of effective training
- Limited time
- Lack of teachers’ competency.

4.5 Findings from the Closed-ended Questionnaire Items

This section focuses on the closed-ended questionnaire item responses. respondents were given a list of possible factors and asked to indicate whether these adversely affect the use of ICT in teaching and learning. This part of the questionnaire sought to answer the following research question: What are the Science teachers' perceived obstacles and constraints to ICT integration into the teaching and learning of Science?

Items on possible factors that may be barriers to ICT integration into teaching and learning were given (Table 4.7) and respondents were asked to select how much the factors influenced their ICT the integration. They could choose from *not at all*, *partially* and *a lot*.

Table 4.7 Is the use of ICT in teaching and learning adversely affected by the following?

	Not at all	**Partially**	**A lot**
Lack of adequate skills on your part			
Insufficient technical support			
Insufficient pedagogical support			
Inability to create activities in the computer on your part			
Inability to use educational software to create digital content for use during lesson delivery			
Time needed to learn using ICT prevents me to use ICT			
Limited understanding on how to integrate ICT into teaching			

The following subsections discuss the factors that may hinder ICT integration into teaching and learning and shows the respondents' responses.

4.5.1 Lack of skills to integrate ICT into teaching and learning

Figure 4.5 summarises the respondents' responses as frequencies and expressed as a percentage of the total number of the respondents.

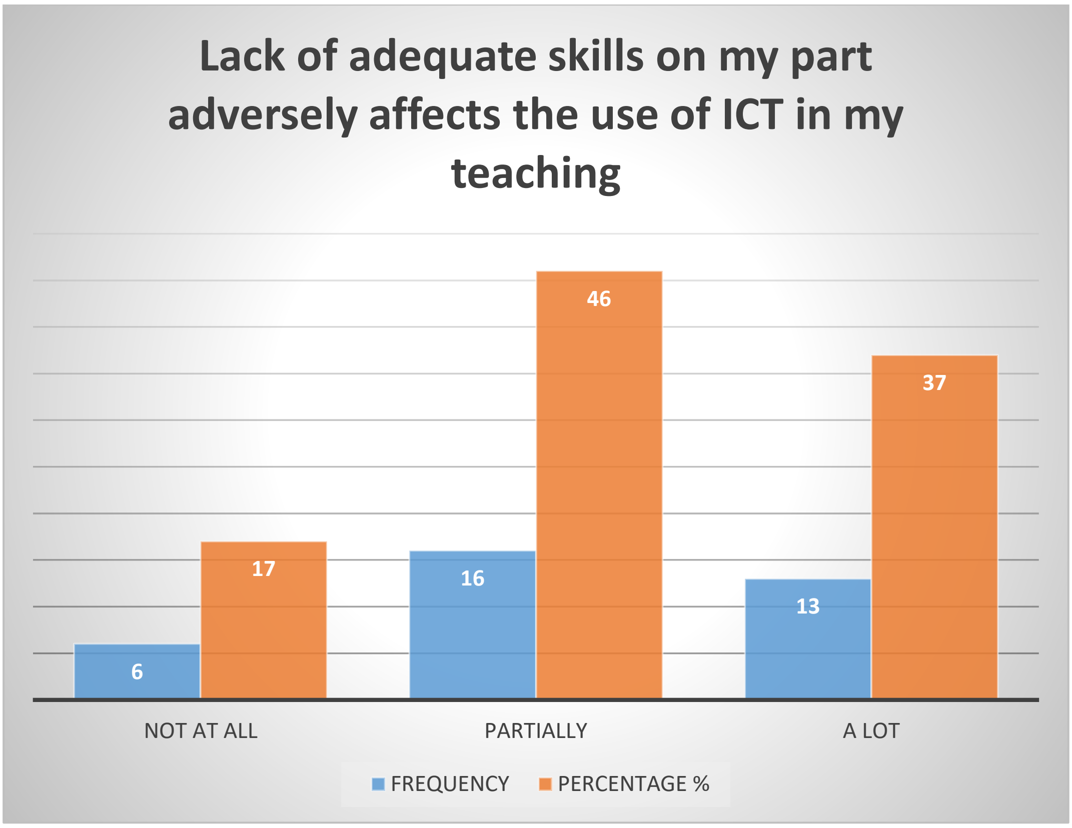

Figure 4.5 Lack of skills to integrate ICT into teaching and learning

Only 17% of the respondents indicated that lack of adequate skills on the part of the teacher does not affect the use of ICT in teaching and learning. Of the respondents, 83% (46% = *partially* and 37% = *a lot*) indicated that lack of adequate skills affected the use of ICT in teaching and learning. Most respondents therefore perceived themselves as lacking the necessary skills to ensure ICT integration into lesson delivery. Ghavifekr, et al, (2016) found that teachers who do not use computers in teaching and learning claim that lack of skills is a constraint preventing them from using ICT for teaching.

This study and other studies reviewed indicated that some digital devices that can be used by teachers in the teaching and learning process can be imported from every life, implying that teachers do not need any form of expertise to use them. This study proposed a professional development model to enhance Science teachers' self-efficacy. The choice to employ digital teaching methodologies in classroom practice is determined by the teacher's skills and self-efficacy beliefs, among other variables (Bitner & Bitner, 2002).

4.5.2 Insufficient technical support

Another factor that may hinder the use of ICT tools in teaching and learning is insufficient technical support. respondents were asked to indicate the degree to which they agreed with the assertion and their responses are shown in Figure 4.6.

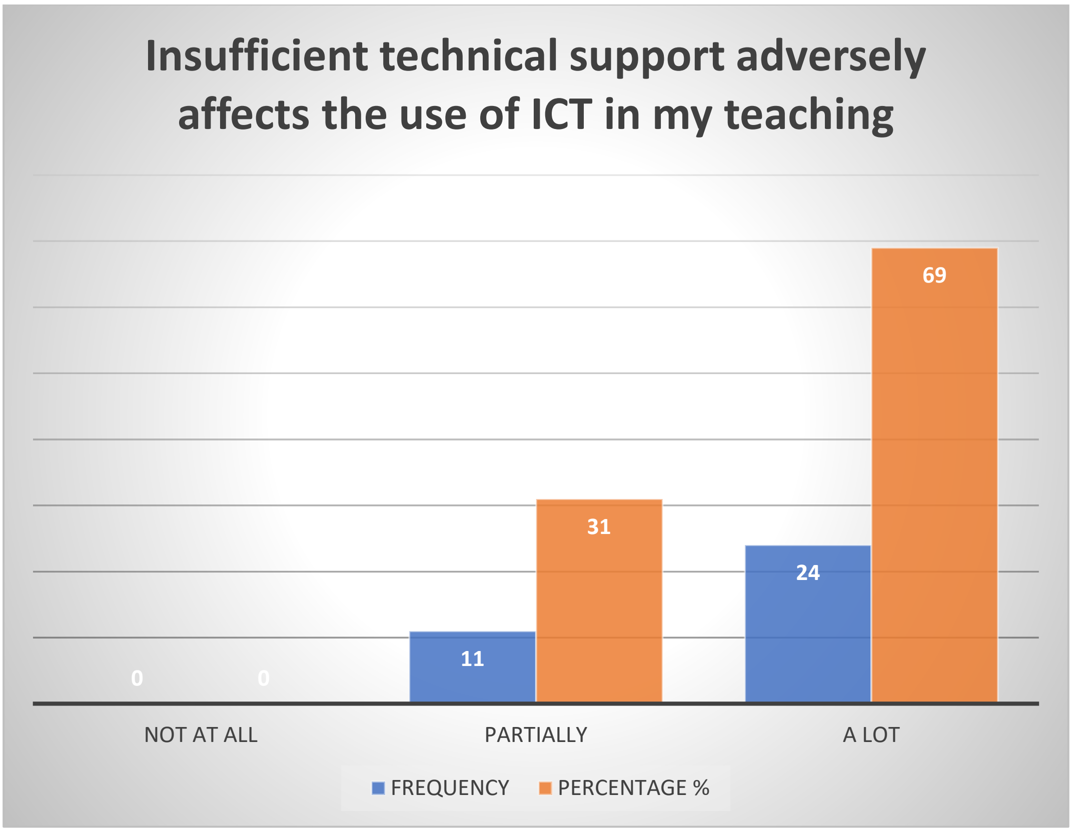

Figure 4.6 Insufficient technical support adversely affects the use of ICT in teaching

Figure 4.6 shows that 31% of the respondents indicated that insufficient technical support partially adversely affects the use of ICT in the teaching and learning process, and 69% felt it affects integration of ICT into teaching and learning a lot. Therefore, all the respondents in the study felt that insufficient technical support adversely affects the integration of ICT into teaching and learning of Science. Ogbomo (2011) posited that that technical support staff are important if ICT use in schools is to remain viable. Technical staff are required to maintain digital equipment. Respondents responding to a questionnaire item supported the above claim with the following comments:

Lack of support upon breakdown/malfunctioning of gadgets. (Respondent 7)

Insufficient technical knowledge. (Respondent 32)

4.5.3 Insufficient pedagogical support

Figure 4.7 shows the respondents' responses to how pedagogical support affects the use of ICT in teaching and learning.

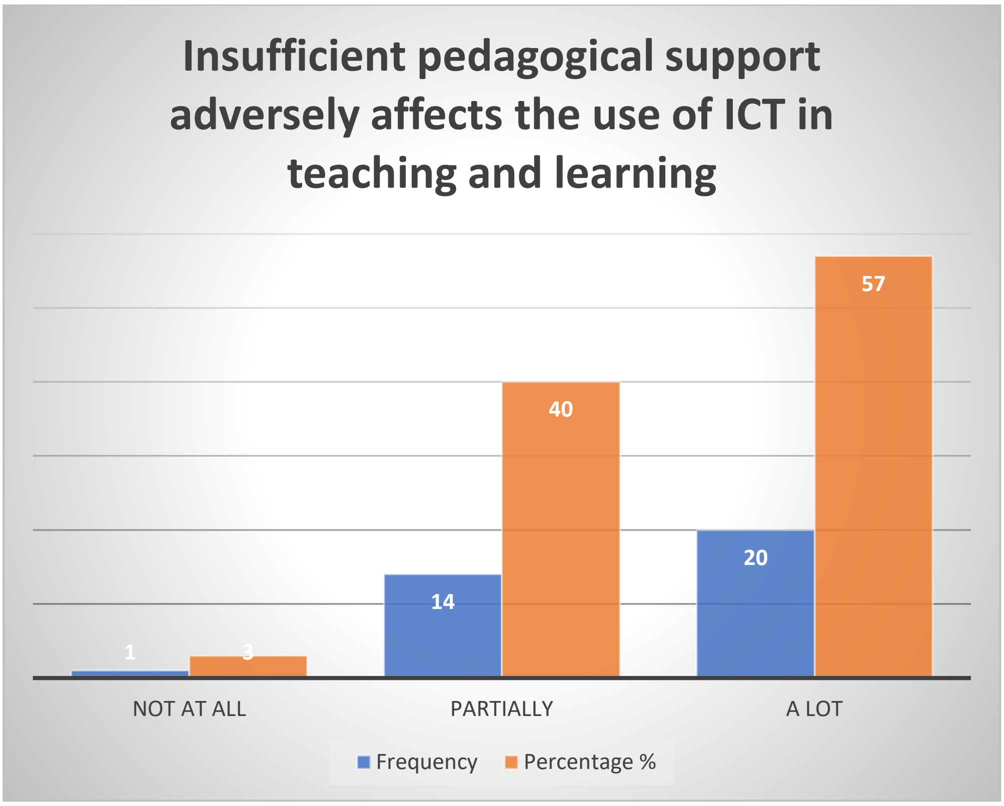

Figure 4.7 Insufficient pedagogical support

Only 3% of the respondents did not regard insufficient pedagogical support as a barrier to ICT integration into teaching and learning, and 97% (40% = *partially* and 57% = *a lot*) felt that it was barrier.

All the headmasters indicated that workshops on the use of ICT in teaching and learning were held either at district level or at school level, as the following responses show:

> Currently we are depending on staff development workshops mounted by our district. School based workshops are still to be started. (Headmaster 1)
>
> What happens is that resource persons are invited to develop teaching staff on ICT. (Headmaster 2)
>
> We do have teachers who are going for ICT workshops, and we also hold ICT workshops locally though the ICT department have a role to play in inducting other teachers in other subject areas. (Headmaster 3)

The teachers also concurred that professional development on the use of ICT in teaching and learning were held.

Zindi and Ruparanganda (2011) recommended that to ensure ICT integration into the teaching and learning process, effective staff development programmes must be launched. Staff development workshops were held with the target population as implied in the excerpts above. The respondents, however, indicated that integration was not yet achieved in their schools. This study sought to propose a staff development model to ensure successful ICT integration into teaching and learning.

4.5.4 Time needed to learn using ICT

Figure 4.8 shows that 52% of the study sample did not regard time needed to learn using ICT as a constraint to using ICT in teaching and learning, and 48% (37% = *partially* and 11% = *a lot*) felt that it was a barrier to ICT integration into the practice of teaching.

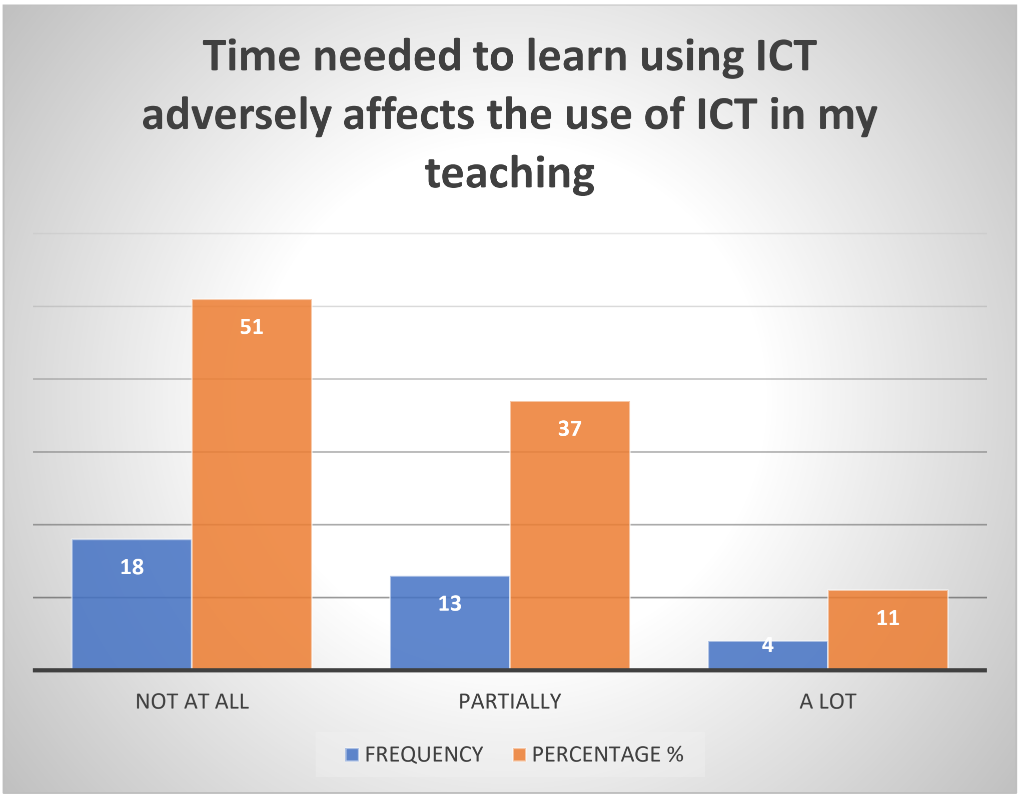

Figure 4.8 Time needed to learn using ICT

It can be assumed that the respondents' responses to this questionnaire item was not informed by practice since most of them indicated that they had never used ICT in teaching and learning. Many teachers are willing to use ICT in teaching and learning, but they claim they do not use digital teaching methodologies because they lack the time (Ghavifekr, et al, 2016).

4.5.5 Content creation on the computer

The next two items asked respondents whether they can create content for the teaching and learning process on the computer. The results are shown in Figure 4.9 and 4.10.

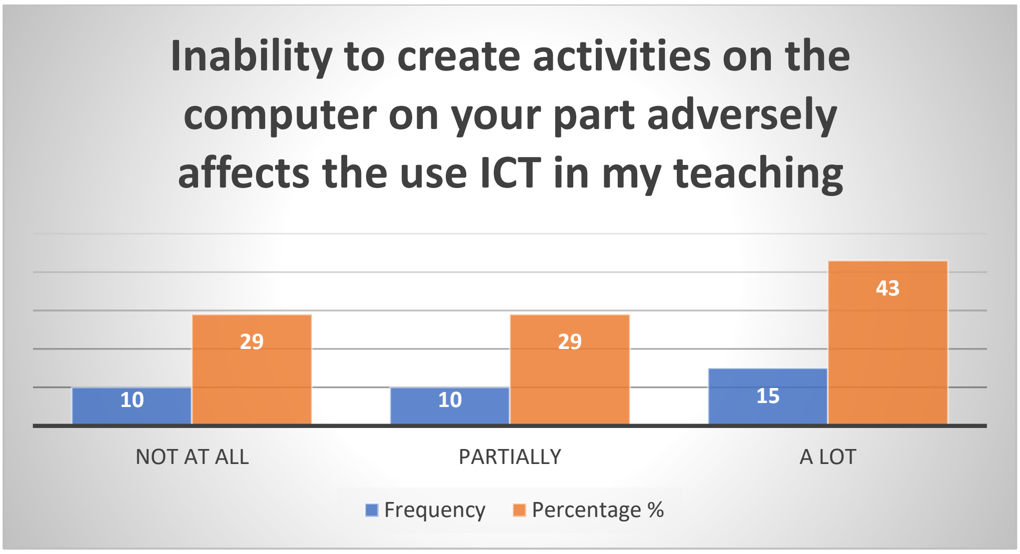

Figure 4.9 Content creation

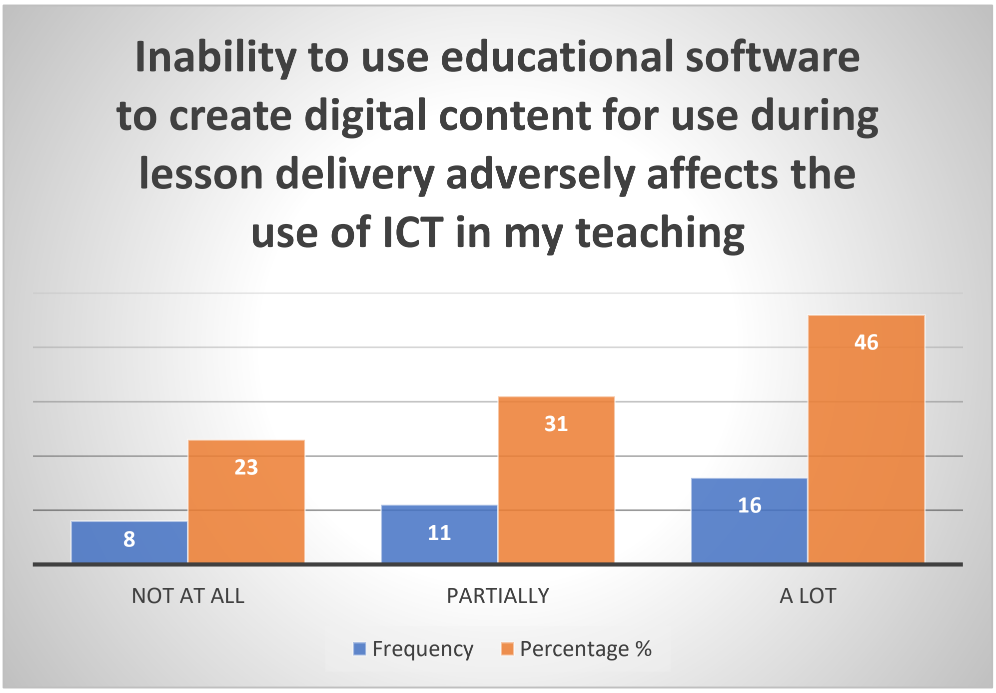

Figure 4.10 Content creation

The data shown in Figures 4.9 and 4.10 shows that teachers do not have the capacity to create digital content. This was to be expected because in most cases teachers are users and not developers of educational software and/or content. Ogbomo (2011) suggested that schools or the ministry could engage specialist content developers and that content development is an area that is usually ignored. Individuals and companies have developed educational software in Zimbabwe. These, however, are not accessible to most schools and no participant in this study mentioned these.

