The impact of Information and Communications Technology (ICT) on effective teaching of Environmental Education in rural high schools

By

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DECLARATIONS

(a) Originality

I declare that this dissertation is my original work. To the best of my knowledge, this study is not a reproduction of previously published or unpublished research or materials accepted for the award of any qualifications, except where due acknowledgement has been made in the test.

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(b) Supervisors' statement

This dissertation has been submitted with/without my approval

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Professor E.O Adu (Supervisor) Date

ABSTRACT

Information and Communication Technology (ICT) has become commonplace entities in all aspects of life. Over the past twenty years, the use of ICTs has drastically changed the procedures of almost all forms of endeavour within business and governance. Additionally, throughout the world there is an awareness of the fundamental role of new ICTs in the field of education. Education is a socially oriented activity, and quality education has traditionally been associated with strong teachers having high degrees of personal contact with learners. The use of ICT in education lends itself to learner-centred learning settings.

With the world moving rapidly into digital media and information, the role of ICT in education and the influence of ICT in schools cannot be overemphasised as its utility is changing the way learners learn, teachers teach, and how it supports staff work. Whilst ICT is fully integrated into many schools in the urban areas of South Africa, regrettably the same cannot be said about rural high schools. This has created a digital division between rural and urban high schools. Most of these rural high schools still do not have access to these technological tools and educators have not been given the professional training for them to integrate ICT in their lessons. This study explores the effectiveness of integrating ICT into teaching of Environmental Education in selected rural high schools. The quantitative study adopted survey research design with sample randomly selected for the study. From the findings, it can be concluded that integrating ICT in education cannot be comprehended by exploring the pedagogical orientations at play in the teaching and learning situation. It becomes the basis that teachers use ICTs to achieve the determined goals.

***Keywords*:** Information and Communication Technologies; Integration; pedagogy; Environmental Education

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DEDICATION

My sincere thanks go to the Lord Almighty for the strength and for sustaining me through this study.

I dedicate this academic monument to my late father, Mr Ernest Osei, and to my children Melissa Akore Mireku and Kwaku Obeng Mireku.

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

Becta	British Education Communication and Technology Agency
CAL	Computer Assisted Learning
CAI	Computer Assisted Instruction
CAPS	Curriculum and Assessment Policy Statement
CD–ROM	Compact Disc Read Only Memory
DST	Department of Science and Technology
DoE	Department of Education
ECDL	European Computer Driving License
EE	Environmental Education
EECI	Environmental Education Curriculum Initiative
EEPI	Environmental Education Policy Initiative
ELFE	European e–learning Forum for Education
ESD	Education for Sustainable Development
ETUCE	European Trade Union Committee on Education
GET	General and Educational Training
ICT	Information and Communication Technology
ICTs	Information and Communication Technologies
IEEP	International Environmental Education Program
IT	Information Technology
MIS	Management Information Systems
NCS	National Curriculum Statement

NEEAC	National Environmental Education Advisory Council
NEIMS	National Education Infrastructure Management System
NEEP	National Environmental Education Project
NEPAD	New Economic Program for African Development
NGO	Non-Governmental Organization
TELI	Technology Enhanced Learning Initiative
UNDP	United Nations Development Program
UNESCO	United Nations Educational Scientific and Cultural Organization
WWW	World Wide Web

Table of Contents

CHAPTER ONE

INTRODUCTION AND BACKGROUND

1.0 Introduction

The 21st century global explosion in Information and Communication Technology (ICT) has obvious implications for the increasing use of ICT in schools. Traditionally, teaching and learning in schools could be enhanced with the provision of learning resources to increase active learner participation. But now with the advancement in ICT, learners can have access to a wide range of learning resources, especially where teaching and learning take place on the web. Digital technology is often presented as a driving force of the transformation of education, which carries positive overtones that ICT will make a contribution to this transformation "for the better" (Fisher, 2006; Nivala, 2009). With the rapid explosion of ICT, this leads to computers becoming part of daily life and has pushed ICT and computers into classrooms at all educational levels during the last three decades.

The act of improving the quality of education through diversification of contents and methodology and promoting experimentation, innovation, the dispersion and sharing of information and best practices as well as policy dialogued are UNESCO's strategic objectives in education. Education systems around the world are under increasing pressure to make use of new information and communication technologies (ICTs) to teach learners the knowledge and skills they need in the 21st century. The 1998 UNESCO World Education Report, Teachers and Teaching in a Changing World, describes the radical implications ICT has for conventional teaching and learning, and predicts the transformation of the teaching and learning process. It states:

> "New possibilities are emerging which already show a powerful impact on meeting basic learning needs, and it is clear that educational potential of these possibilities has barely been tapped. These new possibilities exist largely as a result of two converging forces, both recent by–products of the general development process. First quantity of information available in world

> much of it relevant to survival and basic well–being is exponentially greater than that available, only a few years ago, and the rate of its growth is accelerating. A synergistic effect occurs when important information is coupled with the second modern advance – the new capacity to communicate among the people of the world" (UNESCO World Education Report, 1998, p. 19).

According to Daniels (2002), ICT has become, within a short time frame, one of the integrants of modern society. Many countries now understand ICT as a basic skill and entity which forms part of the core of education. Presently, many teachers are embracing new technologies and have been concerned about how to improve learning through the more effective way and appropriate use of technology. The rate of Information and Communications Technology innovation diffusion in high school classrooms has not kept pace with other professions nor even with the general environment (Cuban, 1994, 1997; Geoghegan, 1994). While a minority of educators have aggressively adopted ICT in the classroom, majority of educators in the rural high schools have not adopted or have rejected most ICT innovations and have maintained the traditional lecture based instruction format (Duderstadt et al., 2002).

Presently, ICT is considered as an important way of promoting new methods of teaching and learning. The availability of the Internet provides a channel for the use of an electronic approach to learning, known as 'electronic learning' or 'e-learning'. E-learning is the method of teaching and learning using the Internet via the computer. It comprises of delivering structured instructional content to the learner. Erah (2006) defined e-learning as using computers and the Internet to enhance learning. Rosenberg (2001) also explained that e-learning is using the appropriate application of the Internet to support the delivery of skills and knowledge.

The gap between integrating ICT in educational settings and the current level of ICT integration has inspired researchers to focus on teachers and the difficulties they encounter integrating tools into their classroom practices (Drent & Melissen, 2008; Hsu et al., 2008). Identifying the facet and explaining ICT use is seen as a way of answering the question why some teachers welcome the use of technologies in teaching whilst others do not. These determinants are usually technology related teacher characteristics where, for example, teachers' attitudes and self-efficacy are

in focus (Herman, Tondeur, van Braak, & Valcke, 2008). ICT has become an indispensable tool in today's information age, making a great footprint in the lives of people. Its influence is the most important in education. The computer has become a contraption or an aid for teaching and learning in many schools almost throughout the world (Mossom, 1999; World Bank, 1999).

There have been a quite numerous of attempts to equip South African schools with ICT. Organisations, especially School Net SA (Caroll, 1998), address on a national level the issue of providing ICT to South African schools. The World Links for Development (WorLD), which is a networking programme, has been providing ICT to South African schools where it is needed most (the Eastern Cape and Kwa Zulu Natal). The WorLD programme intends to network and provide professional training for teachers in developing countries including South Africa to improve their ICT skills and to ensure that technologies are used effectively. The South African government has committed itself to improving the information and communication technology skills of its people and to bridge the gap by targeting the disadvantaged groups. This is in line with the New Partnership for Africa Development (NEPAD) programme to achieve a sustainable development in the 21st century (DoE, 2003).

In 1997, the National Centre for Educational Technology and Distance Education in the National Department of Education, following on from the Technology Enhanced Learning Initiative (TELI), discovered the need for the expansion of clear, umbrella policies for addressing the development of sustainable ICT capacity in South African schools. The main objective was to inquest the nature and extent of ICT provision in the schooling sector, soliciting how ICT is being used and to consider factors that could hinder the effective use of ICTs in schools. The South African government has participated in the global market place of ICT and the importance of education in contributing to effective participation. It uses "Technology Enhanced Learning" as a phrase to describe the implementation of technologies in teaching and learning for education purposes (SAIDE Report, 2001).

Many initiatives have been run aimed at addressing the concerns in this area. These initiatives were made up of conferences on the issue of developing countries and the introduction of policies on ICT development in education. For these to be sustainable, ICT should be effectively infused into school programmes, and it needs

to be seen as important by teachers and administrators. By so doing, it will be part of a more comprehensive programme towards improving the quality of an education system.