4.5.6 Knowledge on ICT use in teaching and learning

Figure 4.11 shows that 74% of the respondents felt that limited knowledge on how to make full use of ICT in teaching adversely affects the use of digital teaching methodologies *partially* (40%) or *a lot* (34%), and 26% indicated that the use of ICT in teaching and learning is not affected by limited knowledge on the part of the teacher. Only 17% of the respondents indicated that lack of adequate skills on the part of the teacher does not affect the use of ICT in teaching and learning (Figure 4.5). This compares well with data collected on lack of adequate skills on the part of the teacher (Figure 4.5) where 83% indicated that lack of adequate skills affects the use of ICT in teaching and learning either *partially* (46%) or *a lot* (37%).

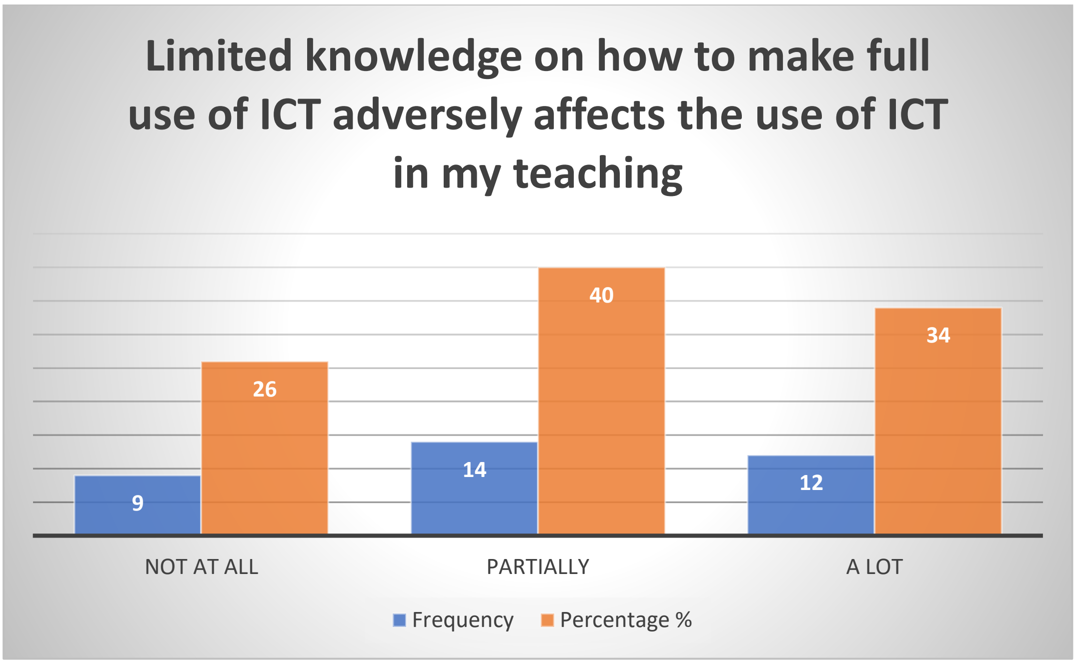

Figure 4.11 Knowledge on ICT use in teaching and learning

4.5.7 Limited knowledge on ICT integration in teaching and learning

Figure 4.12 shows that 72% of the respondents indicated that limited understanding on how to integrate ICT into teaching adversely affects the use ICT in my teaching either *partially* (43%) or *a lot* (29%).

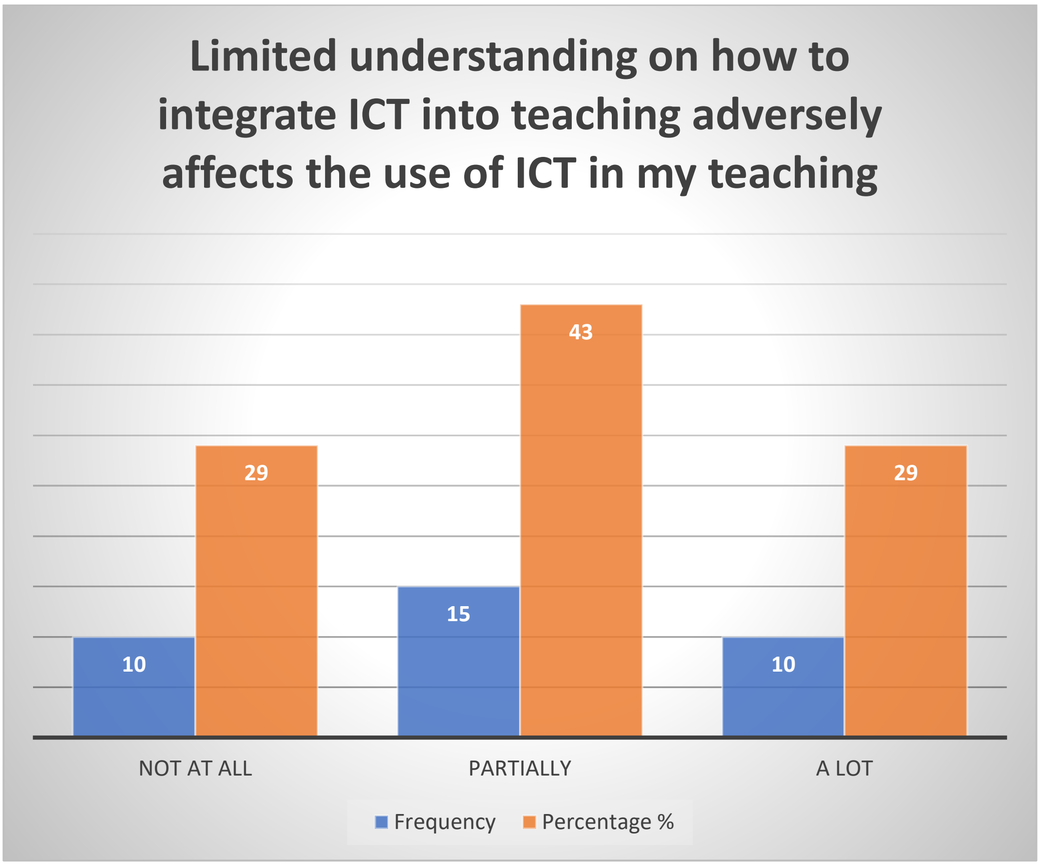

Figure 4.12 Limited knowledge on ICT integration in teaching and learning

4.6 Interviews

Three headmasters and a District Schools Inspector were interviewed to get an administrative and policy perspective on the integration of ICT into teaching and learning. The interviews also served to triangulate the information given by teachers. The three headmasters were code named Headmaster 1, Headmaster 2 and Headmaster 3.

The vision of the government in general and headmasters may determine the success or failure of ICT integration into teaching and learning. Qureshi (2013) observed that leaders are critical in the effective implementation of ICT in the classroom. Three headmasters were interviewed to determine the level of support afforded to the integration of ICT in the teaching and learning of Science by the institutions and to determine the perceived obstacles to the use of ICT in the teaching-learning process. A District Schools Inspector in the province was interviewed to articulate government policy issues on ICT integration in education and government support.

4.6.1 Headmasters' interviews

The responses from the headmasters were categorised under the themes, as shown in Table 4.8, to gain insights on their perceived obstacles to the use of ICT in teaching and learning and to triangulate them with the teachers' responses and the District Schools Inspector's interview responses. The detailed excepts are found in appendix P.

Table 4.8 Codes and themes

Code	Basic theme	Global theme
School policy on ICT	Institutional support	Science teachers' perceived obstacles/constraints to ICT integration in the teaching and learning of Science
Professional development		
ICT budget		
Learners free to bring digital devices to school	Learners' ICT ethics	
Control of learners' behaviour online		
Challenges encountered in the process of ICT integration	Challenges	
Use of digital teaching methodologies by teachers		

Institutional support

All three headmasters indicated that they had a school policy on ICT integration in teaching and learning.

Headmaster 2 indicated that they encouraged teachers to use ICT and Headmaster 1 reported that teachers use digital teaching methodologies and that the school had ICT resources.

All the headmasters indicated that they conduct professional development workshops.

Only Headmaster 3 explicitly reported that they had an ICT budget.

Use of digital devices by learners during learning time

All the participants reported that they do not allow learners to bring mobile phones to school. The participants claimed that the learners misuse these digital devices. They all however agreed that despite the ban, learners bring the devices secretly. Learners, however, are allowed to bring laptops and the use of these is closely monitored. All the participants reported that its difficulty to control or monitor use of digital devices by learners. Headmaster 2 reported that as a way of closely monitoring the use of digital devices, internet connection was only confined to the computer lab where teachers monitor use.

Challenges encountered in the process of ICT integration

Respondents reported the following as the challenges encountered in the process of ICT integration in classroom practice:

- Limited ICT tools,
- learners accessed non-educational material on internet,
- teachers did not have skills to use ICT as teaching and learning tools,
- power outages,
- those who had generators reported that it was uneconomical to use them for longer periods of time considering fuel costs they also indicated that solar, while they don't it, was a better alternative and

- schools were incapacitated financially to professionally develop teachers on the use of digital teaching methodologies,

4.6.1.1 Analysis of data from Headmasters' interviews

The responses from the headmasters categorised under the themes as shown in Table 4.8 are analysed in the following subsection.

Institutional support

The three headmasters indicated that they have a school policy on ICT integration in teaching and learning. Schools derive their policies from the ministry policy and the ministry derives its policy from the National ICT Policy. The interpretation of the existence of a school policy, however, differed from school to school. The fact that teachers are encouraged to use ICT in teaching and learning was taken as indicator of the existence of such a policy in one instance. One can infer from the statement that there is no mechanism at the school to ensure the effective use of ICT. The fact that schools do not have a guiding policy on ICT integration into teaching and learning can be attributed to the fact that the country does not have an ICT policy dedicated to education. Though Zimbabwe has an ICT policy, there is no specific national policy on ICTs in education (Isaacs, 2007). Teachers may or may not employ digital teaching methodologies.

Zindi and Ruparanganda (2011) recommended that effective professional development programmes are necessary to ensure ICT integration into the teaching and learning process. The three headmasters specified that they conduct professional development workshops for the teachers using local facilitators or outsourced facilitators. The workshops are either school or ministry initiated. The ministry workshops usually target a few teachers from each school who are then expected to cascade what they have learnt to the other teachers. The teachers and the headmasters responding to other questionnaire items reported minimal to no use of ICT pedagogical tools in teaching and learning. The workshops might therefore be having no effect on the use of ICT in teaching and learning.

Two out of the three respondents explicitly indicated that they had a budget for ICT integration into teaching and learning. However, one of them was quick to point out that though they had funds set aside for ICT integration, the year was coming to an end, and they had only repaired a few computers and paid Wi-Fi subscriptions. The third responded implied in his response that they had no funds set aside for ICT integration but when need arises money is taken from the school fees. The District Schools inspector indicated that the Ministry of Primary and Secondary does not have a budget for the individual schools to fund the use of ICT in education.

Funding is important for the successful integration of ICT into teaching and learning. Jhurree, (2005) pointed that the first source of funding that should be used to ensure the effective use of ICTs in teaching and learning to purchase and maintain digital devices and for professional development programmes is the school's operating budget. Most of the schools in Manicaland Province do not have the capacity to fund ICT integration into classroom practice. Funding is therefore a major challenge in the effort to integrate ICT into classroom practice. The procurement of high-cost ICT infrastructure and maintenance is an impediment to ICT integration into teaching and learning (Farrell, 2007). This study, however, advocates for the use of available pedagogical digital tools and/or the use of the available digital devices. The underlying principle for using ICT must be anchored in pedagogy rather than the availability of the tool (Lominé & Buckhingham, 2009).

Use of digital devices by learners during learning time

Responses from the participants revealed that learners are not allowed to bring mobile phones to school. However, the headmasters were quick to point out that despite the prohibition learners bring their mobile phones to school.

The participants noted that it is difficult to monitor whether learners have mobile phones during learning time. One of the participants indicated that the issue of learners bringing mobile phones to school an important matter worth discussing.

The District Schools Inspector indicated that now learners are not allowed to have a mobile phone during learning time but that the issue was still being debated.

It should be noted that the teachers indicated that in some schools, especially the private schools, learners could use their mobile phones during learning time.

The headmasters and the District Schools Inspector stated that learners are allowed to bring laptops to school. All headmasters indicated that the use of laptops is closely monitored during learning time. The participants indicated that monitoring the responsible use of laptops is the responsibility of senior administration staff. One headmaster explained that to ensure the responsible use of the laptops, internet connection was restricted to the computer laboratory.

Mobile phones have several functions that are vital for learning and teaching; however, in Zimbabwe, secondary school learners are not allowed to use them in class. The reason given for this restriction is that they are disruptive (Chigori & Zvavahera, 2018).

The researcher observed that mobile phones are the readily available and easy-to-use technological digital tools; therefore, the ban should be lifted, and a close monitoring mechanism should be put in place to ensure the responsible use of the devices by learners. Adhikari and Parsons (2012) also noted that when learners are allowed to use mobile phones during the teaching and learning process, they may spend time on activities that are not related to what they are learning. Chigori and Zvavahera, (2018) recommended that the ban on bringing mobile phones to the learning area be lifted and that schools instead develop strategies to address implementation challenges.

Challenges

All the headmaster in the study sample admitted that they encountered the following challenges in the process of ICT integration into teaching and learning:

- Limited ICT teaching and learning tools.
- Learner's access non-educational material when they are connected to the internet.
- Teachers do not have the skills to use ICT as teaching and learning tools.
- The school does not have financial resources to train teachers on how to use ICT in the learning process; and
- Power outages (load shedding).

One of the respondents reported that half of the teachers at his school do not have basic ICT skills. He referred to these teachers as "born before computers". The phrase "born before computers" in Zimbabwe is often used to refer to people of a certain age range who claim that they do not use computers because the computer era came when they were already old.

The challenges voiced by the headmasters conform with those cited by the District Schools Inspector.

Zindi and Ruparanganda (2011) cited lack of confidence, lack of competences and lack of access to resources as the major barriers to the effective integration of ICT into the teaching and learning process. The other barriers to the integration of ICT into the teaching and learning process are related to technical problems and a lack of knowledge (Unluer, 2011)

4.6.2 District Schools Inspector Interview

The District Schools Inspector was interviewed to get information on the government policy on ICT integration into teaching and learning and the support availed to this innovation by the central government and to triangulate data with that obtained from the teachers and the headmasters. The District Schools Inspector's interview excerpts are captured and presented in the following subsections.

Ministry policy on ICT integration into teaching and learning

> Yes, indeed there is a policy that digital methodologies should be integrated in nearly all learning areas.

The Government of Zimbabwe formulated a National ICT Policy that was approved by the cabinet in 2016. The following objectives were listed under the policy statement on ICT skills development:

- To increase ICT usage in primary and secondary schools through improved teaching and learning through ICTs.
- To enable the deployment and use of ICTs in the educational system.
- To promote e-learning.

Though Zimbabwe has a National ICT Policy that embraces ICTs in education, it does not have a dedicated national policy on ICTs in education (Isaacs, 2007). A specific policy on ICT in education would ensure clear and global strategies for the integration of ICT in education, budget allocations for the implementation of ICT, and a clear monitoring and evaluation plan, among other policy considerations.

Strategy for professional development on ICT integration in districts

> Through supervision that we get to schools and check whether teaching and learning is being done accordingly, including the use of ICT in teaching, and learning areas. The ministry mounts professional development workshops.

The teachers and headmasters concurred that ministry-initiated workshops on digital teaching methodologies were mounted.

Funding of digital teaching activities

> There is no specific allocation in terms funding; however, donations from various organisations with respect to gadgets, equipment for digital equipment. Yes, we do receive that, and we encourage organisations to provide such gadgets, but with regards to having specific allocation, there is no such allocation.

Funding is crucial if effective ICT integration into teaching and learning is to be realised. Most participants cited inadequate ICT resources as a barrier to the use of ICTs as teaching and learning tools. The reviewed literature concurred (Ghavifekr et al., 2016; Jones, 2004; Khalid, Abdulla, & Binimlas, (2009), Ndawi, Thomas, & Nyaruwata, (2013) Ogbomo (2011) observed that a lack of an ICT budget exacerbates the problems of ICT integration in education.

Challenges encountered in ICT integration in the schools' curriculum

> Indeed, there are many challenges. It's the teacher capacity, ability to use ICT digital tools in the methodology of teaching, the availability of the gadgets, and as I said, there are no funds allocated specifically for that.

The challenges cited by the District Schools Inspector matched those singled out by the Science teachers and the headmasters. (Ghavifekr S. , Kunjappan, Ramasamy, & Antony, 2016) also singled out lack of teacher competencies as a significant challenge.

Ministry’s position regarding learners bringing personally owned digital devices such as laptops or mobile phones to school

> The ministry, yes, allows learners to provide their own with regards to laptops. However, when it comes to mobile phones, there is still a debate, something you may be aware, that they may not be allowed to use the mobile phones particularly during the learning process. However, for the laptops there is not much of a challenge, yes.

In the 2016 ICT policy document, the government acknowledged that the uptake of ICTs by 2015 had greatly increased, reducing the rural-urban digital divide. The indicators of the growth were the active mobile penetration reaching 95.4%. Internet penetration had surpassed 45%. These statistics infer that most of the learners had access to mobile phones as opposed to internet connectivity. The District Schools Inspector, however, hastened to mention that the issue of allowing learners to bring mobile phones is still a subject of debate.

Strategies to ensure ICT use in schools

> No [there is nothing I can add to what I said earlier], basically that’s the major method of ensuring that digital methods are being used through supervision or in some cases getting an inventory of availability of the gadgets in the schools.

The District Schools Inspector stated that through supervision, the district ensured the use of ICT in teaching and learning in schools. He also said that the availability of digital gadgets is an indicator of the use of ICT tools in teaching and learning. Most of the teachers (66%) felt that there is no clear strategy at their schools to guide ICT integration into teaching and learning.

4.7 Summary

Findings from the open-ended questionnaire items indicated that Science teachers have a strong desire to integrate ICT into education but encounter the following major barriers:

- Insufficient ICT tools
- Lack of ICT skills
- Lack of support from the school authorities
- Non-availability of electricity and power outages
- Lack of access to resources

Data from the close-ended questionnaire items revealed that the respondents feel they lack sufficient skills to employ digital teaching methodologies. They also claimed that the school headmasters are not supportive in ensuring the integration of ICT into teaching and learning. The schools do not have a deliberate strategy to integrate ICT into teaching and learning. Most of the schools have insufficient ICT pedagogical tools, and the tools they do have are in some cases not accessible to the classroom practitioners. The respondents do not or rarely use the ICT pedagogical tools in classroom practice.

The headmasters' and the District Schools Inspector' interviews yielded the following:

- There is no funding for the integration of ICT into teaching and learning from the government.
- Schools do not set aside funds specifically for the integration of ICT into classroom practice.

- Professional development workshops are initiated by the MoPSE and some schools organise local professional development workshops.
- The use of mobile phones by learners is not allowed during learning. A position which is likely to change as it is still under debate. The former Minister of Education was of the view that there is nothing wrong with allowing learners to use mobile phones in school since they are necessary in the era of technological advancement (Ndlovu T. , 2015)

CHAPTER 5: PHASE 2 DATA PRESENTATION AND ANALYSIS

5.1 Introduction

The first phase of the study sought to discover Science teachers' perceived barriers to the use of pedagogical ICT tools in teaching and learning. The previous chapter presented and analysed the findings.

This chapter presents and analyses the data collected for the second phase of the study (quantitative). It should be noted at the outset that the proposed number of participants for phase 2 of the study were greatly affected by lockdowns due to the Covid-19 pandemic. The onset of the lockdown coincided with the process of data collection. Schools closed and teachers were not at their workstations. Two hundred and seventy questionnaires were proposed for the study but only 164 were returned, which is a 60.7% return rate. The rest of the questionnaires were either not returned or not distributed to the respondents as schools had been closed and it was difficult to follow up on the questionnaires. According to Nulty, (2008) response rates higher than 60% are acceptable. Fincham, (2008) concurred that response rates of 60% and above are worth reporting on.

Teachers in phase 1 were asked to respond to questionnaire items on things that made it difficult for them to integrate ICTs into the teaching and learning process. The identified constraints were then compared with those to be used in the quantitative survey on self-efficacy and were found to be consistent. Perceived efficacy should be measured against levels of task domains that represent gradations of challenges to successful performance (Bandura, 2006). Self-efficacy reflects the level of difficulty individuals believe they can surmount. If there are no challenges, the activity becomes easy to perform and everyone is highly efficacious (Bandura, 2006)

The chapter focuses on determining the Science teachers' self-efficacy scores. Data obtained from questionnaire responses by 164 Science teachers was entered into SPSS for analysis. Descriptive statistics and Pearson's moment correlation coefficient were used for the analysis. The following research question were answered: What is the level of computer self-efficacy of Science teachers in Manicaland Province of Zimbabwe?

5.2 Demographic Data

The demographic data collected from respondents is presented in this section.

The demographic data presented in Table 5.1 suggests that Science teaching in Zimbabwe is dominated by males.

Table 5.1 Gender

Gender	**Frequency**	**Percentage (%)**
Male	114	70
Female	50	30
Total	164	100

The age of the respondents is presented in Table 5.2.

Table 5.2 Age of the respondents

Age	Frequency	Percentage (%)
18–20	0	0
21–30	34	20.7
31–40	48	29.3
Above 40	82	50.0
Total	164	100

The collected data in Table 5.2 shows that most of the teachers in the sample (50%) are above 40 years old.

Table 5.3 shows that 59% of the teachers sampled have been in the teaching field for more than 11 years.

Table 5.3 Work experience

Work experience/years	Frequency	Percentage (%)
1 year and below	17	10.4
2–10	57	34.7
11–20	32	19.5
21 and above	58	35.4
Total	164	100

Table 5.4 shows that most of the sampled teachers (82%) have less than 10 years' experience in the use of computers, 19.5% of these has less than one-year experience working with a computer, and 17.7% has worked with a computer for more than 10 years.

Table 5.4 Experience in using a computer

Experience in using a computer	Frequency	Percentage (%)
1 year and below	32	19.5
2–10	103	62.8
11–20	21	12.8
21 and above	8	4.9
Total	164	100

5.3 Respondents' Self-Efficacy Levels

Respondents were asked to rate their level of confidence or certainty in their ability to accomplish a specified task on a continuum expressed in 10% increments. The responses were interpreted as a measure of their ICT self-efficacy. The questionnaire items were behaviour focused and specified a task or skill to be accomplished.

The mean efficacy scores were determined for the individuals and per questionnaire item from the data collected. The respondents responded to 23 questionnaire and had to choose one of the following: *Cannot do at all*, *moderately certain can do*, and *highly certain can do*.

The respondents rated their confidence level by responding to the following questionnaire items with the stem "rate your degree of confidence on the following tasks/skills":

1. Teaching Science using ICT
2. Creating a teaching and learning activity on the computer

3. Using a computer for lesson delivery
4. Using subject specific software to create digital content for use during lesson delivery
5. Accessing teaching and learning resources using online data bases
6. Browsing the internet to collect information to prepare a lesson
7. Video conferencing for teaching and learning purposes
8. Creating a teaching and learning presentation with a video or audio clip
9. Capturing and editing digital photos/images for use during lesson delivery
10. Using television, radio or digital cameras as teaching and learning tools
11. Generally employing digital teaching methodologies in lesson delivery effectively
12. Helping learners when they have difficulty with the computer
13. Giving instruction to learners on how to use the computer for learning Science concepts
14. Managing the class well when using ICT resources in lesson delivery
15. Teaching learners to acquire new content directly from the computer
16. Teaching learners to search for information on the internet
17. Following the right steps to teach science concepts effectively using ICT tools
18. Teaching learners to work collaboratively when using digital equipment
19. Using email to give learners homework and feed back
20. Using WhatsApp to give learners homework and feed back
21. Using SMS to give learners homework and feed back
22. Inviting the head of department or headmaster to evaluate my digital-based instruction
23. Motivating learners to use ICT tools in the learning process.

While technology is ever changing, the study considered the above activities to be general and to stand the test of time in determining the teachers' levels of ICT self-efficacy. To determining the respondents', mean scores on the 23 questionnaire items, the respondents were coded SE 1 to SE 164 and the items Q1 to Q23. The data was then entered into SPSS with the respondents as the variables and the questionnaire items as the cases.

Most of the respondents logged scores of 100 (*highly certain can do*) on the 0–100 rating scale on the following questionnaire items:

- Browsing internet to collect information to prepare a lesson.
- Using television, radio or digital cameras as teaching and learning tools; and
- Using WhatsApp to give learners homework and feedback.

These three items were eliminated for the purposes of analysis. Self-efficacy reflects the level of difficulty one believes they can surmount. If there are no challenges, the activity becomes easy to perform and everyone is highly efficacious. Items where most of the respondents indicated a high level of self-efficacy were eliminated as they lack sufficient difficulty (Bandura, 2006).

The study used the criteria in Table 5.5 for the interpretation of the scores for the research question.

Table 5.5 Categories for level of efficacy (decision rule)

Score range	**Category**
49 and below	Not confident (very low self-efficacy)
50–70	Little confidence (low self-efficacy)
71 and above	Very confidence (highly efficacious)

A high score was interpreted to represent high levels of self-efficacy. Figure 5.1 shows the number of respondents who fell into each of the categories.

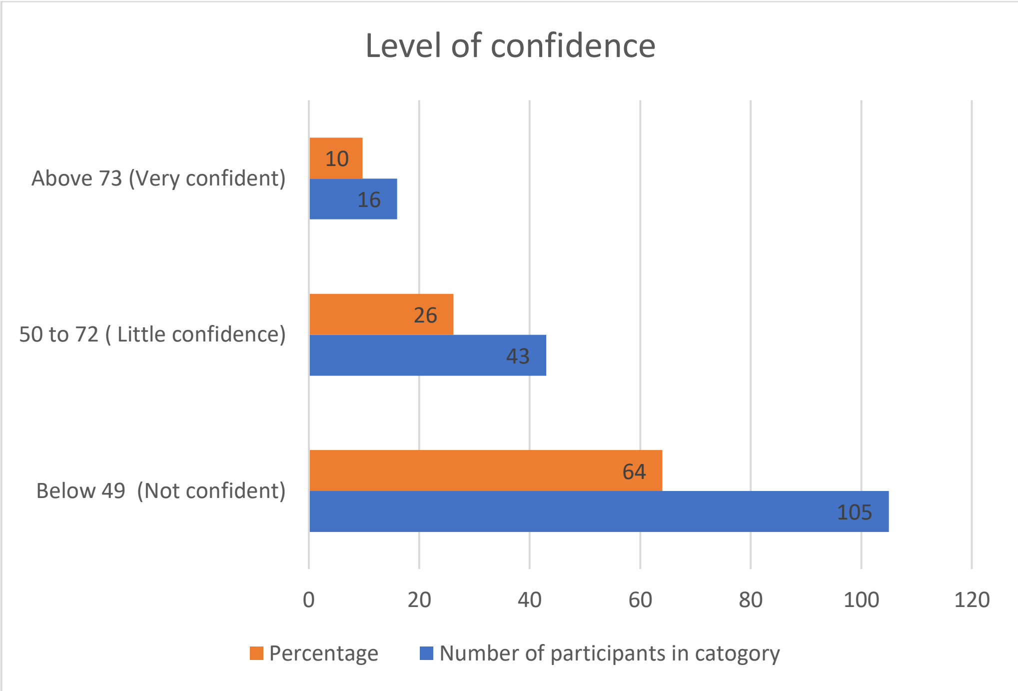

Figure 5.1 Level of confidence

Sixty-four percent (64%) of respondents agreed that they are not confident using ICT as a teaching and learning tool. Twenty-six percent (26%) of the respondents indicated that they have little confidence, while only ten percent (10%) agreed that they are very confident in using ICT in the practice of teaching (highly efficacious).

Figure 5.2 shows the number of respondents who logged each of the 10 steps (0–100) on at least one of the questionnaire items as a minimum rating on the question.

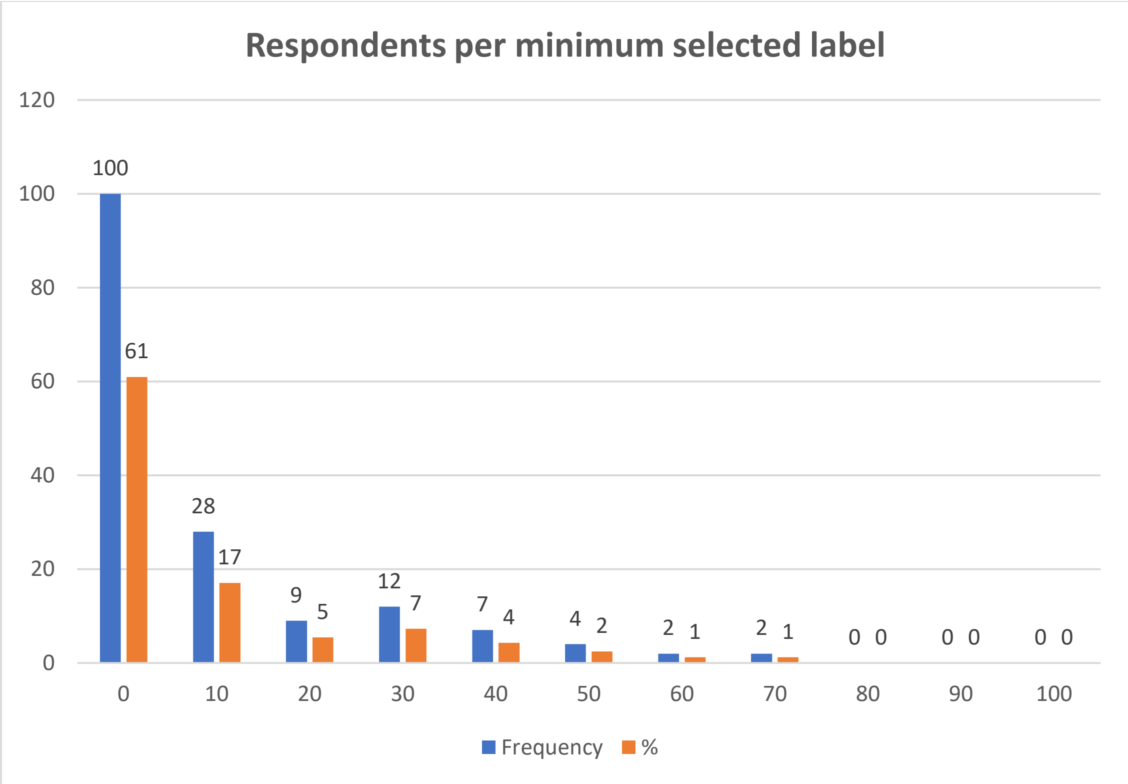

Figure 5.2 Number of respondents per minimum selected label

Sixty-one percent (61%) of the respondents indicated zero confidence on at least one of the questionnaire items, and seventeen percent (17%) indicated 10 on at least one of the questions they answered. The rest indicated between 30 and 70.

To determine the respondents' composite mean scores per questionnaire item on the 20 items, the respondents were coded SE1 up to SE 164 and the items Q1 up to Q20. The data was then entered into SPSS with the questionnaire items as the cases and the respondents as the variables. Table 5.6 presents the SPSS output of the distribution of the mean and standard deviation of the computed self-efficacy scores for the Science teachers.

Table 5.6 Descriptive statistics for Manicaland Science teachers' self-efficacy levels in ICT integration

Descriptive statistics					
	N	**Min**	**Max**	**Mean**	**Std dev**
Teaching Science using ICT	164	10	100	44,33	27,045
Creating a teaching and learning activity on the computer	164	0	100	29,02	28,591
Using a computer for lesson delivery	164	0	100	41,83	29,625
Using subject specific software to create digital content for use during lesson deliver	164	0	100	25,55	26,359
Accessing teaching and learning resources using online data bases	164	0	100	47,44	28,124
Video conferencing for teaching and learning purposes	164	0	100	25,37	25,462
Creating a teaching and learning presentation with a video or audio clip	164	0	100	25,06	27,526
Capturing and editing digital photos/images for use during lesson delivery	164	0	100	21,16	26,152
Generally employing digital teaching methodologies in lesson delivery effectively	164	0	100	43,05	27,745
Helping learners when they have difficulty with the computer	164	0	100	35,06	26,872
Giving instruction to learners on how to use the computer for learning Science concepts	164	0	100	34,33	26,193

Descriptive statistics					
	N	**Min**	**Max**	**Mean**	**Std dev**
Managing the class well when using ICT resources in lesson delivery	164	0	100	37,01	26,100
Teaching learners to acquire new content directly from the computer	164	0	100	57,13	24,862
Teaching learners to search for information on the internet	164	0	100	62,68	25,042
Following the right steps necessary to teach Science concepts effectively using ICT tools	164	0	100	36,52	25,103
Teaching learners to work collaboratively when using digital equipment	164	0	100	33,29	24,870
Using email to give learners homework and feed back	164	0	100	48,11	26,552
Using SMS to give learners homework and feed back	164	0	100	66,71	23,838
Inviting the head of department or headmaster to evaluate my digital-based instruction	164	0	100	26,40	28,519
Motivating learners to use ICT tools in the learning process	164	0	100	40,06	27,902
Valid N (listwise)	164				
Overall computer self-efficacy mean score				39.00	26.624

An overall computer self-efficacy mean score of 39 (standard deviation = 26.624) was reported by the respondents, indicating that generally the teachers agree that they are not confident in using ICT in teaching and learning, meaning they are not computer self-efficacious. The standard deviation of 26.624 is low, indicating that a few Science teachers rated their self-efficacy outside what most reported.

Most of the respondents indicated that they have very low self-efficacy on 18 out of the 20 activities and that they have a little confidence performing only two of the activities as shown in Table 5.7.

Table 5.7 Level of self-efficacy and number of activities per category

Category	**Number of activities**	**Percentage (%)**
Not confident	18	90
Little confidence	2	10
Very confident	0	0

Specifically, however, teachers indicated a moderate to high level of confidence in the following skills:

- Teaching learners to acquire new content directly from the computer with a mean score of 57.13 (standard deviation = 24.862); and
- Using SMS to give learners homework and feed back with a mean score of 66.68 (standard deviation = 23.838).

The pattern of how the respondents logged their responses for the three questions is presented in Tables 5.8 and 5.9

Table 5.8 Teaching learners to acquire new content directly from the computer

		Frequency	Percent	Valid percent	Cumulative percent
Valid	0	3	1.8	1.8	1.8
	10	5	3.0	3.0	4.9
	20	11	6.7	6.7	11.6
	30	11	6.7	6.7	18.3
	40	22	13.4	13.4	31.7
	50	27	16.5	16.5	48.2
	60	20	12.2	12.2	60.4
	70	23	14.0	14.0	74.4
	80	16	9.8	9.8	84.1
	90	15	9.1	9.1	93.3
	100	11	6.7	6.7	100.0
	Total	164	100.0	100.0	

Thirty-nine percent (39%) of the respondents indicated that they are very confident to teach learners to acquire new content directly from the computer.

Table 5.9 Using SMS to give learners homework and feed back

		Frequency	Percent	Valid percent	Cumulative percent
Valid	0	3	1.8	1.8	1.8
	20	5	3.0	3.0	4.9
	30	9	5.5	5.5	10.4

		Frequency	Percent	Valid percent	Cumulative percent
	40	10	6.1	6.1	16.5
	50	22	13.4	13.4	29.9
	60	27	16.5	16.5	46.3
	70	31	18.9	18.9	65.2
	80	10	6.1	6.1	71.3
	90	22	13.4	13.4	84.8
	100	25	15.2	15.2	100.0
	Total	164	100.0	100.0	

Of the respondents, 53.6% agreed that they are confident using SMS in the teaching and learning process. No technical training is required to use SMS since it is already being used in society (Lominé & Buckhingham, 2009). The use of SMS in teaching and learning is therefore simply importing a tool already in use in everyday life into classroom practice.

Table 5.10 Teaching Science using ICT

		Frequency	Percent	Valid percent	Cumulative percent
Valid	10	29	17.7	17.7	17.7
	20	25	15.2	15.2	32.9
	30	18	11.0	11.0	43.9
	40	12	7.3	7.3	51.2
	50	22	13.4	13.4	64.6

		Frequency	Percent	Valid percent	Cumulative percent
	60	20	12.2	12.2	76.8
	70	7	4.3	4.3	81.1
	80	18	11.0	11.0	92.1
	90	7	4.3	4.3	96.3
	100	6	3.7	3.7	100.0
	Total	164	100.0	100.0	

Twenty-three percent (23%) of the respondents agreed that they are confident teaching Science using ICT. This is in line with Tsvere, Nyaruwata, and Swamy, (2010)'s observation that the use of ICT in teacher education is very low in Zimbabwe.

The data presented in Table 5.11 reveals that only 14.6% are confident to invite the headmaster or the head of department to evaluate their lesson when they use digital tools.

Table 5.11 Inviting the head of department or the headmaster to evaluate my digital-based instruction

		Frequency	Percent	Valid percent	Cumulative percent
Valid	0	56	34.1	34.1	34.1
	10	32	19.5	19.5	53.7
	20	9	5.5	5.5	59.1
	30	7	4.3	4.3	63.4
	40	10	6.1	6.1	69.5

		Frequency	Percent	Valid percent	Cumulative percent
	50	19	11.6	11.6	81.1
	60	7	4.3	4.3	85.4
	70	14	8.5	8.5	93.9
	80	6	3.7	3.7	97.6
	90	1	0.6	0.6	98.2
	100	3	1.8	1.8	100
	Total	164	100.0	100	

Supervision is important in schools to ensure the standards set by the ministry are adhered to. It also ensures timely and effective corrective measures are implemented for professional growth (Abubakr, 2018). Science teachers in this study reported that they are reluctant to invite school managers to their classes when they use ICT digital tools during their teaching. This effectively means that there is no room for professional growth through supervision. It can be inferred from this reluctance that they are not confident using ICT tools in lesson delivery.

5.4 Frequency of Using Digital Teaching Tools

Respondents were asked to indicate how often they carried out the following activities related to the use of digital teaching methodologies.