1.1 Distinctions between Rural and Urban Areas in South Africa

There is a continuous technological advancement that has benefited both developed and developing countries' progress. This section reflects on problems faced by teachers from rural disadvantaged communities of South Africa in relation to the use of ICT in education.

According to Rural Development Framework of 1997 cited in Van Donk, Swilling, Pieterse, and Parnell (2012, p. 1), rural areas are defined as:

> "Sparsely populated areas in which people farm or depend on natural resources, including the villages and small towns that are dispersed through these areas, which also include the large settlements in the former homelands, created by apartheid removals which depend for their survival on migratory labour remittances."

Rural areas can also be classified as communal areas, whereas commercial areas are characterised by large farms. The workforce is composed mainly of poor Black people, and the lands they have occupied have no economic base. The people practise subsistence farming from the fields and home gardens (Van Donk et al., 2012). A study by Index Mundi (2012) indicated that the rural population in South Africa was 19 146 670, which constituted 38,3% of the total population in South Africa. However, there has been a rise in urbanisation, but the depth of poverty still remains in the rural areas.

On the other hand, urban settings, which include cities and towns, are densely populated and are more affluent. For example, in 2010, Guateng had a population density of 616 people per km square (Brand South African Media Services, 2012). The population in urban South Africa was 30 844 630 which made 61,7%, according to a World Bank report published in 2012 (Anon, 2012).

ICT for rural schools has gradually become a political issue in developing countries. The situation is seen as a matter of equity with regard to access and opportunities.

Communication infrastructure is usually a more complex issue. Many rural areas in the Eastern Cape Province of South Africa lack telephone or mobile coverage, which makes it extremely difficult to use the Internet access solutions as compared to those learners in the urban areas. In addition, regular communication and Internet facilities may be more expensive in rural areas. Even though it is possible to have access to Internet facilities in rural schools, regardless of their geographical location, it is still implemented on a small scale which is for one specific school or for a few schools.

1.1.1 Teachers in rural schools and ICT

Rural high school teachers, however, are used to working within a stressful working environment with limited resources, which makes them become creative in solving problems in different ways. They progressively integrate technology in their teaching for pedagogical objectives. The integration of ICT in pedagogical practice is very important in developing the teacher in the rural high schools. If it is overlooked, it cannot be implemented. Therefore it is necessary for teachers in rural high schools to be developed for these technological basic skills (Mfum–Mensah, 2003).

South Africa faces significant challenges as a nation, more especially with regard to implementing ICT in Environmental Education classrooms in rural areas. Many people in the rural areas exist below subsistence levels and remain impoverished, so for this simple reason alone that they have no access to infrastructure for development. Class sizes in the rural areas in South Africa are large, and providing adequate resources for these classrooms has always been a challenge.

The ICT Research Priorities for the South African National Research Foundation (Information and Communication Technology, 2002,p.1) has stressed the need for ICT to form a new impact which will bring about the information age and the information society, both popular concepts in use today.

South African policy on ICT in education is determined by the Department of Science and Technology (DST), the Department of Communications, and the Department of Education. The collaboration between the Departments of Education and Communication came up with the e–Education white paper [18] which made a contribution to the reduction of Internet tariffs by 50% in schools. The targets set were to:

- Build an education and training system to support ICT integration in teaching and learning;
- Build a framework for competencies for teacher development in the integration of ICTs into the curriculum;
- Establish ICT in schools; and
- Ensure that schools are connected and have access to the Internet.

The South African government has made a commitment to improve the Information and Communication Technology (ICT) skills of its people, and to bridge the digital divide by targeting previously disadvantaged groups. The idea is in line with the New Partnership for Africa's Development (NEPAD) programme to achieve a sustainable development in the 21st century (Department of Education, 2003).

The integration of technology into a curriculum is complex. Akbaba–Altun (2004) and Reid (2002) warned that the successful integration of ICT depends on incorporating variables such as teachers' knowledge, skills and attitudes towards ICT, adequacy of infrastructure, curriculum strategy, and school managements' attitude.

Semenov (2005) reported that ICT provides opportunities:

> "To facilitate learning for learners who have different learning styles and abilities, make learning environments more useful with more senses in a multimedia context; and more connections in a hypermedia context; provide a broader international context for approaching problems as well as being more sensitive to local needs" (p.23).

In these times of immense change, much of which is directly associated with technological advances, educators are beginning to think about the implications of the utilisation of the new information technologies for communication and representation. In this context of rapid and far reaching change, educators are asking substantive questions about pedagogical practices. In particular, they are beginning to take account of the new implications of the use of ICT.

ICT competency has become necessary because learners have to work in the modern knowledge economy since the labour market has been penetrated and

driven by modern ICT. ICT developments require and enable a greater integration of education, both merging in ways not seen before. There is opportunity for innovative practices to be developed for schools to open space for new connections and to realise the potential for life-long learning, which can be seen, for example, with the development of the University for Industry and the validation of practice related degrees.

1.1.2 South Africa's general ICT profile in schools

South African schools have incorporated traditional teaching modes that have stayed the same for the last few decades or so. Most South African institutions – in particular previously disadvantaged schools – face numerous challenges such as declining financial support from the government. The challenges faced by schools in South Africa that do not use ICT as a means of enhancing teaching and learning has led South Africa to failing to close the digital divide (DoE, 2003). The digital divide is defined as the gap between those individuals who benefit from digital technology and those who do not (DoE, 2003).

The Electronic and Communication Transaction Act, No 25 of 2002 was established by the Department of Communication (DoC) in a bid to promote all ICT initiatives in South Africa and to develop a five year national e-strategy which would empower all citizens, especially the education sector. The South African government, in collaboration with the DoC, hosted a National ICT Policy Colloquium on 19- 20 April 2012 at Gallagher Estate. The main objective was to start a process of scrutinizing all government ICT policies that have existed since 1994. The DoC also hosted an ICT Indaba in Cape Town in 2012, which met together with other stakeholders in business labour and civil society across Africa and the world.

Computer usage was established in South African Schools around the early 1980s, chiefly in private schools and a few well-resourced government schools. The computers were mainly used for administrative purposes, for example recording marks and creating timetables, until ICT exploded globally and came to be considered as a basic requirement for the knowledge society for which universities now prepare students (Castells, Flecha, & Freire et al., 1999). Thus an investigation into its integration into education to meet the changing dynamics is of great importance.

Although there is an urgent need for ICT implementation in schools to be spread across the entire of South Africa, there are numerous challenges that make it impossible to attain this goal. According to Crawford (2006), one of the major challenges in implementing ICT in schools is that Information Technology (IT) based Management Information Systems (MIS) are expensive to set up. Crawford (2006) further argued that it is costly to buy some hardware and the software required.

1.1.3 ICT in Environmental Education

Education is a community oriented activity and quality education has traditionally been affiliated with educators having personal contact with learners. Educators have within their power the opportunity to shift their own beliefs and understanding about new technologies and about their place in teaching Environmental Education. The use of ICT in teaching Environmental Education lends itself to more learner-centred settings (SchoolNet, 2006, p. 2). Educators have been working to break this lecture–centred instructional model by shifting the focus from the curriculum to learner learning needs as the driver of the instruction. There is usually available time for learners to collaborate with their peers on projects, engage more deeply with content, and practical skill (SchoolNet, 2006, p. 2).

Orr (1992) cited in Culter Mackenzie and Smith (2003) explained that education is the single most important element needed to address world environmental challenges (). Thus, a good number of EE teachers strongly argue that, ideally, every school curriculum must mainstream EE instead of offering it as a stand-alone subject. Similarly, cross–sectional coordination in the development of EE teaching and learning materials stands out as a major recommended strategy in the innovative NSW Environmental Education Plan (2007-2010, learning for sustainability).

Environmental Education has been embedded in most subjects like natural sciences in the GET Band. The main goal of Environmental Education in the National Curriculum Statement (NCS) is that learners develop methods in solving environmental problems (UNESCO, Tbilisi Declaration, 1978). Environmental Education is part of the curriculum since it helps the learners to be knowledgeable of their environment and how to solve problems. Through Environmental Education, learners will be expected to have opportunities to develop skills such as questioning,

observing and interpreting observation. ICT can be utilized for teaching EE by facilitating information.

With the revision of Curriculum 2005 and the adoption of the National Curriculum Statement for General Education and Training (GET) came the need to refocus Environmental Education work in the curriculum policy document. This means that Environmental Education processes are now integral to all learning areas in the formal curriculum. These are held together by the principle of the National Curriculum Statement (NCS) that recognizes the relationship between human rights, inclusivity, and a healthy environment and social justice (Lotz–Sisitka & Raven, 2001). ICT is becoming more integral to the lives of South African citizens. Learners of the new curriculum based on the latest revised Curriculum and Assessment Policy Statement (CAPS) implemented in 2004 (DoE, 2002) are expected to have access to relevant information through the World Wide Web, which is an important facility in the implementation of NSC.