1. Use computer for lesson preparation
2. Use computer for lesson delivery

3. Use educational software
4. Use e-learning
5. Use videos as instructional media
6. Use PowerPoint presentations
7. Use social media as a teaching and learning tool
8. Use electronic media
9. Use email in teaching

They had to select one of the following options in response to this question: *Never* (label 1), *rarely* (label 2), *sometimes* (label 3), *all the time* (label 4). The data was entered into SPSS and the output descriptive statistics are presented in Table 5.12.

Table 5.12 Descriptive statistics: Frequency of using digital teaching tools

	N	Minimum	Maximum	Mean	Std. deviation
Use computer for lesson preparation	164	1	4	3.17	.723
Use computer for lesson delivery	163	1	4	2.26	.752
Use educational software	164	1	4	1.71	.799
Use e-learning	164	1	4	1.73	.874
Use videos as instructional media	162	1	4	1.79	.915
Use PowerPoint presentations	164	1	4	2.30	.792
Use social media as a teaching and learning tool	164	1	4	1.72	.904
Use electronic media	164	1	4	1.64	.885
Use email in teaching	164	1	4	1.44	.777

	N	Minimum	Maximum	Mean	Std. deviation
Valid N (listwise)	161				
				1.97	0.825

The composite mean score of 1.97 (standard deviation = 0.825) shows that Science teachers in the study sample never or rarely use ICT in the teaching and learning process. The standard deviation (0.825) was low, indicating that a few teachers rated their frequency of using digital tools for teaching and learning outside what most reported.

However, the descriptive statistics in Table 5.12 shows a high frequency in the use of computers in lesson preparation. Some schools in Zimbabwe require teachers to present typed schemes of work/plans and other records. Most teachers who indicated that they use computers for lesson preparation therefore use it to type their schemes of work. Mundy, Kupczynski and Kee (2012) noted that most teachers only use computers for administrative work and that most learners do not use technology in the learning process.

The respondents' reported moderate frequency (2.26) in the use of computers for lesson delivery (*rarely* to *sometimes*). Table 5.13 shows how the respondents logged their responses between *never* (use the computer for lesson delivery) through *rarely* and *sometimes* to *all the time*.

Table 5.13 Use computer for lesson delivery

		Frequency	Percent	Valid percent	Cumulative percent
Valid	1 (*never*)	5	21.0	21.0	21.0
	2 (*rarely*)	16	19.8	19.8	40.8
	3 (*sometimes*)	89	54.3	54.3	95.1
	4 (*all the time*)	54	4.9	4.9	100.0
	Total	164	100.0	100.0	

Fifty-four percent (54%) of the respondents reported that they sometimes use the computer for lesson delivery. There was a mismatch, however, between the responses to this questionnaire item and the other responses, which consequently had the effect of bringing down the composite mean score to 1.97. A closer look at the frequency outputs of the other questionnaire items indicated that 51.2% of the respondents reported that they sometimes used PowerPoint presentations during lesson delivery. Most of the respondents who reported that they sometimes used the computer for lesson delivery therefore only use the computer for PowerPoint presentations.

Only 17.7% of the respondents reported that they use social media in the teaching and learning process, even though mobile phones are easily accessible. Keskin and Metcalf (2011) noted that learning can potentially be improved using mobile devices as they are portable, universal, easily accessible, and popular. Social incidences of conversation and debate afford learners the opportunity to learn.

Table 5.14 shows how the respondents logged their responses to using social media as a teaching and learning tool between *never* through *rarely* and *sometimes* to *all the time*

Table 5.11 Use social media as a teaching and learning tool

		Frequency	Percent	Valid percent	Cumulative percent
Valid	1	89	54.3	54.3	54.3
	2	39	23.8	23.8	78.0
	3	29	17.7	17.7	95.7
	4	7	4.3	4.3	100.0
	Total	164	100.0	100.0	

Relationship Between Self-Efficacy Scores and Frequency of Using Digital Teaching Tools

The choice of employing digital teaching methodologies and the effort and determination of using digital tools in classroom practice are influenced by teachers' level of computer self-efficacy (Teo & Joyce, 2010). The frequency of using ICT tools in teaching and learning must therefore be related to level of self-efficacy.

A correlation test between the respondents' efficacy scores and the frequency of ICT use in teaching and learning was run in SPSS to answer the following research question: Is there a relationship between teacher ICT self-efficacy scores and frequency of ICT use in the classroom? The following hypothesis were formulated:

- H_0: There is no significant correlation between teacher ICT self-efficacy and the frequency of ICT use in teaching and learning.
- $H_{1:}$ There is a significant correlation between teacher ICT self-efficacy and the frequency of ICT use in teaching and learning.

Prior to conducting the correlation analysis, the researcher plotted the two variables self-efficacy scores and frequency of ICT use in teaching and learning mean scores to visually determine the relationship between them in a scatter plot. The scatter plot in Figure 5.3 was produced in SPSS.

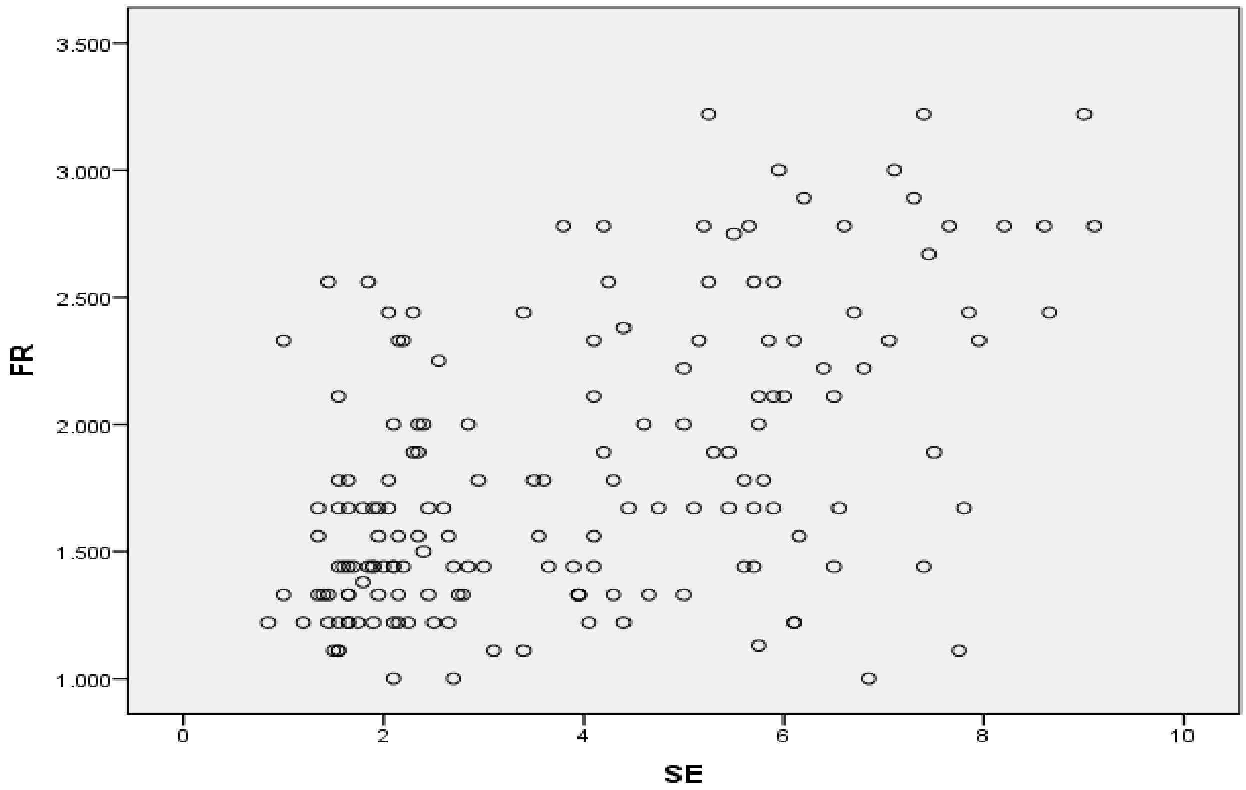

Figure 5.3 Self-efficacy scores and frequency of technology use in teaching and learning

Key:

FR: Frequency of using digital teaching tools

SE: Self-efficacy scores

The closer the scatter plots lie to the line, the stronger the relationship between the variables. The scatter plot in Figure 5.3 that was produced when frequency of using digital teaching tools was plotted against self-efficacy scores are further away from the line, predicting a weaker relationship. However, the scatter plot shows a positive linear trend and prompted the researcher to run a correlation analysis to test whether the relationship is statistically significant. Data for the two variables was entered into SPSS, and the output for the Pearson's moment correlation coefficient is presented in Table 5.15. Table 5.16 shows the interpretation for the Pearson's moment correlation coefficient.

Table 5.12 Pearson's correlation moment coefficient output

		VAR00001	**VAR00002**
VAR00001	Pearson Correlation	1	.521**
	Sig. (2-tailed)		.000
	N	164	164
VAR00002	Pearson Correlation	.521**	1
	Sig. (2-tailed)	.000	
	N	164	164
**. Correlation is significant at the 0.01 level (2-tailed)			

Table 5.13 Pearson' correlation moment coefficient interpretation

Correlation	**Interpretation**	**Correlation**	**Interpretation**
0.9 to 1.0	Very high positive	-0.9 to -1.0	Very high Negative
0.7 to 0.9	High positive	-0.7 to -0.9	High negative
0.5 to 0.7	Moderate positive	-0.5 to -0.7	Moderate Negative
0.3 to 0.5	Low positive	-0.3 to -0.5	Low Negative
00 to 0.3	Negligible	00 to -0.3	Negligible

Adapted from Mukaka (2012)

The output shows a positive correlation coefficient of 0.521. This indicates that there is a positive but moderate correlation between the Science teachers' ICT self-efficacy and their frequency of using digital teaching methodologies. The linear relationship is statistically significant ($p < 0.01$). The sample used in this research therefore contained adequate evidence to reject the null hypothesis and conclude that there is a correlation (moderate) between the Science teachers' self-efficacy scores and their frequency of using digital tools in the teaching and learning process. The study revealed that the use of ICT in the teaching and learning process by the target population is very low. Pearson' moment correlation coefficient predicted a positive relationship between teachers' ICT self-efficacy and the use of ICT in classroom practice. This study therefore proposes a professional development model to enhance teachers' ICT self-efficacy. It is hoped the professional development model, which considers the teachers' contexts and use participatory methodologies, will boost the teachers' confidence (self-efficacy) in using ICT pedagogical tools in classroom practice.

5.5 Summary

The results from the quantitative phase of the study showed that the Science teachers have low ICT self-efficacy. It also emerged that the teachers are confident that they can use social media as a teaching and learning tool but most of them have never used this pedagogical tool for teaching and learning.

Pearson's correlation coefficient moment statistical test showed a positive correlation between teachers' ICT self-efficacy and the frequency of using ICT pedagogical tools in classroom practice. According to the statistical test, teachers who are highly ICT efficacious are more likely to use ICT in the teaching and learning process. Teachers in the study sample therefore are not likely to integrate ICT in classroom practice. This agrees with the other findings of this study where the Science teachers reported never to rarely using ICT in teaching and learning.

CHAPTER 6: INTERPRETATION OF FINDINGS AND SUMMARY

6.1 Introduction

The previous chapter presented and analysed findings of the quantitative phase of the study that showed that Science teachers in the Manicaland Province of Zimbabwe have low ICT self-efficacy. This chapter summarises and interprets the main findings.

The study analysed Science teachers' ICT self-efficacy as defined by Bandura (1979). Teachers' perceived barriers to ICT integration in classroom practice were established through qualitative analysis. Science teachers' self-efficacy scores were determined using descriptive statistics in SPSS. The relationship between Science teachers' self-efficacy and the frequency of ICT use in teaching and learning was determined by running a Pearson's moment coefficient correlation test in SPSS. The Pearson's correlation coefficient moment statistical test showed a positive correlation between teachers' ICT self-efficacy and the frequency of using ICT pedagogical tools in classroom practice.

6.2 Objectives of the Study

The primary aim of the Zimbabwe government in the early days of independence was to reform the education system to align it with the developmental needs of the population. The reforms mainly focused on the expansion of the provision of education, redressing the quantitative inequalities that existed in the past. However, it emerged later that the country had to develop technologically, economically, and socially in line with the emergence of a highly competitive global economy and the rapid technological changes. The new thrust therefore had to emphasise quality rather than quantity. It was necessary to reform and restructure education so that it became competitive enough to meet the challenges of the 21st century (Nziramasanga, 1999). ICT integration into education was one of the approaches to ensure quality education as learners had become digitally oriented. The introduction of digital technologies to society is influencing ideas about knowledge and teaching theory and beliefs about teaching in the digital age (Starkey, 2010).

Having noticed a mismatch between the country's aspirations on the direction education should take regarding ICT and classroom practice and what was happening in schools in terms of teaching and learning using ICT tools, the researcher decided to carry out this study guided by the following objectives.

- To establish Science teachers' perceived obstacles and constraints to ICT integration in the teaching and learning of Science.
- To determine the extent to which Science teachers in Manicaland Province of Zimbabwe integrate ICT into their teaching practice.
- To determine the level of ICT self-efficacy of Science teachers in Manicaland Province of Zimbabwe;
- To determine the relationship between teachers' ICT self-efficacy and frequency of ICT use; and
- To propose a professional development model to enhance Science teachers' ICT self-efficacy.

6.3 Review of Related Literature

The review of the related literature acknowledged that there are several benefits associated with the use of digital devices as pedagogical tools. Barriers that hinder the integration of ICT into education were also identified. Low ICT self-efficacy on the part of the teachers was identified as a major barrier to the use of ICT tools in teaching and learning. The secondary school teachers are not using technology in teaching and learning due to the cited barriers to the ICT integration in education. The major barriers are lack of ICT infrastructure, ICT resources and low ICT teacher self-efficacy.

The Government of Zimbabwe was making efforts to electrify rural secondary schools and provide functional ICT gadgets to these schools (Alexeyeva, 2004). Mandoga, Matswetu, & Mhishi, (2013) noted that the Government of Zimbabwe tried to tap into the empowering benefits of ICT by embarking on a massive drive to turn around the education sector by providing computers to many rural schools. This study therefore proposed that the Science teachers' ICT self-efficacy should be enhanced if effective technology integration in teaching and learning is to be achieved.

6.4 Main Findings

The demographic data collected suggested that males dominate Science teaching in Zimbabwe. This can be attributed to the fact that fewer females opt for Science subjects at secondary school. In Zimbabwe, female learners are underrepresented in Science subjects (Gudyanga, 2016). Kang, Scheersoi, and Keinonen, (2019) observed that females perceive science, technology, engineering, and mathematics careers as leading to having less time for oneself and not supporting communal goals, and therefore, they usually prefer family friendly occupations. This could explain the gender disparity in the teaching profession in Zimbabwe. The low number of young Science teachers as shown in the demographic data can be attributed to the migration to perceived greener pastures by younger teachers. De Villers (2007) noted that South African schools alone has 10 000 Zimbabweans in their establishment, and of these 4 000 are qualified Science and Mathematics teachers. Ngwenya, (2019) also noted that Science and Mathematics teachers are leaving Zimbabwe for greener pastures.

This study was carried out in two phases. The first phase was qualitative and sought to answer the following research question: What are the Science teachers' perceived obstacles and constraints to ICT integration into the teaching and learning of Science?

6.4.1 Findings to answer research question 1

This section summarises the Science teachers' perceived obstacles and constraints to ICT integration into the teaching and learning of Science to answer research question 1.

The questionnaire used to solicit for the perceived barriers to ICT integration into teaching and learning had open-and closed-ended questions. The findings discussed and interpreted next.

The researcher found it imperative to determine the extent of the teachers' appreciation of the benefits of integrating ICT into classroom practice. The questionnaire therefore included items that would determine whether the respondents perceived the use of technology in the teaching process to be valuable (value) and whether they expected the integration be successful (expectancy). This is in line with the expectancy-value theory, which postulates that for the successful implementation of an innovation, the implementers must see value in it and expect it to succeed. The respondents' responses showed that all of them perceive ICT use in lesson delivery as the way forward to ensure effective teaching and learning. They articulated the benefits of employing digital teaching methodologies and these matched those found in the literature reviewed. The teachers generally appreciate the benefits of using ICT in teaching and learning. The expectancy-value theory predicts that if a teacher sees value in an innovation and expects it to be successful, they are likely to implement it. The expectancy-value theory is anchored in the understanding that an innovation is more likely to be accepted if its perceived value or expectancy of success is high (Wozney, 2006). According to this theory, expectancy and value are two essential aspects that control and guide a person's behaviour. Individuals turn to the task that is most likely to be performed after comparing their choices (Yurt, 2015)**.**

Wozney, (2006) suggested that teachers' decision to use an innovation, such as digital devices, in classroom practice is a function of how they value the innovation and how successful they expect the innovation to be. The responses from the teachers in this study suggested that they value the use of ICT and expect digital teaching methodologies to be effective. It can therefore be concluded that the teachers can embrace digital teaching methodologies if the barriers to its use are dealt with, including raising their confidence on their ability to use ICT in lesson delivery.

The study respondents are therefore aware of the benefits of using digital teaching methodologies in education. The responses given by the study respondents on benefits of employing digital teaching methodologies matched those cited by Lavonen (2008). He cited the following as benefits of using ICTs in Science education:

- Learning becomes active, constructive, contextual, co-operative, self-regulated and reflective.
- It increases interest and is motivating.
- Affords access to quality and relevant resources.
- Enables visualisation of complex images enhancing understanding of scientific concepts.

According to Rogers' diffusion of innovation model, successful implementation of an innovation follows the following five steps:

- Knowledge
- Persuasion
- Decision
- Implementation
- Confirmation

Based on the data collected from the respondents, namely that they agreed that the use of ICT tools has a positive effect on the teaching-learning process, this study places them on the second step of the diffusion of innovation spectrum. The quantitative results of this study indicated that the Science teachers have low ICT self-efficacy. They are not confident using ICT tools in teaching and learning. This study proposed that enhancing the teachers' ICT self-efficacy may persuade them to use ICT tools in teaching and learning; hence, leapfrogging from the second stage to the implementation stage. The findings of this study therefore helped the researcher create an appropriate professional development model.

The respondents cited the following as the barriers to ICT integration in teaching and learning:

- Lack of strategies on how to integrate,
- lack of school leadership support,
- no budget for ICT integration,
- insufficient ICT tools,
- lack of access to digital resources,
- lack of ICT skills on the part of the teachers,
- non availability of electricity and power outages where the electricity is available,
- lack of confidence in employing digital teaching by the teachers, that is low ICT self-efficacy and
- insufficient technical and pedagogical support

The barriers cited by the respondents matched those found in literature. The findings showed that the respondents are willing to integrate ICT into teaching and learning as they indicated that ICTs led to effective, efficient lesson delivery. However, they also indicated that they rarely or never employ digital teaching methodologies. Among other factors discussed under the quantitative findings, the perceived barriers listed in may have contributed to the above observation, namely that Science teachers were not using ICT tools in teaching and learning. From the respondents' point of view and by implication, these problems may take some time to resolve. This may mean that the Zimbabwean education system could lose out on the benefits of ICT integration into teaching and learning. Teachers' role remains key in the implementation of pedagogical innovation, and hence, enhancing their self-efficacy may kick start the implementation of the pedagogical innovation (use of ICT in the practice of teaching) with the available digital devices. Lominé and Buckhingham (2009) posited that the rationale for using ICT must be anchored in pedagogy rather than the availability of the tool. Schools could make their timetables in such a way that all teachers use the few available ICT teaching and learning tools. The teachers could also take advantage of social media and facilitate teaching and learning using applications like WhatsApp and SMS.