ICT can be utilised for teaching Environmental Education by facilitating information gathering and dissemination. According to Adu and Tella (2010), applying ICT as a tool for teaching in the curriculum areas enables students to become “competent, discriminating, creative and productive users of ICT’’ (p.___). Learners are better able to achieve skills and develop capacity to select and use ICT to inquire, develop new understanding, and also create and communicate with others in order to participate effectively in society.

There is currently considerable interest within the field of Environmental Education in developing learners’ abilities to apply their knowledge and to solve environmental problems. Signs of improvement in using ICT still reveal significant shortcomings. These shortcomings together with the importance of developing ICT knowledge and skills have led to calls for light to be thrown on pedagogy for ICT to be used in teaching and learning (Johnson & Mclean, 2001).

The focus of this research is on the application of new technologies in teaching Environmental Education, aims to present a framework for ICT use in subject teaching based on understanding of theoretical issues, possible approaches and examples from practice. Teaching and learning through ICT is used to describe situations where ICT facilities become the whole teaching and learning environment

by providing learning material and acting as assessor or a tutor. The traditional role for teachers has been as presenters of ready–made information and as organisers of learning experiences. One way in which ICT can be used in the classroom is to take over these presentational and organisational roles. This has implications for both the teachers and learners; by providing an additional source of knowledge, the computer may reduce the dependency of learners upon the teacher.

There is learner autonomy in learning, which means the teacher no longer needs to adopt a didactic approach but gain freedom to function increasingly as "enablers of quality learning experience" (Somekh & Davies, 1991, p. 221). The teacher acts as a facilitator of learning, drawing on a range of information sources, trusting in technology's ability to offer greater sufficiency and effectiveness of student learning, and ICTs' growing prevalence in society at large.

Computer–aided tasks in Environmental Education of any kind can be more authentic than the traditional teacher–centred tasks. For example, through the wide range of information sources that modern technology makes available, learners can be exposed to many opportunities which open up spontaneity in learning in Environmental Education. In these ways, IT tools appear to be able to support what Vygotsky (1978) called "the zone of proximal development" which, together with interactive support, enables learners to use skills and concepts they have only partially mastered (Pea, 1987; Salomon, 1988).

According to Daniels (2002), ICT has quickly emerged as a vital building block in the fabric of contemporary society. Virtually every country currently regards understanding ICT concepts and mastering basic ICT skills as part of the core of education. However, there is a prevailing narrow view that ICT only refers to computers and applications associated with computers. Tracing the evolution of ICT, Pelgrum and Law (2003) stated that, in the late 1980s, IT (Information Technology) came to replace the previous narrow conception of 'computer' because of its revolutionary capability to store and retrieve information, thereby shifting from mere computing technology which hitherto had been the domain of the 'computer'. This was followed by the introduction of the term ICT (Information and Communications Technology) around 1992, when e–mail started to become available to the general public (Pelgrum & Law, 2003).

In order to be precise, effective teaching and learning of EE has been positively affected and enhanced by ICT (Yusuf, 2005). A number of researchers have identified many benefits of ICT in promoting the quality of education (Al– Ansari, 2006). ICT has the ability to enrich, deepen skills, accelerate, motivate and engage learners to help relate school experience to work practices and create economic viability as well as strengthen teaching and helping schools to change (Davis & Tearle, 1998).

The use of ICT in teaching Environmental Education can help teachers improve the quality of education by providing support. According to Zhao and Cziko (2001), three conditions are necessary for educators to introduce ICT as pedagogy: educators should believe in its effectiveness, the use of technology should not cause any disturbances, and educators should have control over it.

1.1.4 Adoption and use of ICT in Environmental Education

The availability and use of ICT in EE have undoubtedly been beneficial to teaching and learning in almost every community — whether urban or rural. Learners in rural high schools can have access to education despite their geographical barriers. It also provides intrinsic motivation for the teaching process, which will then have a positive impact on learners' performance and achievement. ICT usage significantly prepares learners for their future careers in the modern workplace where computers, the Internet and related technologies have become increasingly indispensable and commonplace.

In addition to technological literacy, which is the ability to use ICT effectively, En Gauge in Tinio (2002) has identified other job skills referred to as 21st century skills, such as digital age literacy, information literacy and global awareness, which learners can acquire through the use of ICT in Environmental Education. Emerging ICT tools offer new opportunities to develop some of the critical early literacy skills, the fundamental developments, which will affect many numbers of low–literate learners in the rural areas to take advantage of educational opportunities presented to them through formal education.

As a tool, technology entails the use of a wide range of word processors, hardware, software graphic packages, databases, and spread sheets among others. This group of hardware and software does not have limited educational purpose; rather it is

designed to help extend teachers and learners' abilities to do work. The ICT theatre makes it possible for certain forms of large group presentation; the overhead projector makes possible presentation of texts and images to all those in the room. Sharma (2003) further identified teleconferencing, e-mail, audio conferencing, television lessons and radio broadcast as tools that have been and can be used for different purposes in education (Sangul, 2001). These are also thinking tools that educators use to integrate into teaching and learning strategies and encourage independent learning (Hyeon–Suk, 2001).

Several experts in educational technology suggested that the reason for the low level of ICT integration in teaching Environmental Education in rural high schools is a conflict between the educator-centred educational values and learner-centred educational values expressed in most forms of information technology. ICT plays an important role in a school which provides new frameworks that can help improve the teaching and learning culture. There has been a remarkable breakthrough in the use of ICT on a large scale, and teachers are benefiting from the easy access to educational resources such as software packages, the Internet and other electronic resources (Kozma, 1999).

In a developmental state such as South Africa, learners do not acquire enough skill in dealing with experiments in Environmental Education, a basic understanding of scientific concepts during school years. ICT provides tools and content to help them build up such skills. It is therefore not ideal to have ICT as a separate subject, but should become integrated into their daily teaching. Furthermore, ICT should be included as teaching and learning resources for all teachers teaching Environmental Education.

The study seeks to say that, as teachers in rural high schools are now embracing technology and use them to impact on teaching within some schools in the Eastern Cape Province of South Africa. The use of ICT tools offer opportunities to 'liberate' learners in the classroom while providing teachers with the opportunity to pay more attention to individual needs. It is also emphasises the complexity of environmental problems like poaching, waste and littering.

It is therefore appropriate to say that using ICT in Environmental Education is more than learning about the environment. It deals with changing behaviours in such a

way that people will not act against the environment. Our natural resources are being depleted and environmental degradation is increasing because of our unsustainable life and uncontrolled population (UNESCO–UNEP, 1994). The myriad environmental problems facing our world today generates the need for motivating and elucidating Environmental Education. Because of the urgency of many environmental problems, Environmental Education will engage all members of the society — children, parents and community members — in identifying environmental problems and solutions which will be necessary to foster the culture of sustainability we all need.

Environmental Education is simultaneously blessed and cursed in that it is not considered to be a subject on its own, a subject equal to the other subjects which are traditionally studied. The transformative nature of Environmental Education signifies that teachers' perspectives and actions within the environment will radically change in order to deal with its problems. A whole school approach similar to that conducted by exemplary schools in New Zealand, Sweden, China, United Kingdom, Canada (Henderson & Tilbury, 2004) and integral education in Brazil (Haddad, 2009) could be seen to offer the transformative potential of EE in schools.

Why is Environmental Education important?

- Environmental Education has been found to increase learners' achievement.

Environmental Education connects knowledge that learners gain in the classroom with real-world situations, allowing them to make new discoveries and understand their world on a whole new level.

- Environmental Education has been found to assist learners in other subject areas.

It has been shown that Environmental Education reduces discipline and class management issues, increases student engagement in the learning process, facilitates student pride, and promotes ownership in achievement.

- Environmental Education creates an environmentally literate learner population.

Across the board, learners are becoming detached from the natural world and this will only make the environmental crisis worse. An education with a strong foundation on the environment will enable learners to be creative and deal with environmental problems effectively.

The whole school approach is used by all teachers in their school work to integrate EE across the school curriculum and to seek quality in the teaching and learning process. Environmental Education was introduced as a theme to be learned by all learners in South African schools through the implementation of the National Environmental Education Project for General Education and Training (herein referred to as NEEP-GET) (DoE, 2004). The NEEP-GET focused on the development of teachers and curriculum implementers to implement Environmental Education fully in South African schools (DoE, 2004).

The Department of Basic Education in South Africa recognized Environmental Education as a critical component of every school curriculum to respond to the national and global crisis (DoE, 2001, p. 3). For this reason, post 1994 education sought to infuse EE into the new curriculum (Curriculum 2005). The White Paper on Education and Training (RSA, 1995) perceived EE as a means to a better quality of life for all people and concluded that it should be integrated at all levels of the South African education system. Additionally, Section 24 of the Constitution of the Republic of South Africa (1996) protects the right of everyone to an environment that is not harmful to his or her health (South African Constitution, 1996).

1.2 Statement of the Problem

Generally, the rural areas of South Africa lag behind in technological development. The people in urban areas usually enjoy the benefits of ICT as compared to the level of some global trends. In view of this, learners who receive formative education in rural schools face serious challenges in their career development. Because of no emphasis on ICT in the schools' curricula (South Africa Info, 2011; Koranteng, 2012, p. 26- 27), learners can hardly compete with their counterparts from urban schools that are better resourced with computers and equipped with ICT skills.

Several education research topics and journal articles are directly related to ICT in teaching and learning, its benefits and challenges. Teachers are expected to integrate technology in the teaching process, so that it supports instructions and

enables learners to use ICT tools to meet their information needs and to construct knowledge (Addam, 2013).

There is a wide range of tools that can be used by teachers to present or model ideas in front of the whole class. Knowledge of and experience with computers is not enough to enable teachers to make the best use of ICT in the classroom. Effective adoption of computers within the classroom takes time (Somekh & Davis, 1996). In addition, the way in which teachers' skills, beliefs and practices are related is complex (Wild, 1996) and how effective they are at using ICT tools in the classroom differs (Higgins & Moseley, 2001). The knowledge of ICT has become the must–have knowledge for many learners who pass through high schools. This is easy for the learner in an urban setting owing to his/her closeness to a number of institutions. However, a learner in the rural set–up lags behind in getting access to ICT knowledge because technological tools are not readily available. This has greatly disadvantaged the learner, hence the issue of integrating ICT in teaching Environmental Education in rural high schools in the Eastern Cape in South Africa.

The issue with the fact that ICT changes rapidly and innovations offer new possibilities for teaching and learning not only open up to new technologies and techniques, to influence the existing curriculum effectively, but change the nature of it. This poses a real dilemma for teachers, where spending time on learning how to use ICT has not appeared to be justified in terms of knowledge gained in subsequent learning. A number of international studies have shown that rural high schools teachers lack competencies in the use of ICT as a pedagogical tool in the teaching and learning process (Nihuka & Voogt, 2011). Most educators are still embracing the old style of teaching because of ineffective use of ICT as a pedagogical tool (Tapscott, 1998; Knight et al., 2006).

The use of modern technological tools such as computers and the Internet is still in its infancy stage in most developing countries including South Africa. These developing countries are currently developing ICT policies (Hare, 2007; Moonen, 2008; Tilya, 2008), which in most educational practices their impacts are found to be insignificant (Hervanger, Vanden Akker, & Reiter, 2007). ICT as a pedagogical tool is referred to as the use of ICT facilities in the teaching process for students to be

able to solve problems, to provoke students' capabilities, and share their perspectives with each other (Jonassen, Howland, Marra, & Crismond, 2008).

The need for Environmental Education is to address the numerous environmental crises as well as the importance of the role of teachers in Environmental Education. The need to protect the environment is of human responsibility. The main goal of Environmental Education is for the world to develop a population that is aware and can care for the environment and the associated problems, of which they will be committed to work individually and collectively towards the solutions to correct the problems and to avoid new ones (Bennet, 1985, p.11).

Bennet (1985) stated that Environmental Education can be taught using different approaches and methods of teaching. He made mention of the interdisciplinary approach as one of the most characteristic of Environmental Education, stating that Knowing how to select and apply these approaches efficiently is of importance. It is to this end that evaluation of instructional program is to be directed (p. 4).

Now, as the educational sector is faced with many changes, it is vital to reflect on matters concerned with Environmental Education and the dissemination of Environmental Education knowledge and lessons. Numerous teaching styles have been adapted which tend to accommodate learners' need and diverse learning methods. One such teaching style involves the use of ICT. The concept of Environmental Education emerged only in the 1970s, which was known as the decade of Environmental Education. During that period, the world realised that environmental concerns and awareness could be spread only through a mass environmental education programme.

An inter–governmental conference to consider Environmental Education was organised at Tbilisi, USSR in 1977 by UNESCO and UNEP which resulted in the famous Tbilisi Declaration. It was all about the understanding among individuals and social groups about environmental problems. The basis of such a training programme would be the preparation of teaching learning materials and adoption of the interdisciplinary approach. Use of mass media to disseminate information was also emphasized (UNESCO–UNEP, 1985).

To have a positive impact on the quality teaching and learning of Environmental Education in e rural high schools in the Eastern Cape, the aims for ICT in teaching this subject must go beyond acquisition of skills, for example to access a database, and engage at a higher cognitive level.

1.3 Rationale of the Study

The theme of the study centres on education and the use of ICT. The present study aims to find out how effective using ICT in teaching Environmental Education is in rural high schools. The use of ICT tools in teaching Environmental Education has long been studied. However, most of the studies were confined to developed countries such as USA, Britain and Australia. It was found that in both Britain and Australia use a drill and practice such as software and have shown an increase in learners' achievement in performance (Yelland, 2001). In high schools it was found that the use of ICT tools supports higher order thinking skills. However, very little studies have been done in developing countries (Yelland, 2001). Therefore, the focus on the importance of ICT tools in rural high schools should be on how the tools can enhance EE teaching given the enormous challenges that rural schools are faced with.

1.4 Significance of the Study

Environmental Education involving an interdisciplinary and active approach to learning must be a vital element in all levels of programmes of the education system (South Africa White Paper on Education and Training, 1995). This approach to Environmental Education teaching needs to be facilitated by teachers, and they are expected to ensure that Environmental Education allows learners the chance to comprehend the many varied environmental issues that surround them, how decisions are made about the environment, and how people can have the opportunity of participating in the decision- making process (Palmer & Neil, 1995).

The findings of this study may expose the challenges facing the integration of ICT in the teaching of Environmental Education in rural high schools and can therefore set the tone for the effective planning for integration and implementation. For example, e-learning technologies and other alternatives as well as interactive digital content may improve the quality contribution of ICT skills in the curriculum and the use of ICT to support 21st century learning.

The findings are also expected to explore new models of learning that are radically changing the current perception of education. The Department of Basic Education believes that the development in ICT can create access to learning opportunities, redress inequalities, and improve the quality of teaching and learning. ICT integration in the Environmental Education curriculum can accommodate differences in the learning environment by providing expanded opportunities and individualised learning experience.

In this study, the role of ICT becomes more important as it is already transforming many aspects and is also considered a means for educational reform (Collins & Halverson, 2009; Davis, 2008; Gilbert, 2005).

1.5 Scope and Limitations of the Study

The current study will be focused on the GET Band ,that is Grades 8 and 9, with teachers offering Environmental Education in some selected rural high schools in the East London district of the Eastern Cape Province of South Africa. Previous research has been done on the integration of ICT into teaching. Hence, the research will predominantly source primary research materials based on international studies. Furthermore, this study is limited to the implementation process of the technology initiatives and does delve into long-term use.

1.6 Research Questions

The research aims to address the main question in 1.6.1. However, the subsidiary questions in 1.6.2 are posed to provide further insight into the main question.

1.6.1 Main research question

How can the integration of ICT improve the teaching of Environmental Education (EE) in rural high schools?

1.6.2 Sub-research questions

i) How can ICT be used effectively in the selected rural high schools to improve the teaching of EE?

ii) What ICT facilities are available for teaching EE?

iii) What are the attitudes of teachers towards the use of ICT tools in teaching EE?

iv) Do teachers use ICT efficiently in teaching EE?

1.7 Research Objectives

i) To find out teachers' perceptions on the adoption and use of ICT tools to teach EE effectively.
ii) To determine whether the adoption of ICT tools is influenced by the availability of resources.
iii) To investigate if the adoption of ICT tools is influenced by teachers' attitudes.
iv) To determine the support system available for teachers to use ICT tools efficiently in teaching EE.

1.8 Operational Definition of Terms

1.8.1 Environmental Education

This is a learning process that increases peoples' knowledge and awareness about the environment and associated challenges, develops the necessary skills and expertise to address the challenges, and fosters attitudes, motivations and commitments to make informed decisions and take responsible action (UNESCO, Tbilisi Declaration, 1978). It is a process of recognizing values and clarifying concepts in order to understand and appreciate the interrelatedness among people, their culture, and their biophysical surroundings. Environmental Education also entails practices in decision-making and self–formulation of a code of behaviour about issues concerning environmental quality (IUCN, 1971).