6.5 Quantitative Phase Findings

This section presents a summary and the interpretation of the findings from the quantitative phase of the study to answer the following research question: What is the level of computer self-efficacy of Science teachers in Manicaland Province of Zimbabwe?

6.5.1 Science teachers' ICT self-efficacy

The findings showed that the Science teachers have very low ICT self-efficacy. They do not believe in their capabilities to use ICTs as pedagogical tools. Bandura (2006) described teacher self-efficacy as teachers' beliefs in their own ability to plan, organise and carry out activities that are required to accomplish stated educational outcomes. The teachers agreed that they rarely or never use ICT tools during the teaching and learning process, yet they believe digital teaching methodologies are effective to achieve educational goals. This mismatch is caused by the teachers' low self-efficacy scores. The teachers' efficacy level must be enhanced to realise the benefits of ICT tools in teaching and learning. Teachers' ICT professional development needs are therefore not sufficiently addressed in a well-coordinated manner to ensure the effective implementation of pedagogical innovations. This study proposed a professional development model to enhance the Science teachers' self-efficacy.

6.5.2 Relationship between teacher self-efficacy scores and frequency of technology use in the classroom

The self-efficacy scores and the composite mean scores for the frequency of use of digital devices was entered into SPSS and subjected to a corelation statistical test (Pearson's moment correlation coefficient) to answer the following research question: Is there a relationship between teacher ICT self-efficacy scores and frequency of ICT use in the classroom? The following hypothesis were formulated:

- H_0: There is no significant correlation between teacher ICT self-efficacy and the frequency of ICT use in teaching and learning.
- $H_{1:}$ There is a significant correlation between teacher ICT self-efficacy and the frequency of ICT use in teaching and learning.

Data for the two variables was entered into SPSS and the output showed a Pearson's moment correlation coefficient of 0.521. This indicates that there is a positive but moderate correlation between the Science teachers' ICT self-efficacy and their frequency of using digital teaching methodologies. The linear relationship is statistically significant ($p < 0.01$). The sample used in this research therefore contained adequate evidence to reject the null hypothesis and conclude that there is a correlation (moderate) between the Science teachers' self-efficacy scores and their frequency of using digital tools in the teaching and learning process.

Generally, the results indicated that to a certain extent the Science teachers in Manicaland with a high level of self-efficacy are more likely to employ digital teaching methodologies and those who are low efficacious are not likely to use ICT tools in teaching and learning. It should be noted that some teachers who reported high levels of ICT self-efficacy may not have used ICT tools in lesson delivery because of the barriers to ICT integration discussed in the preceding discussions. This had an effect of depressing the correlation coefficient.

Sarfo, Amankwah, & Konin, (2017) investigated the relationship between self-efficacy beliefs of teacher educators and actual use of ICT tools in teaching and learning and found that lack of belief in the teachers' ability to use ICT tools in teaching and learning translated into the teachers not actually employing digital teaching methodologies in lesson delivery. This agrees with the findings of this study.

6.6 Limitations

The period when the research entered the data collection phase was a limitation. The onset of the Covid-19 pandemic and subsequent lockdowns coincided with the process of data collection. Schools were closed and teachers and headmasters were not at their workstations. Only essential services were allowed to continue operating in compliance with lockdown restrictions. The respondents were not even available online. This affected the headmaster interviews because the study proposed interviewing four headmasters but, in the end, only three were interviewed. The study proposed a sample of 270 participants for the second quantitative phase, but 164 were distributed and returned, which is a 60.7% return rate. The rest of the questionnaires were either not returned or not distributed to the respondents as schools had been closed and it was difficult to follow up on the questionnaires. According to Nulty (2008), response rates higher than 60% are acceptable. The research therefore proceeded to present, analyse, and interpret the findings since the data available was worth reporting on. According to Fincham (2008), response rates of 60% and above are worth reporting on.

6.7 Summary

The aim of the study was to determine the ICT self-efficacy and practices of Science teachers in Manicaland Province of Zimbabwe and to propose a model to enhance Science teachers' self-efficacy to ensure ICT integration into the teaching and learning of Science.

The study established that the Science teachers in Manicaland Province of Zimbabwe were aware of the benefits of integrating ICT into teaching and learning and they encounter a multiplicity of barriers hindering the use of ICTs in teaching and learning. Most of them do not employ digital teaching methodologies although at some of the schools, digital devices are available, and all the schools have accessible ICT teaching and learning tools like mobile phones and cameras. The study also inferred that teachers who are low ICT self-efficacious do not use technology in the teaching and learning process.

CHAPTER 7: THE PROPOSED PROFESSIONAL DEVELOPMENT MODEL

7.1 Introduction

The previous chapter was a summary and interpretation of the findings of the study. It was established that there are barriers to the ICT integration into teaching and learning. The ICT self-efficacy of the Science teachers in the target population is low, and the frequency of ICT use in teaching and learning is correlated to the teachers' self-efficacy score. Professional development programmes become effective when:

- Teachers collaborate with others.
- Reflect on their classroom practice; and

  Receive support and feedback (Huffman, 2006).

A review of the literature related to the study and findings of this research revealed that teachers struggle with multifaceted expectations surrounding ICT in education but are in most cases left alone to negotiate the terrain. In cases where support comes in the form of professional development it is not well coordinated and often adds little or no value to lesson delivery. Participants in this study reported that workshops were held in the study area on ICT integration into teaching and learning, but the efficacy scores and frequency of use of digital teaching methodologies remained low. It was discovered from the literature that low ICT self-efficacy is a major hindrance to the integration of ICT in teaching and learning. This chapter presents the proposed professional development model to enhance teachers' ICT self-efficacy. This addresses the following research objective: To propose a professional development model to enhance Science teachers' ICT self-efficacy.

7.2 The Proposed Model

Teaching is an art, and the success of the art depends on how the teacher blends the different facets that are considered imperative for effective lesson delivery. The facets include the content to be taught and the methodologies employed. These two were combined by Shulman, (1986) to create the pedagogical content knowledge framework.

With the advent of computers and the internet, hardly any home is without technology; hence, learners are exposed to digital devices. The need to integrate technology in education is therefore a core factor of quality in the teaching and learning process (Mishra & Koehler, 2006). Basing on Shulman's pedagogical content knowledge, Mishra, and Koehler (2006) developed a framework that encompasses technology, the technological pedagogical content knowledge framework.

Engida (2011) argued that professional development is about changing perceptions and beliefs about education and changing classroom activities. Engida (2011) created a conceptual model based on Mishra and Koehler's (2006) framework to enhance ICT use in teaching and learning. The model, called the ICT-enhanced teacher development model, assumes that teaching in a broad sense involves all the activities of teaching a particular subject. The model (Figure 7.1) gives guidelines for the preparation of pre- and in-service teachers for the 21st century.

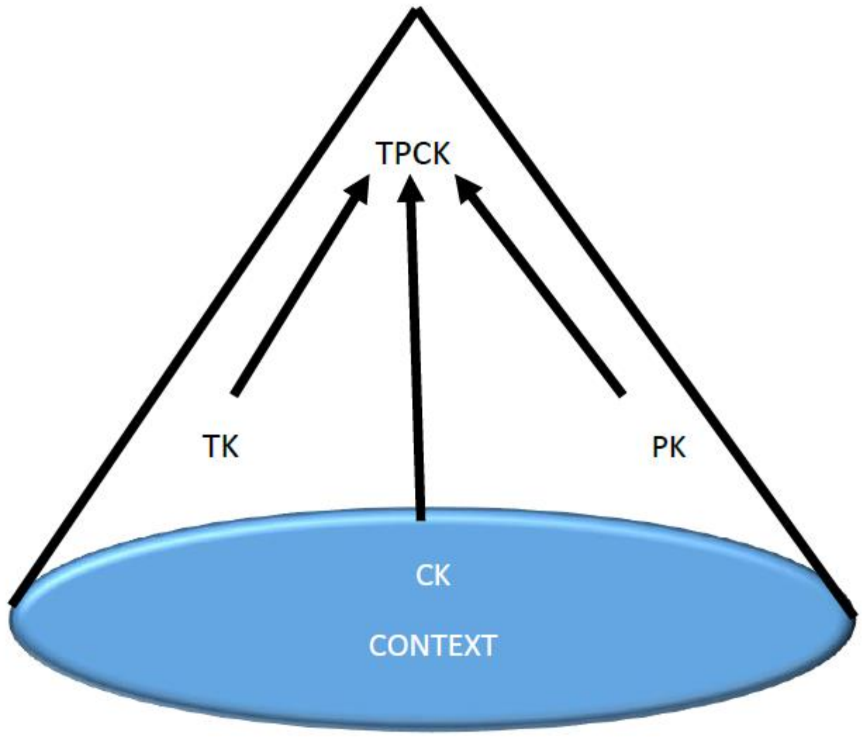

Figure 7.1 ICT-enhanced teacher development model (Adopted from Engida, 2011)

In Figure 7.1:

- TK stands for technological knowledge
- PK stands for pedagogical knowledge
- CK stands for content knowledge
- TPCK stands for technology, pedagogical and content knowledge.

For the purposes of coming up with a professional development model, this study focused on the section of (Engida, 2011) ICT-enhanced teacher development model formed by ttechnological and pedagogical knowledge. The section represented technological pedagogical knowledge with emphasis on pedagogical knowledge. While all the parts of the framework are equally important, it was assumed that the Science teachers in this study acquired content at school and at higher and tertiary institutions.

Teacher participation in professional development concerning any pedagogical innovation enhances the implementation of the innovation. Professional development workshops to enhance the effective integration of technology in the teaching-learning process were mounted in Manicaland for the study population. The results of this study, however, revealed very little in terms of implementation of the pedagogical innovation. Teachers who participate in professional development use ICT teaching and learning tools more regularly in classroom practice and are more ICT self-efficacious (Drossel & Eickelmann, 2017). This study revealed no to minimal use of ICT tools in classroom practice and low teacher ICT self-efficacy.

Charalambos & Glass, (2007) cited lack of teacher professional development as one factor that may hinder the use of ICT in teaching and learning. Zindi and Ruparanganda (2011) recommended that effective professional development programmes must be launched to ensure ICT integration in the teaching and learning process. This chapter proposes a professional development model to ensure ICT integration in teaching and learning. The model will be presented to the Ministry of Primary and Secondary Education for approval.

The proposed professional development model for the Science teachers has four cyclic stages. The integrated reflection of experiences and sources of self-efficacy (IRESSE) model for professional development is the fundamental stage of the model. Figure 7.2 show the components the model.

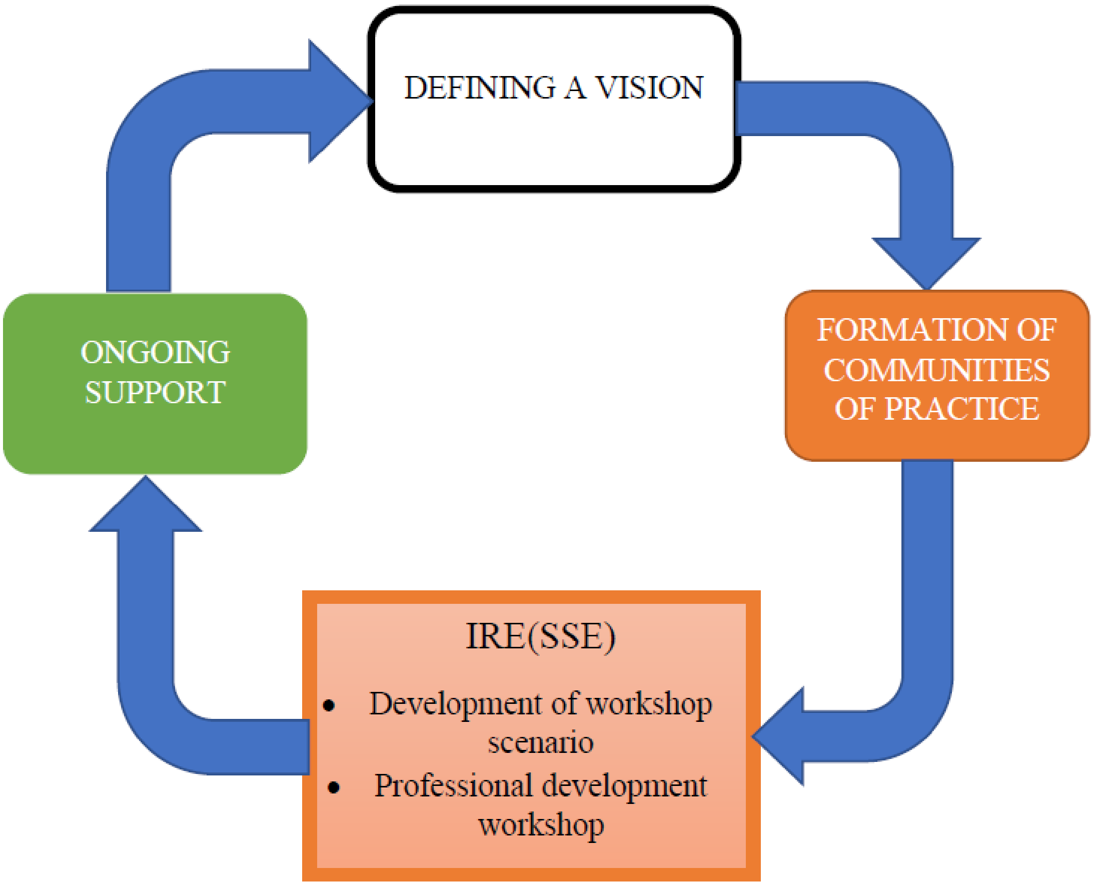

Figure 7.2 Summary of the professional development model to enhance teachers' ICT self-efficacy

Table 7.1 describes the stages of the proposed model for the integration of technology into teaching and learning.

Table 7.1 A description of the stages of the proposed model for the integration of technology into teaching and learning

Key issue	**Strategies/activities**	**Focus**
Defining vision or developing a school strategy on technology integration in teaching and learning	• Appoint an ICT coordinator at school level to superintend ICT integration issues at school level • Formulate a school strategy on ICT integration at school level.	• To ensure alignment of all stakeholders (headmaster, deputy headmaster, senior management staff and all teachers) at the school with • what needs to be achieved in terms of ICT integration into teaching and learning. • For schools to have a clear sense of direction on how to embrace ICTs to enhance student learning.
Learning designs IRESSE model	• Appoint an ICT coordinator at district level to superintend ICT integration issues at district level • Authentic engagement within teachers' contexts • Collective reflection of experiences	• To situate workshop content in teachers' context to ensure authenticity of activities giving them the opportunity to make sound pedagogical decisions

Key issue	Strategies/activities	Focus
	• Reflect on current practices of using ICT tools in classroom practice • Evaluate current practices • Compare current performances with the expected performance • Share success stories on the use of ICT tools in teaching and learning at the individual schools • What could have been done differently • Encourage progress (Facilitators encourage workshop participants on progress made during workshop proceedings)	• To afford teachers opportunities to engage in meaningful activities, collaborate with peers, exchange ideas, give and receive feedback and reflect on practices.
	• Exposure to cost-effective and available pedagogical digital tools (practical activities in a participatory method on use of ICT tools in teaching and learning).	To collaboratively engage in authentic activities on the use of digital teaching methodologies.
	• Exposure to other pedagogical digital tools (practical activities using participatory methods on use of ICT tools in teaching and learning).	To collaboratively engage in authentic and challenging activities on the use of digital teaching methodologies.

Key issue	Strategies/activities	Focus
Ongoing Support	• Monitor and evaluate • Periodic professional development workshops to reflect on current practices (new technologies) exposing the teachers to new digital tools and how to integrate them in classroom practice.	• To get data to guide the planning of future workshops, showcase progress and improve methodologies. • To ensure teachers keep abreast with new technology in teaching and learning and afford them the opportunity to be innovative.

7.2.1 Defining the school vision or strategy on ICT integration in the practice of teaching

The starting point of any attempt to implement an innovation is to have a vision that guides generating plans, setting objectives, and making the correct decisions. It keeps stakeholders focused. The National ICT Policy revealed that the government vision on effective teaching and learning is to adopt digital teaching methodologies, and the District Schools Inspector concurred.

The participants reported that schools do not have a deliberate strategy for ICT integration into the practice of teaching and learning. Insufficient ICT planning and lack of strategies on how to integrate ICT into the teaching and learning process may hinder teachers' efforts to use digital teaching methodologies (Wozney, 2006). Ndawi, Thomas, and Nyaruwata, (2013) researched barriers to effective integration of ICT in Harare secondary schools and revealed that teachers in Harare schools have no clear sense of direction on how to embrace ICTs to enhance student learning. The professional development model proposed by this study will be effective if all schools start their bid to integrate ICT into education by clearly defining their vision. This will ensure that all involved are aligned with what needs to be achieved. The respondents reported lack of support from school administrators, indicating that there is no alignment at all. Issues of the requirements for successful ICT integration into teaching and learning, including funding, will be considered at the onset.

7.2.2 Formation of communities of practice (CoP)

To use the proposed model, Science teachers from a district or a cluster will be asked to voluntarily form a working group in the form of a CoP. CoPs are voluntary, and therefore, could generate excitement and relevance, attracting and engaging members in the process (King & Cattlin, 2016). Discussions in such groups may guide the teachers' choices and experiences. Membership to a community, in this case Science teachers, is envisaged to give a standpoint that may guide teachers' choices and practices. Charalambos & Glass, (2007) described CoPs as groups of people bound by what they do together and engaging mutually in discussions and in solving problems.

7.2.3 Integrated Reflection of Experiences and Sources of Self-Efficacy (IRRESSE)

Professional development programmes need to be well coordinated and planned if they are to be effective. In the proposed professional development model, the starting point is the appointment or nomination of programme coordinators, who can include provincial and district ministry officials and teacher representatives from the school. An IT expert could also be seconded in the coordinating team. The team, which must include the facilitation team, will then work out the workshop programme (scenario) using the suggested template below. The facilitation team could be selected from the teachers.

The professional development model proposed is based on the findings of the study. The model provides an interactive and participatory approach rather than transmission-based methods to develop teachers' use of digital teaching methodologies. The model emphasises staff showing teachers how to use digital tools in the teaching-learning process by focussing on enhancing the teachers' self-efficacy.

Collective reflection of experiences

Reflection in this context is where teachers mirror their earlier actions and explore them in greater depth. Exploration and curiosity about previous experiences lead to focused learning (Beck & Jamissen, 2011). Reflective practice therefore creates opportunities for learning from experience. When teachers reflect on their actions, it helps them perceive themselves as instrumental, individually, and collectively, in setting programmes for ICT use in classroom practice (Phelps et al., 2005).

Teachers jointly reflect on their experiences of using ICT in lesson delivery (collective reflection of experiences). They share and interrogate their practices of using technology in the teaching and learning process. Teachers who reported low levels of self-efficacy reported that they use the internet and that although they have not used social media for teaching and learning, they were very confident that they could use it in classroom practice. Therefore, with the right learning environment and allowing participatory approaches, all participants will be expected to give input in the reflection phase. The proposed approach will allow teachers to jointly reflect on their experiences of using ICT in lesson delivery (collective reflection of experiences). The model will allow Science teachers to share and interrogate their practices regarding the use of technology in the teaching and learning process.

Hord, (2004) claimed that through reflection teachers evaluate their practices and create a supportive and sustainable structure for effective teaching. Redmond (2010) singled out self-evaluation as one of the processes of the social cognitive theory that may lead to goal realisation.