1.8.2 Teaching

This is the social and interactive process where inter–personal influence is aimed at changing the behaviour of another person (Gage & Amidon, 1996). This social process employs the most effective teaching and learning strategies to enable learners and young people to make progress. In the same process, teachers are able to access what their learners know, understand and can do, and then use this assessment to plan for future teaching and learning.

Teaching is carried on primarily by uncodified rules of thumb and through accumulated individual experience. At the same time, there probably exists enough knowledge and experience stored in an individual's head to provide the basis for sophisticated technologies (Joyce & Weil, 2003).

1.8.3 ICT

Information and Communications Technology (ICT) refers to all the technology used to handle telecommunications, broadcast and the media. Although ICT is often considered an extended synonym for Information Technology (IT), its scope is broader. Information and Communications Technology (ICT) education is basically our society's effort to teach current learners valuable knowledge and skills around computing and communication devices, the software that operates them, the applications that run on them, and the systems that are built with them.

The United Nations Educational, Scientific and Cultural Organization (UNESCO) uses the term ICT to describe the tools and processes to access, retrieve, store, organise, manipulate, produce and present information by electronic and other automated means. These include hardware software and telecommunications in the forms of personal computers and scanners. According to Tella and Adu (2010), the use of ICT in education only begins when access to ICT services and higher band widths become more available to learners. The danger is that we ascribe to new technologies and the characteristics of the previous media and its educational practices without considering the development and reflection of the concept.

While definitions of ICTs are varied, it might be useful to accept the definition provided by the United Nations Development Program (UNDP, 2003). ICTs are information handling tools – a varied set of goods, applications and services that are used to produce, store and process, distribute and exchange information. They include the "old" ICTs of radio, television and telephone, and the "new" ICTs of computers, satellite and wireless technology as well as the Internet and the web. ICTs also include simple audio visual aids such as power point slides, video, cassette etc. The older technologies are termed as analogue and the newest, which are Internet based technologies, are the digital media.These different tools are now able to work together in our "networked world".

1.8.4 GET band

This refers to the General Education and Training Band that is Grades R to 9 in the high school learning areas. They are composed of learners who are of compulsory school going age (about five to fifteen years of age). All South Africans have the right

to a basic education. The National Qualification Framework (NQF) recognises three bands of education of which the General Education and Training Band is included. The GET Band includes Grade R–9 and follows an integrated curriculum. It is further subdivided into phases, called the Foundation Phase (Grade 0 plus Grade 1 to 3), the Intermediate Phase (Grades 4 to 6) and the Senior Phase (Grades 7 to 9). The study focuses on the teaching of Environmental Education in Grades 8 and 9 which is also part of the high school system. As their school curriculum suggests, whilst at school their skills and values should be developed about the environment where they live.

1.8.5 Teacher or educator

The term teacher is often interchanged with the term educator. The teacher (or educator) who imparts knowledge to learners is the sample of the study.

1.8.6 Learners

In the current study, ‘students’, ‘learners’ and ‘pupils’ are terms that are synonymous. However, the term ‘learner’ has been used consistently. A learner, as implied in this study, is a person who is learning in the formal schooling period.

1.8.7 Schools

Schools are classified as public, government or state schools, former model C schools, or independent schools. Former model C schools are public schools that were previously (prior to 1994) designated for white learners only. Township schools are public schools previously for Black learners only, which are typically situated in the suburbs away from the city centre. Independent schools are defined as schools that receive minimal financial support from the state. Rural schools are situated in most disadvantaged communities which lack basic infrastructure for learning.

1.8.8 Sustainable development

Sustainable development is defined as the best strategy to deal with environmental issues and crises in an on-going way without jeopardising the chances of future generations. According to O’Donoghue (2008), sustainable development is a concept that seeks for modernisation of living patterns. Additionally, it aims at promoting individuals’ opportunities to achieving social prosperity and environmental compatibility (http://en.wikipedia.org/wiki/sustainable.dev, 2008).

1.8.9 Curriculum

There has been a total lack of an agreement on how to define the concept of curriculum. Marks, Stoops, and Kind–Stoops (1978, p. 457) define curriculum as:

> "The total sum of the means by which a learner is guided in attaining the intellectual and moral disciplines to the role of an intelligent citizen in a society. It is not only a course of study, but rather consisted of all the learning experiences that learners have under the direction of a school."

1.9 Research Methodology

1.9.1 Research paradigm

The research was conducted within a positivist paradigm which included a quantitative methodology. Measurement of data was used to confirm casual effect; that is, independent and dependent variables were used.

1.9.2 Research design

Survey

Surveys are thought of as methods used for descriptive research. They are used to collect data from a larger number of people than generally is possible. The substantial amount of data which is collected is used to draw conclusions about the phenomenon under investigation. Johnson (1994, p. 13) described it as "eliciting equivalent information from an identified population". Research was conducted in the selected rural high schools which the researcher conveniently chose in the East London district of the Eastern Cape Province of South Africa. The researcher considered the timeframe and accessibility when choosing these schools.

1.9.3 Population sample

The target population is the teachers of Environmental Education in the rural high schools of the Eastern Cape, South Africa. The sample was selected at random, which consisted of 60 teachers.

1.9.4 Data collection

Data was collected by using various instruments such as a structured questionnaire to obtain factual information, attitudinal information, or both. A structured questionnaire with Modified Likert responses was used. These range from Strongly

Agreed (SA), with the highest numerical value of 4, to Strongly Disagree (SD), with the lowest numerical value of 1 as below:

SA = 4

A = 3

D = 2

SD = 1

1.9.5 Procedure

The research instrument was administered personally by the researcher. A letter of introduction was first sought from the Department of Basic Education and sent to the various selected rural high schools in the East London district. The researcher first explained the purpose of the research to respondents and also addressed their concerns before distributing the questionnaire to them. Each of the items was also elaborated on.

1.9.6 Data analysis

Descriptive and inferential statistics was used in the data analysis. Descriptive statistics summarises raw data in order for it to be visualised, and enables the study to present the data in a more meaningful way which allowed simpler interpretation of data. The researcher found the central tendency of a variable, meaning the average score of a participant on a given study measure. These are ways of describing the central position of a frequency distribution for a group of data by using the mode, median and mean.

Inferential statistics is concerned with making predictions about a population based on a random sample. The results of the study could then be analysed using a sample and the researcher could generalise them to the larger population that the sample represented. The sample was representative of the group to which it is being generalised. To address this issue of generalisation, tests of significance. A Chi-square or T-test, for example, can tell the probability that the results of the analysis could have occurred by chance when there is no relationship at all between the variables studied in the population.

1.10 Ethical Considerations

The research followed a strict code of ethics in conducting the study. The research was conducted in public schools and as such, it was necessary to obtain the approval of the Department of Basic Education as well as the management of the schools as a whole.

The participants were fully informed about the procedures and risks involved in the study, and they had to give their consent to participate. The study guaranteed the participants' confidentiality. They were assured that identifying information would not be made available to anyone who was not directly involved in the study.

Information about the participants remains strictly confidential and anonymous, and they had the right not to participate, to withdraw from the study at any time once the research had begun. The study adhered to the prescripts of the University of Fort Hare ethical clearance policy.

1.11 Structure of the Research Report

The study consists of five chapters. The arrangements of the chapters take the following format:

Chapter One provides a general overview of the study. It introduces the research problem and explaines how the research was done.

Chapter Two is a review of literature of the research problems based on the questions asked in Chapter One. It delves into the literature review dealing specifically with technology integration in education. The chapter further provides consideration of why technology integration in teaching in rural high schools could be viewed as innovation.

Chapter Three provides a description of the research methodology employed in the study. It also includes the methods of collecting data.

Chapter Four provides a detailed description of how the data was presented and analysed.

Chapter Five concludes with a summary of the results and findings, conclusions and recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

Confucins (2006) cited in Hofstee (2006, p. 91) highlights the immeasurable import of literature review in any academic investigation by pointing out that a man who reviews the old so as to find the new is qualified to teach others. There is an explosion of information and technological advancement in the world which is coupled with the flow of information. This is transforming the world from isolated islands to interconnected super highways of ICT (Herselman, 2002). In this chapter, the review of existing literature on the subject begins with a brief description of the role of ICT in education, the implications of ICT on the curriculum development, as well as the availability, cost and implementation of ICT resources. The chapter concludes with a discussion.

The literature review considered a number of books published in Europe, especially in the Netherlands where many studies on ICT policy implementation have been conducted. However, a considerable number of articles with a focus on ICT in African countries were also considered. The articles considered in this study were published between the period from 1998 to 2009 because the pace at which ICT changes is faster than the rate at which publications are produced. A number of authors appeared to have been quoted by others many times, and this has led the researcher to rely heavily on such frequently cited studies because of the recognition of the usefulness of the findings in these early studies. Prominent among these authors are Anderson (2008); Law, Pelgrum, and Plomp (2008); Komza (2008); Voogt (2003, 2005, 2008), and many others. Most of these authors provide references to international studies in an attempt to study ICT policy implementation, availability, and cost of ICT.

The mainstreaming of ICT in EE teaching and learning in South African rural schools remains a major developmental challenge with potential risks to the quality of education provided to our youth. School teachers are faced with a problem of having two parallel curricular at the same time as the interim Outcome–Based Education (OBE) syllabus is being phased out while Curriculum Assessment Policy Statements

(CAPS) is being phased in. Educators are still struggling to get their hands on the new curriculum, which is a major challenge on its own. Thus, there might be a lot of reluctance as far as ICT integration is concerned, more so because most of rural high schools get their ICT resources through donors. ICT has the potential to enlarge access to education. Through ICT, learning can occur anytime and anywhere.

The literature review focused on issues related to availability, cost and implementation of ICT policies in rural high schools in the Eastern Cape Province in South Africa and specifically in the EE classroom. EE teachers' use of ICT is therefore investigated for effective Environmental Education curriculum implementation. The goal of most authors is to improve on teaching using ICT in rural areas, particularly in the Environmental Education classrooms. Environmental Education offers a wide variety of ICT modules within its curricular. However, the curricular are not harmonised neither across the region nor within the individual rural high schools. Thus in South Africa, it is not unusual to find great diversity of offerings among rural high schools. However, also underlying this diversity is the national institutions with ICT capacities (Ngulube, 2006).

The South African government recognised that ICT capacity building for its human capital is the key to national development as well as knowledge economy in this information age. To ensure that the country is well positioned for realising its developmental goals, the Department of Basic Education is expected to increase enrolments in the ICT field of study (Ministry of Education, 2001).

In the following section the discussion focuses on ICT and education.

2.1 Overview of the concept: ICT

ICT refers to computer technology, multimedia and networking including the Internet. In some countries, such as United States of America (USA), the term 'technology' or 'information technology' is used, but slowly this appears to be changing to 'ICT' (Anderson, 2008). ICT has become more accessible to people in both developed and developing worlds.

So many terminologies have been used to describe various sets of ICT related curricula, which include cognitive tools (Salomon, 1996) and mind tools (Jonassen, 2000). Tagg cited in Kaffash, Kargiban, Kargiban, and Remezani (2010) explained it

as a tool to extend curriculum method, content, product and process to new information which was not discovered in the past. Previous researchers believe ICT is a combination of computer video and telecommunication technologies as well as the use of multimedia networks (Van Damme, 2003).

For the purpose of this study, ICT is information based technology which can be coordinated with other technologies including communications. Researchers use different terminologies to drive ICT concepts which are probably the purpose for which they are used. In education, these terminologies are mostly a structural unit of society (National Council for Accreditation of Teacher Education, 2002; UNESCO, 2002). Elston (2007) identified ICT as technology to manage information and communication, Educational Technologies (UCT, 2003).

2.2 Education and ICT

This part introduces an apprehension approach of ICT within education. Much attention has increasingly been directed into research in merging fields of education and ICT, and this attention is encouraged by education authorities (Bauer & Kenton, 2005). This will improve teachersand learners' competence in the use of ICT in teaching and learning, and teachers are expected to explore more by means of incorporating ICT into their professional practice (Fitzallen, 2004). The trend of ICT integration continues to increase and as such, researchers identify issues such as inadequate technology, insufficient curriculum, technical and administrative support, limited time for planning, and a general resistance for teachers to adapt to changes (Roblyer, 2004).

As the information we have is increasing all the time, it becomes important to record, process, store and share it with others often at great distances from us. Technological tools help us to do these with much efficiency. The main focus is on computers and the Internet which enhance teaching and learning, particularly with regard to the recording, processing, storing and sharing of information. Various investigations on the impact of technology on education mostly come to a conclusion that technology plays a role in education. One such study was conducted by the North Central Regional Education Laboratory (NCREL), in the USA, which suggested in its report entitled 'Computer Based Technology and Learning' that technology can:

- “make learning more interactive,
- enhance the enjoyment of learning,
- capture and store data for data-driven decision making” (p.__).

Computers are increasingly becoming part of our daily lives. For example, e-mail is used daily to exchange messages, or information is searched for on popular search engines on the World Wide Web. The use of computers in education has been reported to have a link to the levels of economic and social development. They do this by supporting the administration, financial and governance systems, making them efficient.

Education, in the form of teaching and learning, has ever been changing (Theroux, 2004; Day & Sachs, 2004) and this has made technology penetrate into the system of education. This permeation of ICT in education has become a useful resource in teaching and learning. However, the digital explosion has become so great in the previous years that the integration and application of technology in education have become more complex as new tools continue to emerge in the market (Jimoyiannis & Komis, 2007). It has become very important to keep abreast with the changes, which will assist learners and teachers to have much information and develop the expertise in teaching and learning to overcome the educational challenges (British Education Communications and Technology Agency [Becta], 2008).

Rastogi and Malhotra (2013) postulated that different forms of ICTs are sources of powerful tools that are able to help meet some of these challenges. Particularly they can help changing the old methods of teaching where the teacher becomes the centre of the teaching process. Education brings home to the EE teacher that the digital revolution of the last few decades brings with it many positive dividends for teaching and learning. As Quinot and Van Tonder (2014) have explained, the use of ICT in education through the rubric of e-learning can be described as the use of computer network technology, primarily over intranet or through the Internet, to deliver information and instructions to individual learners.

The use of ICT in teaching Environmental Education will support learning, blending the teaching process. Blended learning refers most commonly to the combination of traditional forms of teaching and learning, such as face-to-face classroom sessions

(Oliver & Trigwell, 2005). Oliver and Trigwell (2005) pointed out that blended teaching and learning can bring about the motivation to help learners experience a variety in the critical aspects of the topic being learnt. There is an evidence of literature of blended teaching and learning which can optimise the use of ICT in education.

The DoE (2004, p. 18) identified an e-school which has teachers who use ICT in teaching and are qualified and competent in the use of ICT. South Africa faces a considerable challenge in which both developing and developed conditions prevail (Howie & Bilgnaut, 2009). In addition, Phumzile Mlambo-Ngcuka, former Chancellor of Tswane University of Technology and former Deputy President of South Africa, indicated that there is a shortage of ICT literate teachers in South Africa and this reduces the possibility for rural school learners to acquire the critical 21st century skills (Tshwane University of Technology News, 2011).

Almost all developing countries such as South Africa have realised that ICT has the potential for increasing access to education and could also promote the quality and relevance of education. This provides the chance to promote educational systems in every country. However, some challenges such as poverty and the high population of rural dwellers without access to ICT as well as a majority of the population who lack basic knowledge of ICT may impede the easy access to ICT. ICT has always been used to improve education so as to ensure that teachers in rural high schools acquire skills of ICT which in turn can be used to help learners improve their academic performance. According to Kearns and Grant, any ICTsupported educational system substantially empowers learners for life-long learning (Kearns & Grant, 2002).

In the section below, this study examines the brief history of ICT in education, the South African e-education policy, as well as the concept of educational technology.

2.2.1The brief history of ICT in education

Besterfield et al. (2003, p. 223) have pointed out that the foremost computer was the ENIAC (Electronic Numeric Integrator and Computer), which was developed in 1946. It is this information age that sped up the growth in information and knowledge and the evolution of technologies that has made it possible to grow faster (Pernia, 2008,

p. 13). Since then, several types of hardware and software have developed – the dates given in the table below.

Table 2.1: History of Information Technology (Besterfield et al., 2003, p. 224)

Timeline	Machine	Application
1946–1963	Vacuum tube with input by punch cards	Scientific and engineering
1964–1976	Distributed access to main frame. Compatible models	Accounting and inventory
1977–1984	Mid–range computers with user-friendly interfaces	Users involved in system development
1985–1996	Personal computers, local and area networks	Desktop system with word processors
1997–future	Wireless technology and Internet	E-mail electronic commerce system

2.2.2 General use of ICT in education

This section presents a summary of the general use of ICT in education through a model. The information becomes useful and important for teachers in an effort to elaborate how ICT is being implemented. Kozma (2003) and McGhee (2006) offer a model of the classified uses of ICT.