The model proposes that the sources of self-efficacy discussed in the following subsections suggested by Bandura (2006) be used to focus the discussions during the reflective process. The sources form the second layer of the professional development model.

Mastery of experiences

During the collective reflection of experiences, teachers will evaluate their practices of using technology in lesson delivery. They will compare their current performance with a desired performance (mastery of experiences). When the teachers interpret their efforts as successful (mastery experience), self-efficacy rises (Pajeres et al., 2007). The Science teachers will do the following:

- Reflect on their practices.

- Evaluate the practices.
- Share their success stories of using digital teaching methodologies; and
- Discuss what could have been done differently.

A facilitator will lead and control the discussions to keep them focused on the use of ICT in classroom practice.

The Science teachers in this study cited the gadgets they have used and the methodologies they have employed. These included laptops for PowerPoint presentations, laptops, mobile phones, and desktop computers to surf the internet for teaching and learning materials, and mobile phones for social media functions. Experiences of using these inside or outside the classroom will be shared, explored, and interrogated to achieve a common understanding of how the gadgets and methodologies could be used to enhance the process of teaching and learning.

Social models

People can develop high self-efficacy through other people's performances. The facilitators will be drawn from schools in the area and be led by a chief facilitator with the right expertise, who can be outsourced. The facilitators will demonstrate digital teaching methodologies and actively involve all the participants. Individuals' self-efficacy can increase if they observe someone in a similar position perform and then compare their own competence with the other person's competence. If an individual observes someone like them perform a task successfully, it can make them make judgements about their own capabilities, and thus increase their self-efficacy (Hasan & Hossain, 2014).

Social persuasion

According to Redmond (2010), self-efficacy is also influenced by encouragement pertaining to an individual's performance or ability to perform. Participants will be encouraged in their progress in the use of ICT in the teaching and learning process.

Structured situations

Structured situations that bring success can create and strengthen self-belief (Bandura, 2006). By demonstrating digital teaching methodologies, the facilitators will be presenting structured situations on the use of ICT in lesson delivery. This will strengthen the participants' self-belief in the use of ICT during lesson delivery.

Ongoing support

Professional development programmes may not automatically improve the quality of the teaching and learning process. Any professional development initiative targeting teaching methods should be accompanied by observable changes in teachers' instructional behaviour. The programmes must therefore be subjected to monitoring and evaluation to get data to guide the planning of future workshops, showcase progress and improve workshop methodologies. This will ensure that professional development methodologies are improved to ensure effectiveness and that necessary resources are availed.

Monitoring and evaluation

Monitoring focuses on what is being done and how it is being done, and this information can be used during the evaluation process. Evaluation focusses on performance against the set goals (Wagner et al., 2005). Evaluation is used to guarantee that the direction taken is the right one and that the correct strategies and resources are used to achieve the intended objectives.

For the intervention programme proposed in this study, the evaluation should measure the effectiveness of the professional development model. The model sought to enhance Science teachers' ICT self-efficacy. One of the indicators of the enhanced self-efficacy is the effective integration of ICT in classroom practice.

Monitoring is a routine scrutiny of information regarding progress. This is done to ensure enhancement is taking place in line with defined criteria. It gives assurance that what has been planned is taking place as expected. All the proposed stages in the professional development model will be monitored to ensure the realisation of the objectives set for each stage.

According to Kusek and Rist (2004), monitoring is linked to evaluation in the following ways:

- Monitoring clarifies programme objectives, and evaluation examines the reasons for programmes succeeding or failing.
- Monitoring links programme activities to resources, and evaluation assesses causal contributions of activities to results.

- Monitoring translates objectives into performance indicators and targets, and evaluation analyses the implementation process.
- Monitoring collects data on indicators, and evaluation explores unintended results.
- Monitoring gives progress reports, and evaluation highlights accomplishments and recommends improvements.

Monitoring and evaluation are important for the following reasons:

- It reveals programme progress and highlights accomplishments.
- It shows how a programme can be improved.
- It exposes mistakes and shows a way forward to learn and improve; and
- It allows teachers to learn from each other's experiences.

Kabonga, (2018) posited that the main reason for conducting an evaluation is to allow evaluation results to be consolidated and used to inform decision making on how to improve a programme.

Periodic professional development workshops to reflect on current practices (new technologies) and expose teachers to new digital tools and how to integrate them in classroom practice will be conducted, and therefore, monitoring and evaluation will be important.

The communities of practice working groups besides this programme will also share experiences and have a shared understanding of how to improve the art of teaching and learning in Science on other issues. The ever-evolving technology also requires ongoing programmes of this nature to ensure that teachers keep abreast of new technology in teaching and learning and to afford them the opportunity to be innovative.

The model is based on the collective reflection of experiences and sources of self-efficacy as suggested by Bandura (2006). These sources of self-efficacy are mastery of experiences, social models, social persuasion, and exposure to structured situations. (Bandura, 2006). The model is linked to the specific needs of the Science teachers in the province. It must therefore be a locally developed and contextually relevant model. Professional development programmes depend on context, and thus, models should be designed to serve the needs of the specific teachers and learners. The implementation of digital teaching methodologies needs to consider that these solutions should be context-specific and adapted to local needs and conditions (Hennessy, Harrison, & Wamakote, 2010). The advantages professional development programmes that depend on context are that the ICT teaching and learning methodologies adopted will be appropriate to the local setting and conditions. When being used to enhance Science teachers' ICT self-efficacy, the teachers will engage in peer and team learning and the focus will be on ICT for pedagogy. The use of digital teaching methodologies should be pedagogically driven and not technology driven. Fullan, (2013) noted that most ICT staff development programmes for teachers focus mostly teaching the tools instead of using the tools.

The model is expected to provide an interactive, participatory approach rather than transmission-based methods in staff developing teachers in the use of digital teaching methodologies. The model thus emphasises staff developing teachers on how to use digital tools in the teaching and learning process by focussing on enhancing the teachers' self-efficacy.

The results obtained from phase 1 of the research, which included the needs of the participants, derived from the perceived obstacles to the use of ICT in the teaching and learning process was considered in coming up with the model. The participants' ICT self-efficacy level and the frequency of ICT use in lesson delivery were also considered when the model was designed to align it to the local needs. A workshop scenario was then developed. The model is therefore structured to address the Science teachers' perceptions of the affordances of technology application in lesson delivery, enhancing their self-efficacy.

The proposed staff development model ensures ICT integration into the teaching process by enhancing teachers' self-efficacy to make teachers realise the learning opportunities (affordances) offered by digital devices. Hammond, (2009) suggested that if teachers cannot perceive the affordances of ICT, then they are not likely to use ICT as a tool in the teaching and learning process. The model is thus envisaged to enhance Science teachers' self-efficacy to enable them to realise the affordances offered by digital devices. The model is presented in detail in figure 7.3.

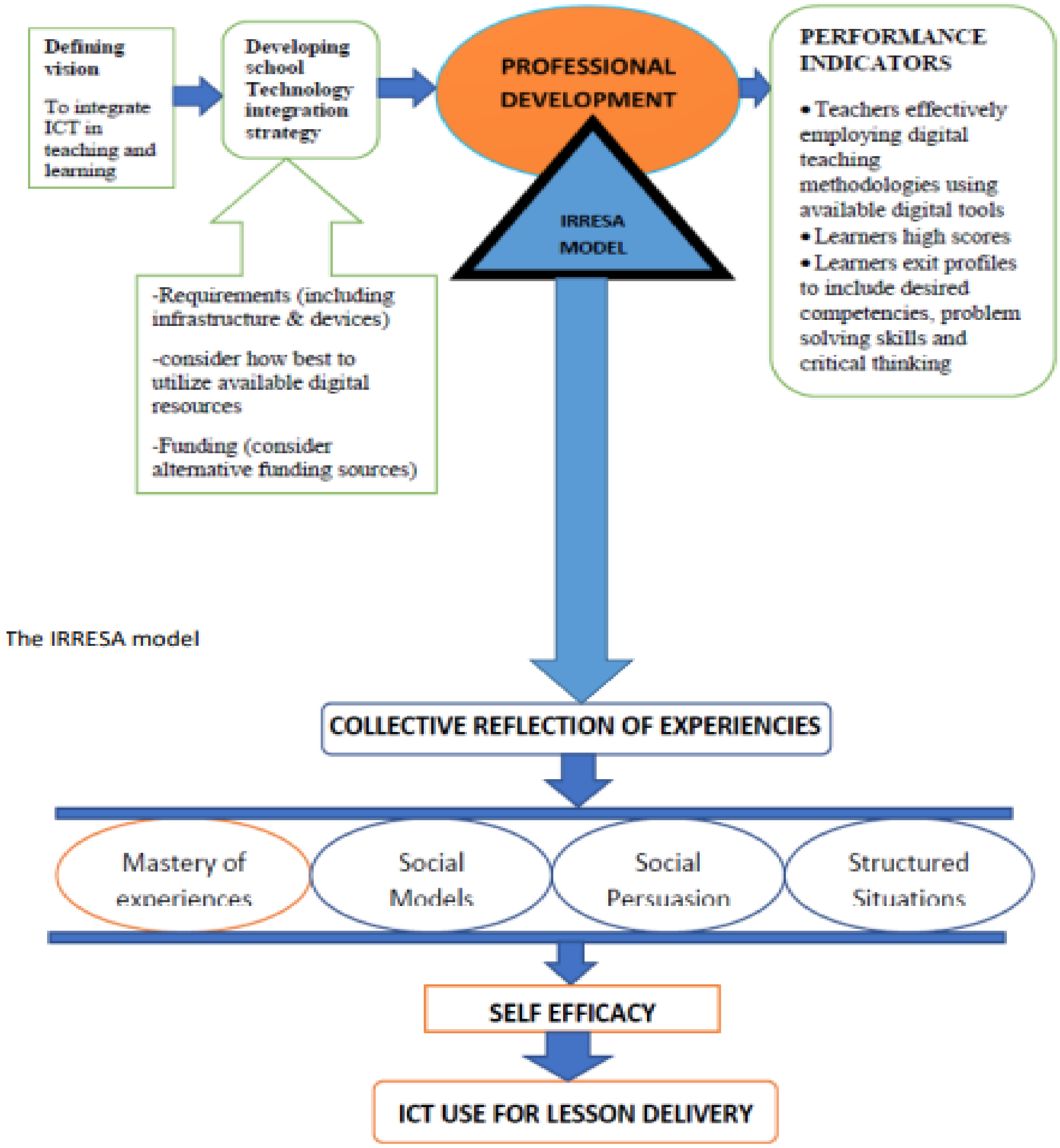

Figure 7.3 Detailed proposed professional development model

7.3 The professional development workshop scenario

The intention of this workshop scenario is to ensure the use of participatory approaches that are key in the execution of the model. The workshop scenario (described below and shown in Appendix N) was constructed using Gessese and Mussa's (2018) ideas on scenario planning for social learning. The ideas were modified to suit the current study. According to Gessese and Mussa (2018), the scenario for the workshop to enhance Science teachers' ICT self-efficacy should do the following:

- Provide a forum for active, equitable and creative discussion on digital teaching methodologies.
- Link scientific and experiential knowledge and enable participants to share and negotiate different views and perspectives on the use of ICT in teaching and learning.
- Enable participants to build their capacities for collective action on the use of ICT in classroom practice; and
- Inform individual behaviour and guide decision making on appropriate teaching methodologies for the 21st century.

Teacher professional development programmes should be empowering, experiential and collaborative and the teachers should engage in concrete tasks in realistic scenarios (Netrag & Mishra, 2017)

The following questions, adopted and modified from those suggested by Beck and Jamissen (2011), could be used during the workshop to kickstart the reflection exercise:

- Which ICT devices have you ever used in teaching and learning?
- What has been working well or is working well and why?
- What challenges were encountered or are being encountered?
- What should we do to mitigate against the challenges?
- What are the consequences of using ICT in pedagogical practice?
- What have you gained and learnt from the success stories of colleagues?

The facilitators would be selected from among the target population and will be assisted by an expert (chief facilitator). The team could convene a meeting to standardise content for the workshop before the date set for the workshop.

The suggested guidelines can be adopted and modified to suit different contexts or only used to guide the construction of a scenario suitable for the workshop. The proposed scenario has an introductory phase and a concluding phase. The facilitators and the coordinating team should work on the other sessions on the use of other digital devices and the methodologies to use them and fit them in the proposed scenario. The workshop could be done over four to five days to cover as many digital teaching methodologies as possible, allowing for the participatory nature of the model and practical activities on the use of digital devices in teaching and learning. The study established that several schools do not have sufficient pedagogical teaching devices, and hence, the use of social media was used as an example in the framework for workshopping teachers to enhance their level of ICT self-efficacy. Other digital devices and methodologies are then suggested for the facilitators to fit into the scenario template (Appendix N). The following workshop objectives can be adopted:

Workshop objectives:

1. To enhance Science teachers' ICT self-efficacy.
2. To provide a platform for Science teachers to share, interrogate and evaluate their practices and experiences in digital teaching methodologies;
3. To expose participants to different ICT pedagogical tools and how they can be used in teaching and learning.
4. To equip participants with basic practical skills on the use of ICT pedagogical tools.
5. To map out the direction to go regarding digital teaching methodologies with participants; and

6. To enhance Science teachers' ICT self-efficacy.

The workshop could be grounded on the following focus points:

- To share a common understanding of the nature of learners in the classrooms (digital oriented).
- To make teachers realise why they should employ digital teaching methodologies.
- To reflect and evaluate current practices and compare them in coming sessions with what they are expected to do in terms of digital teaching methodologies.
- To expose participations to easy-to-use and cost-effective pedagogical digital tools.

The teachers at the workshop will reflect on action (their experiences in the use of digital tools in classroom practice) through step-by-step methods planned by peers. The model is based on the collective reflection of experiences and sources of self-efficacy as suggested by Bandura (2006). These sources of self-efficacy are mastery of experiences, social models, social persuasion, and exposure to structured situations (Bandura, 2006). The proposed model shown in Figure 7.3 was linked to the specific needs of the Science teachers in the province. This study identified the following limitation in the target population:

- Low self-efficacy in the use of ICT in teaching and learning.
- Lack of skill to use digital tools in classroom practice.
- Limited access to ICT devices at most schools; and
- Low frequency of the use of digital tools in teaching and learning.

The model was specifically fashioned to meet the teachers' specific needs. Professional development programmes depend on context, and thus, models should be designed to serve the needs of the specific teachers and learners. The implementation of digital teaching methodologies must consider that these solutions should be context-specific and adapted to local needs and conditions (Hennessy, Harrison, & Wamakote, 2010).

7.4 Summary

A professional development model was proposed and discussed in this chapter. The following findings from the study informed the construction of the model:

- All the participants articulated the benefits of integrating ICT into teaching and learning, and these benefits were also recorded in the literature reviewed.
- The Science teachers in the study sample have a low ICT self-efficacy, and hence, were not confident to use digital teaching methodologies.
- The results of the study showed that there is little to no effective ICT integration into classroom practices in the schools in the study area.
- The teachers in the study sample reported that they lacked the skills to use digital pedagogical tools and they that they have limited access to digital gadgets.
- It emerged from the findings and literature that there is a need for an inclusive and well-coordinated professional development programme that allows teachers to participate to ensure ownership by the innovation implementers.

The model, follows the steps below:

1. Defining vision: This should be done at school level so that a deliberate strategy for ICT integration in teaching and learning is collectively crafted by all stakeholders to define the direction for implementing the integration of ICT in education.
2. Formation of CoP: This should be done at district or cluster level to ensure collaborative action on the use of ICT tools in teaching and learning.
3. Professional development workshop: This can be a four-to-five-day workshop following the proposed IRESSE model. The workshop is preceded by scenario making. The scenario guides the workshop activities and ensures the participatory nature of the model.
4. Ongoing support: The professional development programme is not a once off event, and thus the CoP working groups should be kept alive to cater for the non-static nature of ICT, answering the need to keep abreast with new teaching methodologies associated with new technologies. The efficiency and effectiveness of the workshops can be guaranteed by conducting well-coordinated monitoring and evaluation.

The professional development model proposed in this study is subject specific and meant for Science teachers. Hennessy, Harrison, and Wamakote, (2010) posited that professional development should be tailor-made to a specific subject area to allow participants to adequately develop their ICT pedagogical skills and collectively reflect on their experiences within the discipline. Professional development models can be categorised into innovation-focused and action research. Short seminars, school based professional development workshops and engaging a consultant fall under the innovation-focused model. Action research models are participant driven where the teachers reflect on action through methods that are planned and facilitated by a consultant or a peer (Dunlop, 1990). This research's proposed staff development model fits well into the action research model.

According to Lloyd-Williams, Kite, Hicks, Todd, Ward, & Barnet (2006) continuing professional development (CPD) is a strategy that can be used to ensure ICT integration into teaching and learning. Among other approaches, CPD can be single event programmes, serial courses, or professional learning communities. Any form of staff development that is effective should provide teachers with techniques that enable them to use ICT in teaching and learning. Effective staff development should be experiential, designed and directed by teachers, encompass reflection, be collaborative and participant driven, and involve teachers in concrete tasks (Huffman, 2006) The model proposed by this research addresses these issues. The model provides an interactive and participatory approach rather than transmission-based methods to develop teachers' use of digital teaching methodologies. The model thus emphasises developing teachers' use of ICTs in the teaching-learning process by focussing on enhancing their self-efficacy.

CHAPTER 8: CONCLUSIONS, RECOMMENDATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

8.1 Introduction

ICTs have penetrated the social life of Zimbabweans and other nations the world over, and this has led to a transformation of the education landscape. ICTs are seen as an integral part of 21st century teaching methodologies. Cognisant of the well documented benefits of ICT use in teaching and learning, many schools face significant challenges in their efforts to integrate technology in the practice of teaching. The challenges are multifaceted, but teachers' lack of confidence in using ICT pedagogical tools (low ICT self-efficacy) is a key barrier to the integration of ICT in classroom practice. This study therefore sought to determine the level of ICT self-efficacy of Science teachers in Manicaland Province of Zimbabwe and propose a professional development model to enhance it. The professional development model to enhance Science teachers' ICT self-efficacy was discussed in the previous chapter. This chapter concludes the study and make recommendations and suggestions for further research in related issues.

8.2 Conclusions

This study concluded the following from the findings:

- Science teachers in Manicaland are not confident in using digital tools in teaching and learning.
- The use of digital tools in teaching and learning in the schools is zero to minimal.

- PowerPoint presentations is the foremost digital methodology used by the few teachers who reported employing digital teaching methodologies.
- Besides teachers' low ICT self-efficacy there are several other barriers that hinder integration of ICT into teaching and learning. The following major barriers were cited by respondents and found in literature:
  - Lack of ICT resources.
  - Lack of access to available digital devices.
  - Lack of pedagogical and technical support; and
  - Lack of skills to effectively employ digital teaching methodologies.

However, the teachers do not use the available ICT tools found in their schools, such as mobile phones, cameras and the few available laptops and desktops. It can therefore be concluded that low ICT self-efficacy is the major hindrance to the integration of ICT into teaching and learning. Teachers' ICT professional development needs are not sufficiently addressed in a well-coordinated manner to ensure the effective implementation of the innovation. The teachers who are moderately to high ICT self-efficacious are the ones who use digital teaching methodologies in teaching and learning. The teachers are aware of the benefits of integrating ICT into the teaching and learning process and expect the implementation of the pedagogical innovation to add value to lesson delivery and lead to effective instruction.

It is therefore imperative that effective professional development programmes be embarked on to enhance teachers' ICT self-efficacy and ensure that technology is integrated in teaching and learning. This study proposed a professional development model to ensure that teachers become more ICT self-efficacious.