Table 2.2: An adapted model of patterns of uses of ICT (Adapted from Kozma, 2003 & McGhee, 2006)

Patterns	Characteristics
Tool use	Teachers use e-mail, produce documents, information search, word processing and multi–media.
Information management	Teachers use ICT to organise, manage and use information for teaching and learning.
Teacher collaboration	Teachers design instructional material.
Product creation	Teachers design and create digital products using soft–wares.
Tutorial projects	Teachers use tutorial soft–wares to allow learners wind up taught lessons.

2.2.3 The South African e–Education policy

After independence in 1994, the first South African educational White Paper (DoE, 1995) came up with a clear policy which commits to education. Generally, it relates to philosophy, goals, values and principles for the new education system which forms the basis of a national plan to explore the use of technology in education. The e–Education White Paper (DoE, 2004) was the first and is currently the only policy document dealing with how the use of ICT in education should be implemented. The paper sets out the government's response to new information and communication in education internationally, which will focus on developing learners' 21st century skills. It provides a framework for the collaboration of government and the private sector in the provision of ICT in education.

The importance that the Department of Basic Education places on e-Education is reflected in an Action Plan 2014: Towards the Realization of Schooling 2025, the Department's long-term strategy to achieve quality education. The role of ICT in

education cannot be over-emphasised in South Africa's quest for quality teaching and learning for all teachers and learners. The Action Plan highlights the need for teachers to be computer literate and to ensure that learners have increasing access to a wide range of media, including computers, that will enrich their education (DoE, 2003).

In South Africa, the whole idea of e-Education is all about the use of ICT for the realisation of national educational goals. e-Education is mainly perceived as a connecting tool: it is able to connect learners to learners; teachers to professional support services, and provide other avenues for learning. Moreover, it is also capable of connecting learners and teachers to better information, ideas and one another via combinations of pedagogy and technology. e-Education has the capability to develop computer literacy skills necessary to deal with the various types of ICT, where the application of ICT skills can be used to access, analyse, evaluate, integrate, present and communicate information.

Kozma (2008) has explained that e-Education views ICT as:

- a tool for management;
- a resource for curriculum integration; and
- a learning environment that advances creativity and communication.

Emerging models of learning in the modern age are constantly and radically changing the traditional conception of education which has existed for ages. Education for human development in the learning society needs to involve focusing on building knowledge. The two major factors contributing to change arise from shifts in educational goals and from new concepts of learning. The Department of Basic Education believes that developments in ICT create access to learning opportunities, redress inequalities, and improve the quality of teaching and learning. The e-Education policy goal states:

> "Every South African learner is the General and Further Education and Training Band (GET) will be ICT capable, (that is use ICT confidently and creatively to help develop the skills and knowledge they need to achieve personal goals and to be full participants in global economy) by 2013."

Current changes in societies are transforming the nature of knowledge, which will lead to the need for major reforms in education as well as a new conception for the role of the teacher and learners (Gilbert, 2005; Hargreaves, 2003; Adreotti et al., 2008). The use of modern technology tools such as computers and the Internet is still in its infancy stage in most developing countries, including South Africa. Although most developing countries are currently developing ICT policies (Hare, 2007; Moonen, 2008; Tilya, 2008), the policy impact on educational practice has been found to be insignificant (Hervanger et al., 2007). ICT as a pedagogical tool is referred to as the use of ICT facilities in the process of teaching and for learners to be able to solve problems, provoke their capabilities, and share their perspectives with each other (Howland et al., 2008).

A number of international studies have shown that rural high school educators lack competencies with the use of ICT as a pedagogical tool in the teaching and learning process (Nihuka & Voogt, 2011). However, Tapscott and Knight et al.(1998) opined that most educators are still embracing the old style of teaching because of ineffective use of ICT as a pedagogical tool (Tapscott, 1998). Although there have been numerous changes in the impact of ICT on society, many classrooms and schools still lack their application. Condie and Livingstone (2007) found that while some teachers continue to display an urge to engage with new technology, the rest are fearful of trying new approaches.

The research study by Mlambo (2007) on ICT in A–level physics teaching at secondary schools in Manical and Zimbabwe found the absence of good examples of the best practice in the use of ICT in teaching physics. He found teachers using traditional methods of teaching; mainly, the lecture method. This implies that ICT is not effectively used as a tool in teaching. A similar study in Singapore by Teo (2006) on the use of ICT-mediated lessons identified several barriers to the teacher in ICT integration in the classroom. According to Teo (2006), such barriers include inadequate technical support staff, lack of sufficient time for teachers to prepare for ICT–mediated lesson, lack of support provided by school leaders in addressing ICT concerns, and insufficient training for teachers on how to incorporate ICT into classroom instruction.

However, the study in Cyprus by Dirckinck, Hodgson et al. (2010) shows that most curricula do not include ICT integration. In view of this shortcoming, teachers spend much more time finding, revising and making adjustments for learning and teaching materials for them to fit in the curriculum.

Five merits of ICT in education have been identified by researchers and these have been summarised as the following:

- Assist learners to have access to digital information effectively

As Bush, Glazewski, and Hew (2008) have stated, ICT is used as a tool for students to discover learning topics and provide solutions to problems. ICT makes knowledge acquisition more accessible and concepts in learning easily understood.

- Produce creative learning

ICT develops students' new understanding in their areas of learning (Chai, Koh, & Tsai, 2010). ICT provides more creative solutions to different types of learning inquiries. For example, learners can access all types of texts from beginning to advanced levels with ease through computers, laptops, or personal digital assistants. It therefore provides purpose-designed applications that provide innovative ways to meet a variety of learning needs.

- Offer more opportunities to develop critical thinking skills

ICT helps students focus on higher level concepts rather than less meaningful tasks (Levin & Wadmany, 2006). McMahon's (2009) study showed that there were significant correlations between studying with ICT and the acquisition of critical thinking skills. A longer exposure in the ICT environment can foster learners' higher critical skills. Thus, schools are strongly advised to integrate technology in teaching Environmental Education.

With the major explosion of ICT in education, it is regarded as an aid for teaching and learning. ICTs are said to expand the access to education and strengthen the importance of it. This has a direct link between the use of ICT and learners' academic performance. This further increases the ability of learners to improve their learning by improving the point of communicating between them and the teacher (Valasidou & Bousiou, 2005).

- Improve the quality of teaching and learning

As Lowther, Inan, Strahl, and Ross (2008) have stated, there are three important characteristics that are needed to develop good quality teaching with ICT: autonomy, capability, and creativity. Autonomy means the learners take control of their learning through the use of ICT. In this way they become more capable of working independently. With regard to capability, learners are more confident in the learning process, and they can develop the capability to apply and transfer knowledge while using new technology effectively. The whole teaching and learning process enriches and motivates learners, and broadens their knowledge beyond what they know. Their creativity is also enhanced, that is when they are able to discover new multimedia tools and create materials in the styles readily available to them (Gee, 2007, 2011).

It also facilitates the flexibility of delivery of education, which allows learners to have access to knowledge at any time. Learners are able to now browse through e-books, search for previous examination questions, as well as having contact with resource persons all over the world. This has increased the availability of just-in-time learning for many more learners (Young, 2002).

- It enhances the learning environment

ICT creates on entirely new learning environment for learners in which they require different skills to be successful. ICT is changing the processes of teaching and learning by adding elements of vitality to learning environments including virtual environment for the purpose of ICT. Teachers should encourage learners to engage in active learning (Collins, 1996; Hannafin, Land, & Hill, 1994). The learning environment needs to reflect the potential uses of knowledge that learners are expected to master in order to prevent the acquired knowledge from becoming inert (Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1990).

2.2.4 The concept of educational technology

Richey (2008) has stated that there is a difference between technology in education and educational technology. The former describes the application of particular tools, such as computers in the classroom. The latter is the name of a unique discipline of study. Educational technology is the effective use of technological tools in teaching

and learning. As a concept, it consists of different kinds of tools such as media, machines and networking hardware. Richey (2008) defined educational technology as "the study and ethical practice of facilitating learning and improving performance by creating, using and managing appropriate technological processes and resources" (p.13). That is to say, educational technology is not restricted to high technology but has become an important part of society today.

In practice, as technology has advanced, the particular "narrowly defined" aspect that was initially emphasised has blended into the general field of educational technology. Bernard Luskin, who is an educational technology pioneer, advocated that the "e" of e-learning should be interpreted to mean "exciting, energetic, enthusiastic, emotional, extended, excellent and educational", in addition to ""electronic". Educational technology is thus the application of scientific knowledge about learning conditions to enhance the effectiveness of teaching and learning. It also has practical applications, and the existence of such resources for teaching and learning constitute the most basic evidence of this practical application.