8.3 Recommendations

This study made recommendations for the different stakeholders. These are discussed in the following subsections.

8.3.1 Policy makers, government, and Ministry of Primary and Secondary Education

The respondents cited budgetary constraints and electricity challenges among the barriers to ICT integration in the teaching and learning process. These challenges also surfaced in the reviewed literature. These challenges require government intervention.

Though Zimbabwe has an ICT policy, there is no specific national policy on ICTs in education (Isaacs, 2007). A specific education ICT policy would detail the road map for ICT integration into education. This will ensure budget allocation for ICT integration into teaching and learning from central government. Policy makers are expected to address the constraints to the use of pedagogical teaching and learning tools (Wagner et al., 2005). This can be achieved through all-embracing policy statements. The study therefore recommends the formulation of a dedicated education ICT policy instead of a general one.

While the government rural electrification programme is plausible, in the short to medium term it is necessary to resort to renewable energy sources (e.g., solar) so that learners in communities without electricity also benefit from the use of digital tools. The use of bio-gas driven generators can also be explored. If the problem of ICT integration into teaching and learning in rural schools remains unresolved, this may widen the gap between learners in urban and rural areas, creating social inequality (Tinio, 2003). This study therefore suggests rolling out a programme to provide alternative forms of energy to mitigate electricity challenges in schools with no electricity from the national grid.

The respondents reported that while learners are not allowed to have mobile phones during lesson time most of them smuggle them into the classroom. Steukers (2017) acknowledged that it is necessary explore mobile learning as a strategy to enhance ICT integration into teaching and learning. Mobile learning is the use of mobile devices as pedagogical tools. The possession of mobile phones during learning time may provide an effective pedagogical tool, and therefore, the study recommends that the debate on the issue of learners using mobile phones during lesson time should be invigorated and should involve all stake holders, including the government through the ministry, headmasters, teachers, learners, independent observers, and parents. Parameters to ensure responsible and ethical use of the digital devices by learners should also be set, and more internet accessibility should be provided.

Charalambos & Glass, (2007) cited lack of teacher professional development as one factor that may hinder the use of ICT in teaching and learning. The study respondents reported that professional development workshops were held at local level. However, some schools indicated that they could not mount these workshops due to financial constraints, but they indicated that sometimes they rely on ministry-initiated workshops. Conducting effective staff development programmes requires a concerted effort from all stake holders, and therefore, the study recommends that the ministry should intensify, fund and coordinate staff development workshops to enhance teachers' confidence in using digital devices in lesson delivery; put in place an effective monitoring and evaluation mechanism for ICT integration into education; and make an audit of donated computers.

The respondents reported insufficient ICT pedagogical tools, especially in remote areas. The ministry could therefore provide facilities for clustered schools where learners and teachers can access technological devices. Therefore, this study recommends that the ministry establishes well-coordinated technology centres.

School administrators play a key role in ICT integration in teaching and learning. Several ICT projects were undermined by lack of support from school leadership. ICT integration can only be effective and sustainable if administrators themselves are competent in technology use (Ogbomo, 2011) (Baharuldin, Jamalludin, & Shaharon, 2019).

One of the headmasters interviewed implicitly agreed that he was not computer cultured. The study thus recommends that the ministry staff develop senior management staff at schools.

8.3.2 The schools and headmasters

This study recommends that headmasters should allow all teachers access to the available ICT tools and that headmasters and their senior management teams attend workshops on digital teaching methodologies.

The District Schools Inspector and the headmasters who participated in this study reported lack of funds to support the integration of ICT into teaching and learning. While the central government is expected to avail funds for implementing the pedagogical innovation, schools could take advantage of the government philosophy Education 5.0, which advocates for an education that produces goods and services guided by the heritage-based philosophy. Schools could engage in income generating projects to raise funds. Part of the funds could be channelled to finance the integration of ICT in education. Therefore, the study recommends that schools embrace Education 5.0 to raise funds.

Lack of maintenance of digital devices was cited as one of the barriers to ICT integration into teaching and learning. The study recommends that to collectively fund digital equipment maintenance, each school cluster should employ an IT expert to service digital equipment and to assist teachers with content creation.

8.3.3 Science teachers

Most of the teachers in the study sample reported low ICT self-efficacy. Low ICT self-efficacy is therefore a major barrier to the integration of ICT into teaching and learning, and therefore, teachers should participate in staff development workshops that enhance their confidence to use digital teaching methodologies.

There are digital tools that can be used during teaching and learning available even in technological poor environments. These may include cameras, mobile phones, televisions, and radios. This study therefore recommends that the Science teachers integrate ICT using the available devices.

8.4 Knowledge Contribution

A gap existed in literature on ICT integration in teaching and learning in Zimbabwe regarding the determination of teachers' ICT self-efficacy. The most recent research on teachers' ICT self-efficacy focused on effect of self-efficacy on acceptance of the use of some digital tool in classroom practice and on adoption ICT in teaching and learning (Karimazondo, Castera, Impedovo, & Mango, (2020); Rudhumbu, Du Plessis, & Kelebogilet, (2021). Other research concentrated on preparedness of teachers to integrate ICT in teaching and learning (Kangara, Gocha, Tsokota, & Marovha, 2022) and adoption and integration of ICT in classroom practice (Magodora, M., Mapuwei, T., Basira, K., Chagwiza, C., Masanganise, J., & Mutangi, K. (2016). Most of the reviewed studies on ICT integration in Zimbabwe focused on other factors such as ICT integration obstacles, challenges, competencies, opportunities, and integration at different levels (Konyana & Konyana, (2013); Mandina, (2015); Musarurwa, (2016). A gap therefore existed in reseach on an internal factor, that is the teachers' ICT self-efficacy which may affect technology integration in teaching and learning.

This study adopted a mixed methods research approach to determine the Science teachers' ICT self-efficacy in Manicaland province of Zimbabwe and was aimed at bridging this gap. The Science teachers' perceived barriers to ICT integration to the teaching and learning process were identified, their self- efficacy scores were determined, and it was revealed that the teachers were generally not confident in using ICT devices in classroom practice. The frequency of using digital devices in lesson delivery was determined and found to be very low. The study established a positive correlation between frequency of using ICT in teaching and learning and the ICT self-efficacy scores of the teachers. The study also established the need for well-coordinated professional development programs to enhance the Science teachers' ICT self-efficacy hence a professional development model to enhance teachers' ICT self-efficacy irrespective of whether their teaching space was technology rich or poor was proposed. The assumption being that all teaching environments in Manicaland have some form of digital devices for pedagogical use and that efforts are being made by the government and other partners to digitally equip all schools. Dzinotyiweyi and Taddese, (2020) noted that the Ministry of Primary and Secondary Education in Zimbabwe supported several initiatives to strengthen ICT integration in schools. These initiatives included the school's computerization programme, the Presidential e-learning programme and the electronic application platform.

The model proposed was grounded on participation of the teachers during the workshop, the use of Bandura (2006) sources of self-efficacy and collective reflection of experiences. The professional development programmes where teachers collaborate with other, reflect on their classroom practice, and receive support and feedback have been shown to lead to effective professional growth (Huffman, 2006). Teachers who participate in professional development use ICT teaching and learning tools more regularly in classroom practice and are more ICT self-efficacious (Drossel & Eickelmann, 2017). Garces & Granada, (2016) asserted that when teachers share what works and reflects on their practice, it leads to positive gains in their development. The strategy proposed in this study may develop teachers use of digital teaching methodologies by enhancing their ICT self-efficacy, and it is expected to use interactive and participatory methods rather than transmission-based methods.

8.5 Suggestions for Further Research

Further research can be conducted in the following areas:

- Testing the proposed model.
- Determining the ICT self-efficacy of teacher educators.
- Determining the extent of the use of digital teaching methodologies in colleges of education.

Education the world over has been disrupted by the Covid-19 pandemic. Almost all schools and learning spaces have been closed. This called for far reaching changes in the education sector. Face-to-face learning has been greatly affected by the restrictive movement and social distancing policies. Transitioning from face-to-face tuition to online teaching and learning has become inevitable. The education system in general and teachers need to adopt to new ways of delivering quality education. Online learning has provided a panacea for the global pandemic. This study, however, revealed a dearth in digital resources in most schools in Zimbabwe and low levels of self-efficacy on the part of teachers. Pokhre and Chetri (2021) observed that teachers adopted "Education in Emergency" by using online platforms they are not prepared to use and suggested that teachers' preparedness to use online teaching methodologies should be assessed and that they should be supported accordingly. Further research could therefore focus on developing an online professional development model by adapting the model proposed in this study.

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Appendix A: Ethical Clearance Certificate

Research Office

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)
R14/49 Jabangwe

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: H19/03/07**
PROJECT TITLE	Digital teaching methodologies: Science teachers' self efficacy and classroom technology integration: The case of Manicaland Province, Zimbabwe
INVESTIGATOR(S)	Mr S Jabangwe
SCHOOL/DEPARTMENT	Education/
DATE CONSIDERED	15 March 2019
DECISION OF THE COMMITTEE	Approved Permission letters from schools and Ministry of Education are required before data collection can commence
EXPIRY DATE	16 April 2022

DATE 17 April 2019 PP **CHAIRPERSON** ____________ (Professor J Knight)

cc: Supervisor : Dr R Dlamini

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University. Unreported changes to the application may invalidate the clearance given by the HREC (Non-Medical)

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to completion of a yearly progress report.**

____________________ ______/______/______
Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

Appendix B: Request to Ministry of Primary and Secondary Education to Conduct Research

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

THE PERMANENT secretary,

MINISTRY OF PRIMARY AND SECONDARY EDUCATION.

3 May 2018

Dear Sir

My name is Sifelani Jabangwe (Mr). I am part time PhD student in the School of Education at the University of the Witwatersrand, South Africa. I am a lecturer at Mutare Teachers, College.

I am doing research on Digital Teaching Methodologies: Science Teachers' Self-Efficacy and Classroom Technology Integration: The Case of Manicaland Province, Zimbabwe.

I am kindly asking for permission to carry out the study in secondary schools in Manicaland.

My research involves collecting data using questionnaires and interviews. Questionnaires will be administered to 350 randomly selected Science teachers in Manicaland Province. A questionnaire for Science teachers on obstacles to ICT integration will take a maximum of 20 minutes to fill and that on self-efficacy will take a maximum of 30 minutes. Fourteen headmasters (2 from each district) and three District Schools Inspectors randomly selected in the province will be interviewed. The interview is expected to take a maximum of 30 minutes.

The reason why I have chosen secondary schools in Manicaland is because my study explores the use of digital teaching methodologies at secondary school level in the Science subject area. Secondary school teachers therefore will provide relevant and useful data. The choice of the province was deliberate as it will be convenience for me since I am stationed at Mutare Teachers' College in Manicaland.

The research participants will not be advantaged or disadvantaged in any way by participating or not participating in the study. They will be assured that choice not to participate will not have any consequences and they can withdraw their participation at any time during this project without any penalty. There are no foreseeable risks in participating in this study. The participants will not be paid for this study.

The names of the research participants and identity of the school and district will be always kept confidential and in all academic writing about the study. Their individual privacy will be maintained in all published and written data resulting from the study. All research data will be destroyed 3 years after completion of the project.

I look forward to your response as soon as is convenient.

Yours sincerely,

Jabangwe Sifelani (Mr)

EMAIL: sjabangwe@gmail.com

Mobile number: +263 776332470

Appendix C: Permission to Conduct Research from Ministry of Primary and Secondary Education

All communications should be addressed to "The Secretary for Primary and Secondary Education"
Telephone: 799914 and 705153
Telegraphic address : "EDUCATION"
Fax: 791923

ZIMBABWE

Reference: C/426/3
Ministry of Primary and
Secondary Education
P.O Box CY 121
Causeway
ZIMBABWE

8 July 2019

Sifelani Jabangwe
Mutare Teachers' College
P.O. Box 3293
Paulington, Mutare
Zimbabwe

RE: PERMISSION TO CARRY OUT RESEARCH IN MANICALAND PROVINCE: MUTARE; MUTASA; MAKONI; CHIMANIMANI; CHIPINGE; BUHERA AND NYANGA DISTRICTS: SECONDARY SCHOOLS

Reference is made to your application to carry out a research in the above mentioned schools in Manicaland Province on the research title:

"DIGITAL TEACHNG METHODOLOGIES SCIENCE TEACHERS' SELF EFFICICACY AND CLASSROM TECHNOLOGY INTEGRATION: THE CASE OF MANCALAND PROVINCE, ZIMBABWE"

Permission is hereby granted. However, you are required to liaise with the Provincial Education Director Manicaland Province, who is responsible for the districts and schools which you want to involve in your research. You should ensure that your research work does not disrupt the normal operations of the school. Where student are involved, parental consent is required.

You are required to provide a copy of your final report to the Secretary for Primary and Secondary Education

POLICY PLANNING RESEARCH AND DEVELOPMENT
06 AUG 2019
P.O. BOX CY 121, CAUSEWAY
ZIMBABWE

Mrs T. Thabela
SECRETARY FOR PRIMARY AND SECONDARY EDUCATION

Appendix D: Request to Provincial Education Director to Conduct Research

THE PROVINCIAL EDUCATION DIRECTOR, MANICALAND

MINISTRY OF PRIMARY AND SECONDARY EDUCATION.

3 May 2018

Dear Sir

My name is Sifelani Jabangwe (Mr). I am part time PhD student in the School of Education at the University of the Witwatersrand, South Africa. I am a lecturer at Mutare Teachers, College.

I am doing research on Digital Teaching Methodologies: Science Teachers' Self-Efficacy and Classroom Technology Integration: The Case of Manicaland Province, Zimbabwe.

I am kindly asking for permission to carry out the study in secondary schools in Manicaland. I have attached hereto a copy of the clearance letter from the Permanent Secretary, Ministry of Primary and Secondary Education

My research involves collecting data using questionnaires and interviews. Questionnaires will be administered to randomly selected Science teachers in Manicaland Province. A questionnaire for Science teachers on obstacles to ICT integration will take a maximum of 20 minutes to fill and that on self-efficacy will take a maximum of 30 minutes. Fourteen headmasters (2 from each district) and three District Schools Inspectors randomly selected in the province will be interviewed. The interview is expected to take a maximum of 30 minutes.

The reason why I have chosen secondary schools in Manicaland is because my study explores the use of digital teaching methodologies at secondary school level in the science subject area. Secondary school teachers therefore will provide relevant and useful data. The choice of the province was deliberate as it will be convenience for me since I am stationed at Mutare Teachers' College in Manicaland.

The research participants will not be advantaged or disadvantaged in any way by participating or not participating in the study. They will be assured that choice not to participate will not have any consequences and they can withdraw their participation at any time during this project without any penalty. There are no foreseeable risks in participating in this study. The participants will not be paid for this study.

The names of the research participants and identity of the school and district will be always kept confidential and in all academic writing about the study. Their individual privacy will be maintained in all published and written data resulting from the study. All research data will be destroyed 3 years after completion of the project.

Please find attached the districts and schools where I intend to carry out my research.

I look forward to your response as soon as is convenient.

Yours sincerely,

Jabangwe Sifelani (Mr)

EMAIL: sjabangwe@gmail.com

Mobile number: +263 776332470

Appendix E: Permission to Conduct Research from Provincial Education Director

Heads of schools listed above.
Please assist by allowing Mr Sifelani Jabangwe to conduct his research as granted by the Perm Sec in her letter to him.

Machu

DSI – MAKONI

MIN. OF PRY. & SEC. EDUCATION
MAKONI DISTRICT
DISTRICT SCHOOLS INSPECTOR
17 FEB 2020
P.O. BOX 232, RUSAPE
ZIMBABWE

Appendix F: District Schools Inspector’s Consent Form

UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

Dear Sir/Madam

Please fill in and return the reply slip below indicating your willingness to be a participant in my voluntary research project called:

Digital Teaching Methodologies: Science Teachers’ Self-Efficacy and Classroom Technology Integration: The Case of Manicaland Province, Zimbabwe.

I, ________________________ give my consent for the following:

Permission to be audiotaped

I agree to be audiotaped during the interview YES/NO

I know that the audiotapes will be used for this project only YES/NO

Permission to be interviewed

I would like to be interviewed for this study. YES/NO

I know that I can stop the interview at any time and don’t have to answer all the questions asked. YES/NO

Informed Consent

I understand that:

- my name and information will be kept confidential and safe and that my name and the name of my district will not be revealed.
- I do not have to answer every question and can withdraw from the study at any time.
- I can ask not to be audiotaped.
- all the data collected during this study will be destroyed within 3–5 years after completion of my project.

Sign______________________________ Date____________________________

Appendix G: Headmaster's Consent Form

UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

Dear Sir/Madam

Please fill in and return the reply slip below indicating your willingness to be a participant in my voluntary research project called:

Digital Teaching Methodologies: Science Teachers' Self-Efficacy and Classroom Technology Integration: The Case of Manicaland Province, Zimbabwe.

I, ________________________ give my consent for the following:

Permission to be audiotaped

I agree to be audiotaped during the interview YES/NO

Informed Consent

I understand that:

- the names of the teachers and information will be kept confidential and safe and that the name of my school will not be revealed.
- all the data collected during this study will be destroyed within 3–5 years after completion of my project.

Sign_____________________________ Date___________________________

Appendix H: Headmaster's Consent Form

UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

Dear Sir/Madam

Please fill in and return the reply slip below indicating your willingness to be a participant in my voluntary research project called:

Digital Teaching Methodologies: Science Teachers' Self-Efficacy and Classroom Technology Integration: The Case of Manicaland Province, Zimbabwe.

I, ________________________ give my consent for the following:

Permission to have teachers at my school to participate in the study

I agree to have teachers at my school to participate in the study YES/NO

I know that the audiotapes will be used for this project only YES/NO

Permission to be interviewed

I would like to be interviewed for this study. YES/NO

I know that I can stop the interview at any time and don't have to

answer all the questions asked. YES/NO

Informed Consent

I understand that:

- my name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- I do not have to answer every question and can withdraw from the study at any time.
- I can ask not to be audiotaped.
- all the data collected during this study will be destroyed within 3–5 years after completion of my project.

Sign_______________________________ Date_____________________________

Appendix I: Information Sheet for Teachers

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Dear Sir/Madam

My name is Sifelani Jabangwe (Mr) I am a PhD student in the School of Education at the University of the Witwatersrand.

I am doing research on Digital Teaching Methodologies: Science Teachers' Self-Efficacy and Classroom Technology Integration: The Case of Manicaland Province, Zimbabwe.

The study will be aimed at analysing Science teachers' Information and Communication Technology (ICT) self-efficacy as defined by Bandura (1979). The research involves collecting data using questionnaires and interviews. Questionnaires will be administered to you and some of your colleagues (randomly selected Science teachers in Manicaland Province, Zimbabwe). You as a Science teacher was randomly selected to participate in the research because the study explores Science teachers' self-efficacy therefore you will provide relevant data for the study. The questionnaires will be delivered and handed to you as hard copies and you will be kindly asked to respond to the questionnaire items. The completed questionnaires will then be collected and the raw data from the questionnaires will be summarised and used in the research report. The raw data will be destroyed three years after completion of the research project. A questionnaire for Science teachers on obstacles to ICT integration will take a maximum of 20 minutes to fill and that on self-efficacy will take a maximum of 30 minutes.

Would you mind if I cordially invite you to participate in my research by responding to the questionnaire items? Your name and identity will always be kept confidential and anonymous in all academic writing about the study. Your individual privacy will be maintained in all published and written data resulting from the study. All research data will be destroyed 3 years after completion of the project.

You will not be advantaged or disadvantaged in any way by participating or not participating in the study. Your participation is voluntary, so you can withdraw your participation at any time during this project without any penalty. There are no foreseeable risks in participating and you will not be paid for this study.

Please let me know if you require any further information.

Thank you very much for your help.

Yours sincerely,

Jabangwe Sifelani (Mr)

EMAIL: sjabangwe@gmail.com

Mobile number: +263 776332470

Appendix J: Questionnaire for Science Teachers

My name is **Jabangwe Sifelani**. I am a PhD student at the University of Witwatersrand.

I would very much appreciate it if you could participate in my research project. The research seeks to explore Science Teachers' ICT Self-Efficacy and Classroom Technology Integration. The topic reads thus: **Digital Teaching Methodologies: Science Teachers' Self-Efficacy and Classroom Technology Integration: The Case of Manicaland Province, Zimbabwe.**

This questionnaire is completely anonymous **(Please do not write your name on it)** and data gathered in this study will be treated with strictest confidentiality and presented only in a summary form without your name or your affiliation. Please respond to all the questions with your first reaction. Should you have any questions, comments, etc., regarding the questionnaire and my research, please do not hesitate to contact me.

Thank you for your valuable support and input.

Email address: sjabangwe@gmail.com

Mobile number: +263 776332470

1.0 Demographic Information

Please choose the correct response by placing a tick in the appropriate box.

1.1. Gender

Male ☐ Female ☐

1.2. Age

18–20 years ☐ 21–30 ☐ 31–40 ☐ above 40 years ☐

1.3. Work experience:

1 year and below ☐ 2–10 years ☐ 11–20 years ☐ 21 years and above ☐

1.4. Experience with use of computer

2 year and below ☐ 2–10 years ☐ 11–20 years ☐ 21 years and above ☐

2.0. Obstacles in the use of ICT in teaching and learning

2.1 What do you think about ICT integration into the teaching and learning of science?

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…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

……………………………………………………………………………………..

2.2 Does your school have a deliberate strategy on ICT integration in teaching and learning?

Yes No ☐ ☐

If your answer is yes, explain the strategy.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………

2.3 Does the school administration support ICT integration into the teaching and learning of science

Yes No ☐ ☐

2.4 If your answer is yes, give details of how the school supports ICT integration in the teaching-learning process.

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

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

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

……………………………………………………………………………………..

2.5 What are the available functional ICT gadgets at your school?

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

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

………………………………………………………………………………………………

2.6 Of the available gadgets which ones have you ever used in lesson delivery?

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

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

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

2.7. What is your opinion on the notion that “the efficiency of the learning process can be increased through the use of ICT”

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....

	Not at all	Partially	A lot
Lack of adequate skills on your part			
Insufficient technical support			
Insufficient pedagogical support			
Inability to create activities on the computer on your part			
Inability to use educational software to create digital content for use during lesson delivery			
Time needed to learn using ICT prevents me to use ICT			
Limited knowledge on how to make full use of ICT			
Limited understanding on how to integrate ICT into teaching			

2.8 Is the use of ICT in teaching and learning adversely affected by the following? Indicate your response by ticking in the appropriate box:

2.8 What other challenges/obstacles/constraints have you encountered in the use of ICT in lesson delivery?

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Thank you.

Appendix K: Questionnaire for Science Teachers

My name is **Jabangwe Sifelani**. I am a PhD student at the University of Witwatersrand.

I would very much appreciate it if you could participate in my research project.

The research seeks to explore Science Teachers' ICT Self-Efficacy and Classroom Technology Integration. The topic reads thus: Digital Teaching Methodologies: Science Teachers' Self-Efficacy and Classroom Technology Integration: The Case of Manicaland Province, Zimbabwe.

The questionnaire is completely anonymous **(Please do not write your name on the questionnaire)** and data gathered in this study will be treated with strictest confidentiality and presented only in a summary form without your name or your affiliation. Please respond to all the questions with your first reaction. Should you have any questions, comments, etc., regarding the questionnaire and my research, please do not hesitate to contact me.

Thank you for your valuable support and input.

Email address: sjabangwe@gmail.com

Mobile number: +263 776332470

1.0 Demographic Information

Please choose the correct answer by placing a tick in the appropriate box.

1.1. Gender

Male ☐ Female ☐

1.2. Age

Below 20 years 2 30 31–40 above years

1.3. Work experience:

1 year and below 2- years 11–20 rs 21 years and ove

1.4. Experience with use of computer

1 year and below 2) years 11–20 y s 21 years and ove

2.0. Teacher ICT Self-Efficacy

Below is a list of different activities, in the column titled confidence, rate how confident you are that you can do the activity as of now. Rate your degree of confidence **by placing a tick in the appropriate box to the right of each statement.** Each of the survey items have three choices ranging in 50-unit intervals on a 100-point scale from 0 (cannot do at all) through 50 (moderately certain can do) to 100 (Highly certain can do)

		CONFIDENCE										
	ACTIVITY	**Cannot do at all**					**Moderately certain can do**					**Highly Certain can do**
		0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
2.1	Teaching Science using ICT tools.											

2.2	Creating a teaching and learning activity on the computer.											
2.3	Using the computer for lesson delivery											
2.4	Using subject specific educational software to create digital content for use during lesson delivery											
2.5	Accessing teaching and learning resources											

	using online databases											
2.6	Browsing internet to collect information to prepare lessons											
2.7	Video conferencing for teaching and learning purposes											
2.8	Creating a teaching and learning presentation with a video or audio clip											
2.9	Capturing and editing digital photos/images for use											

	during lesson delivery											
2.10	Using television, radio or digital cameras as teaching and learning tools.											
2.11	Generally employing digital teaching methodologies in lesson delivery effectively											
2.12	Helping learners when they have difficulty with the computer.											

2.13	Giving instructions to learners on how to use the computer for learning some Science concepts											
2.14	Managing a class well when using ICT resources in lesson delivery,											
2.15	Teaching learners to acquire new content directly from the computer											
2.16	Teaching learners to search for											

	information on the internet											
2.17	Following the right steps necessary to teach science concepts effectively using ICT tools											
2.18	Teaching learners to work collaboratively when using a digital equipment											
2.19	Using email to give learners homework and feedback											

2.20	Using WhatsApp to give learners homework and feedback.											
2.21	Using SMS to give learners homework and feedback.											
2.22	Inviting the Head of Department or the headmaster to evaluate my digital-based instruction											
2.23	Motivating learners to use ICT tools in the learning process											

3.0 Frequency of using digital teaching tools.

You are kindly asked to read and answer this question carefully. Please place a tick in the appropriate box to answer the question.

How often do you do the following activities?

		Never	**Rarely**	**Sometimes**	**All the time**
3.1	use the computer for lesson preparation (e.g. typing your scheme-cum-plan, work sheets)				
3.2	use the computer for lesson delivery				
3.2	use educational software in your lesson delivery				
3.3	use e-learning in your teaching				
3.4	use videos as instructional media				
3.5	use PowerPoint presentations in your lesson delivery				
3.6	use social media as a teaching and learning tool				
3.7	use electronic media(e.g. e-books, e-journals etc.) as instructional material				
3.8	use email in your teaching				

Thank you

Appendix L: Interview Guide: Headmasters

Topic: Digital Teaching Methodologies: Science Teachers' Self-Efficacy and Classroom Technology Integration: The Case of Manicaland Province, Zimbabwe.

Data gathered in this study will be treated with **strictest confidentiality** and presented only in a summary form without the name or affiliation of the participant. Please respond to all the questions with your first reaction. Thank you for your valuable support and input.

1. Does the school have a deliberate policy on ICT integration in the teaching and learning of specific subjects?
2. How does the school ensure professional development of teachers regarding ICT integration?
3. Does the school have a budget for the use of digital teaching methodologies?
4. What challenges has the school encountered in ICT integration?
5. Explain how the school ensure that learners behave ethically online
6. Are learners allowed to bring personally owned digital devices such as laptops or mobile phones?
7. How does the school ensure that that teachers use digital teaching methodologies in the teaching and learning process?

Thank you

Appendix M: Interview Guide: District Schools Inspectors

Topic: Digital Teaching Methodologies: Science Teachers' Self-Efficacy and Classroom Technology Integration: The Case of Manicaland Province, Zimbabwe.

Data gathered in this study will be treated with strictest confidentiality and presented only in a summary form without the name or affiliation of the participant. Please respond to all the questions with your first reaction. Thank you for your valuable support and input.

1. Does the Ministry of Primary and Secondary Education have a deliberate policy on ICT integration in the teaching and learning of specific subjects in the schools?
2. How does your office ensure professional development of teachers in the district with regards to ICT integration?
3. Can you please explain how the Ministry fund digital teaching activities or ensure that these are adequately funded in schools?
4. What challenges have been encountered in ICT integration in the school's curriculum?
5. Explain the Ministry's position regarding learners bringing personally owned digital devices such as laptops or mobile phones to school.
6. Can you please give details on how your office ensures that that schools use digital teaching methodologies in the teaching and learning process?

Thank you

Appendix N: Professional Development Workshop Guidelines (Scenario)

Ministry name and logo

Date:………….

Venue:………….

Target group: Science Teachers, School administrators and a Ministry Official.

Workshop objectives

1. To enhance the Science teachers' ICT self-efficacy.
2. To provide a platform for Science teachers to share, interrogate and evaluate their practices and experiences in digital teaching methodologies.
3. To expose participants to different ICT pedagogical tools and how they can be used in teaching and learning.
4. To equip participants with some basic practical skills on the use of ICT pedagogical tools.
5. To map out (with participants) the direction to go regarding digital teaching methodologies.
6. To enhance Science teachers' ICT self-efficacy.

Day….

Time	**Activity & Materials**	**Methodology**	**Focus Point**
	Registration	Registration and workshop materials distribution Facilitator informs participants about the participatory nature of the workshop and asks them to de-role.	Creating a warm and participatory atmosphere.
	Introductions	The chief facilitator introduces the facilitation team. Facilitator asks a volunteer to introduce him/herself and introduce all those he knows among the participants. The last one to be introduced also introduces the participants they know who have not been introduced and the process continues until everyone in the workshop is introduced. Facilitator with the participants formulate the ground rules with one of the participants writing these and beaming them on a screen	Creating a warm and participatory atmosphere.

Time	Activity & Materials	Methodology	Focus Point
		Facilitator gives the workshop objectives. Facilitator asks the ministry official/ a headmaster to officially open the workshop.	
	The learner’s digital image	The facilitator asks the following to raise their hands: Those who stay or have stayed with children still in secondary school Facilitators ask question/s and probe to get the response from participants that “the children are most of the times engaged on their mobile phones” Facilitator initiates discussion with participants on the best method to use to teach learners who are digitally oriented. Facilitator to close session by pointing out that “Mobile phones, computers and the internet are becoming very common in the learner’s everyday life and a	To share a common understanding of the nature of learners in our classrooms (digital oriented).

Time	Activity & Materials	Methodology	Focus Point
		logical conclusion is that the learner will acquire competencies associated with these digital gadgets outside the classroom. The learners' image is thus becoming digitally oriented. The way we educate our leaners therefore must keep pace with the realities they experience in their lives outside the school environment. It is therefore important to consider the digital image of the learner in classroom practice".	
	Benefits of using digital tools in teaching and learning	The facilitator asks participants to get into groups and list benefits of integrating ICT into teaching and learning A member from each of the groups reports on the group findings. The facilitator closes this session by summarising the benefits reported and any others which may have not come out of the discussions and pointing out that "the use of digital teaching	To make teachers realise why they should employ digital teaching methodologies.

Time	Activity & Materials	Methodology	Focus Point
		methodologies is therefore the mission critical if our education sector is to achieve its intended aims and objectives".	
	Teachers' practices and experiences in using ICT tools in teaching and learning (Reflection) Evaluation of practices Share their success stories on the use of digital teaching methodologies	Facilitators ask participants to go into groups and discuss the following: Which ICT devices have you ever used in teaching and learning? What has been working well or is working well and why? What challenges were encountered or are being encountered? What can be done to mitigate against the challenges? What are consequences of the use of ICT in pedagogical practice? What have you gained/learnt from the success stories of colleagues? What challenges were encountered or are being encountered?	To reflect and evaluate our current practices and compare them in coming sessions with what we are expected to do in terms of digital teaching methodologies.

Time	Activity & Materials	Methodology	Focus Point
		What have you gained/learnt from the success stories of colleagues? Facilitators in a plenary ask for group reports and initiates discussion on the teachers'' experiences on the use of digital tools in teaching and learning. The facilitator closes this session by summarising the group reports and pointing out that from reflecting and evaluating our practices we now have a shared understanding of what we have done to date in terms of ICT integration of technology in teaching and learning. The question is can we do more. Let us find out in the next session.	
	Using social media as a teaching and learning tool. (SMS and WhatsApp)	(Prior to session facilitator forms a WhatsApp group with about 10 participants) Facilitator posts a science question to participants in the group and ask them to respond on the platform. (In the	To expose participations to easy-to-use and cost-effective pedagogical digital tools.

Time	Activity & Materials	Methodology	Focus Point
		meanwhile, the other participants are given same question typed on pieces of paper). In a plenary the participants discuss the advantages and disadvantages of the two methods (using WhatsApp or using hardcopies to give an assignment and obtain feedback) and how else WhatsApp can be used besides using it to give homework and feedback. The participants then discuss the other social media platforms and how they can be used as pedagogical tools. The facilitator closes the session by pointing out that "When social media is being used as a teaching and learning tool, no technical training is required both for the teacher and the learner since it is being used already in society. Learners learn at any location at any time. Therefore, even if learners are not allowed to use mobile phones at school,	

Time	Activity & Materials	Methodology	Focus Point
		they can use it while they are at home. This methodology therefore employs a medium and a skill that learners use every day hence it's not divorced from learners, everyday life".	

Appendix O: Editor's Letter

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14 January 2022

To Whom It May Concern:

This letter is to confirm that *Science Teachers' Information and Communication Technology (ICT) Self-Efficacy and Classroom Technology Integration: The Case of Manicaland Province, Zimbabwe* by Jabangwe Sifelani was edited by a professional language practitioner. It requires further work by the author in response to my suggested edits. I cannot be held responsible for what the author does from this point onward.

Regards,

Karien Hurter

Appendix P: Headmasters' interviews: Response excepts.

Does the school have a policy on ICT integration into teaching and learning?

Yes, we shave a policy on integration where we are encouraging our teachers to use ICT tools in their teaching and learning activities. (Headmaster 1)

Yes, it has a specific policy that all teachers conduct ICT lessons in various subjects, be it Geography, Mathematics or English, carry out their lessons using ICT equipment from the ICT lab. (Headmaster 2)

Yes, I can say that we have a deliberate approach to the teaching of all our subjects using ICT tools and we have managed to buy about 42 desktops, which are used by our learners. We integrate ICT in teaching and learning for all our classes that is Form 1 up to Form 6. Teachers in all subject areas use ICT tools in lesson delivery and we also offer Computer Science as a subject at the school. (Headmaster 3)

Strategy for professional staff development on ICT integration at the school

Currently we are depending on staff development workshops mounted by our district. School based workshops are still to be started. (Headmaster 1)

What happens is that resource persons are invited to staff develop teachers on ICT. (Headmaster 2)

We do have teachers who attended ICT workshops mounted by the MoPSE, and we also hold ICT workshops locally. The ICT department have a role to play in inducting other teachers in other subject areas. (Headmaster 3)

Budget allocated for the use of digital teaching methodologies

At the beginning of year when we had our annual general meeting with parents, we proposed and adopted a budget for ICT integration in teaching and learning. We are almost coming to the end of the year, but we have done very little in terms of purchasing equipment needed for the effective integration of ICT in lesson delivery. We have only repaired the computers we have. Fortunately, we have Wi-Fi, which we are subscribing on a monthly basis. (Headmaster 1)

We usually get money to buy and repair digital tools from money paid by the learners as school fees. (Headmaster 2)

Obviously yes, we do have a budget because those computers need to be repaired and those computers need to be updated, those accessories and other equipment which are required need to be purchased and as a result we need a budget. (Headmaster 3)

Challenges encountered in ICT integration

We have a few ICT pedagogical tools. As a school, we would like to have white boards and projectors to use in the classrooms so that our classrooms become ICT rooms, but we do not have these. We have converted a storeroom to a computer room where you find the few ICT gadgets we have, but we can't take this to be a classroom becomes we the ICT tools we have are not sufficient. (Headmaster 1)

Yes, the school has encountered some challenges, especially on WI-FI. Some learners have access to WI-FI using their phones and they won't be accessing information for education but accessing information that is not relevant to education. That is one of the challenges, and the other challenge is that most of the teachers are not equipped with the skills to teach or use ICT methodologies. Financial constraints, there are there. We do not have a sufficient budget for

ICT, and especially during this period of economic meltdown and very difficult now to access equipment such as computers and even to pay for WI-FI so that learners can access internet. (Headmaster 2)

Currently we are having the challenge of power, we wish we could access solar energy because with power outages we normally experience it becomes difficult to use ICT tools in teaching and learning. We do have a generator as a solution but that is not economical because we cannot run the generator for more than three hours due to the high cost of fuel involved. We wish we could have solar as an alternative source of energy. (Headmaster 3)

School strategy to ensure that learners behave ethically during online learning

Thank you, yes, monitoring learners to ensure that they do not misbehave when using ICT tools is a challenge. We are having problems in monitoring the learners. We do not allow them to bring smart phones to school, but some will sneak in with them. To minimise bad behaviour during the use of computers in the learning process we have restricted internet access to the computer room only so learners can go there with their laptops for internet connection. The leaners will be under strict teacher supervision. If the learners are left alone, they will visit other sites, which are not educational. (Headmaster 1)

Ok, as they carry out their research on the internet in the computer laboratory there will be some teachers who will be monitoring how they would be carrying out their research or how would they be working on the gadgets in the computer laboratory. (Headmaster 2)

We ensure that learners do not visit sites which are not educational by monitoring them closely when they are in the computer laboratory. (Headmaster 3)

School’s position regarding learners bringing personally owned digital devices such as laptops or mobile phones to school.

Laptops yes. Mobile phones, on conditions because there is a misuse of these. (Headmaster 1)

We do not allow them to bring these, but they bring them secretly. It comes now to monitor this whether they have these gadgets at school. (Headmaster 2)

Mobile phones, no, but laptops we allow learners to bring laptops, which are supposed to be monitored by ICT teachers. If they want to use them, then they must be locked in all other areas, only leaving the area where our learners need to access information concerning their subject areas. (Headmaster 3)

Strategies to ensure ICT use by teachers

It’s still a challenge, we don’t have resources to train them but there is need to train more than half of our current establishment of 32 qualified teachers. Half of them are okay but the other half including myself, we were ‘born before computers’. There is a need to be developed, but how do we bring in experts to train us, it requires a huge budget. The school cannot afford it considering the current economic hardships. As much as we may need training in the use of ICT pedagogical tools, our hands are tied up financially, we charge very low school fees. (Headmaster 1)

The headmaster, deputy headmaster, head of departments and the senior master monitor through lesson supervision to ensure ICT use in teaching and learning. Not all my teachers are now able to employ digital teaching methodologies. Maybe about 30% of the teachers can use pedagogical ICT tools; 70% of the teachers still need to be developed so that they can fully use the gadgets and fully apply the methodologies in ICT. (Headmaster 2)

As a school we do have some laptops which are accessible to the teachers through the head of department's so we have laptops which are assigned for the 10 subject departments which we have in the school so each head of department has a laptop, and therefore, the teachers also will access those laptops and use them for their research and use them in their subject areas. (Headmaster 3)