The Association for Educational Communications and Technology, the professional society for ET, defines educational technology as:

> "The study of ethical practice of facilitating teaching and learning and improving performance by creating, using and managing appropriate resources. As a field of education, it will emphasize the communication skills and approaches to teaching environmental education through the integration of varied and different media" (p.34)

2.3 ICT Integration in Education

The purpose of integrating ICT in education and the curriculum as a whole is to enhance the quality of teaching and learning and to improve learners' comprehension skills of what is being taught. However, the potential of ICT to motivate pedagogy is yet to be fully realised due to the lack of expertise to help effect the adoption of ICT for curriculum delivery.

Some authors have explained ICT integration as ways and approaches for the use of ICTs in teaching and learning (Hodgkinson–Williams, 2006); technology integration is more cross–curricula than an individual subject. From the definitions given, one

can say that ICT integration in the 21st century involves all essential elements of a system combined to make a whole (Earle, 2002). This simply means in education that integration takes place if ICT and other elements of education such as content are combined into one body.

ICT came from the concept of IT (Sansanwal, 2009), which simply means computer technology for information delivery. Recently, there has been an emergence web, communication and digital networks and the IT concept has had limitations and has to be extended into new technologies. Various authors have tried to explain their understanding of ICT integration into the curriculum by explaining the different ways for harnessing ICTs in teaching and learning (Hodgkison–Williams, 2009; Senapaty, 2012).

Watts–Taffe et al. (2003) realised that educators can play the role of facilitators in the classroom where there has been a successful integration of ICT in the curriculum. As Reid (2002) indicated, ICT offers learners the opportunity to be reflective and ultimately the motivation to continue to learn throughout their lives. Similarly, Anderson (2008) in a study has summarised the implications of the needs of the knowledge required in teaching and learning. Anderson (2008) further discussed the importance of helping learners to develop ICT-related skills which may include finding, organising, retrieving information and ICT usage.

Current changes in the economy and knowledge point out that the need is not only to enable learners to become self–driven, but also to develop as proficient learners as many information sources will be accessed digitally (Wright, 2010; Davis & Fletcher, 2010). In this context, teachers share the moral good of supporting learners achieve their potential while working in societies that are changing rapidly with technology. In the knowledge society, knowledge is a process rather than a product. It develops when needed. Learners are not “tabulae rasae”, but their minds are resources and therefore can create new knowledge (Gilbert, 2005).

Salomon and Perkins (1996) pointed out some years ago that the thinking on ICT in education should not be determined by what is technically possible but by which ICT applications can improve teaching processes. According Saloman and Perkins (1996), the way in which ICT may influence education should be a question of pedagogical and educational choices. Thinking along these lines, Nieder–hauser and

Stoddart (2001) indicated that with regard to the integration of ICT into education, teachers tend to adopt technology in ways that are consistent with their personal perspectives on curriculum and instructional practice. ICT has a clear impact on the development of educational curricula. It is concerned with what is taught and how teaching and learning occurr. What is taught includes objectives, content and learning outcomes, and attitudes that learners tend to demonstrate. Anderson (2008) has argued that integrating ICT in the curriculum largely requires learner–driven activities; the learner must use the computer room to perform almost all educational tasks. Learners need to seek information, evaluate it and process it. In this process they make use of a wide range of resources. Other features of the integrated approach are the collaborative group skills, learning by doing, and providing opportunities for creative expression.

Lowther et al. (2008) have noted that the integrated approach places ICT in a pivotal role in the already transforming learning process. The authors argued that its success as an approach lies in the ability of teachers to set tasks that require learners to use these skills and information. According to them, this is appropriate and necessary at a time when teachers are being encouraged to adopt new teaching strategies to disseminate knowledge to learners. Moreover, the authors emphasised that the kind of learning activities described here are all characteristics of situations where ICT plays the supportive role for the learner and the teacher either as a source of information and communication, or as a productivity tool assisting the processing of information and presentation of findings (Lowther et al., 2008). ICT integration does not demand a 1:1 computer to learner ratio, but low density computer centres with space for learner interaction are best suited to this kind of teaching (DoE, 2001).

The introduction of ICT in the education system would call for redefinition of Environmental Education where ICT will no longer be the transmitters of knowledge but rather facilitators of the learning process. Tinio (2009) noted that “as learning shifts from teacher–centred approach to a learner–centred approach, the teacher becomes the sole voice of authority” (p.__).

2.3.1 ICT integration in South Africa

Enlarging the use of ICTs in teaching and learning has become an important issue in the context of the South Africa education system (DoE, 2001). The Department of Arts, Culture, Science and Technology (2002) declared how ICT plays a major role in education. This emphasises the value ICTs add to education, thereby improving teaching and learning, encouraging innovation, and contributing to transformation (Czerniewicz, Ravjee, & Mlitwa, 2005).

Czerniewicz and Brown (2005) researched through a quantitative study and identified how ICT is being used as part of teaching and learning events and the extent to which it is being used in teaching. It is worth comprehending that Czerniewicz and Brown's (2005) interpretation of ICT integration has to do with combined use of digital resources and how teachers perceive teaching to be organised.

2.3.2 Barriers to integrating ICT into education

The process of integrating ICT into teaching and learning is regarded as complex and teachers may encounter a number of challenges. These challenges are referred to as "barriers" (Schoepp, 2005). A barrier is defined as any obstacle that makes it difficult to make progress to achieve a goal (WordNet, 1997, as cited in Schoepp, 2005, p. 2). Several studies have classified barriers into two: extrinsic and intrinsic barriers. Ertmer (1999) defined extrinsic barriers as first order, examples as in time, support, resources and training, and intrinsic barriers as second order, examples as in attitudes, beliefs and practices.

Some studies also examined the question as to whether the barriers, the teachers, or the school system. However, for the purpose of this study, it is to determine the barriers that face Environmental Education teachers in their rural high schools, which will focus on teacher–level barriers.

2.3.2.1 The teacher's perceptions towards the use of ICT

Integrating ICT into classroom teaching is being promoted globally. Integration of ICT in the classroom teaching involves a diverse set of technological tools used for creating, storing and communicating information, which ultimately enhance teaching and learning. Therefore Cope and Ward (2002) have observed that effective usage of ICT in teaching will promote enhanced learning outcomes. According to Mumtaz

(2002), the educator's perception on the role of ICT is very important as this impacts on how they will integrate it in the classroom. There are also various perceptions on how educators make use of ICT in teaching (Bebell, Russel, & O'Dweyer, 2004). These divergent perceptions on the educators use of ICT will definitely have impact on the planning and implementation of educational technology.

According to Beyerbach, Walsh, and Vannata (2001), if a person has a narrow view of what educational technology is and at technology that may be used for in the classroom, he/she may be ignorant about the importance of ICTs, and which may lead to the perception of computers, for example, as alien and a luxury acquisition. They will always regard it as a constraint in teaching situations, but if one is knowledgeable about technology and how useful it can be in the classroom setting, one will see it as empowerment. Educators' perceptions should be drawn to a wider view so that they see technology as an empowerment.

Teachers believe that the language used on the media is solely English, which may inhibit them from using ICT in their teaching. On the subject of language, Lambert (1996) observed that "access" to the Internet depends not only on ready access to telephone lines and telecoms infrastructure, but also on a working knowledge or proficiency in the English language which is the language of the cyberspace. Without this, finding a way through all the various interfaces on the Internet and to be able to access information becomes extremely difficult. Lambert (1996) noted how lack of familiarity with English has affected the extent to which the Japanese use the Internet compared to the massive use of the Internet in Singapore. Furthermore, many educators perceive the integration of ICT into education as consisting of basic computers whose role is to contribute towards effective and efficient teaching to advance the quality of curriculum delivery (Enochsson & Rizza, 2009).

However, how to get learners get connected to the digital generation comes as a vital component in teaching, and teachers have employed integration as a medium for curriculum delivery. Many published articles report that integrating ICT in education supports learning either directly, as in content delivery, or indirectly through communication (Chai Koh & Tsai, 2010; Enochsson & Rizza, 2009), which makes technology to be essential.

It is important to acknowledge that technology on its own is not likely to lead to effective teaching in Environmental Education (Tee & Lee, 2011), rather it is a way in which teachers integrate technology that can bring about change in the education process. Therefore, educators in rural high schools must develop a positive attitude and believe that ICT is an important educational tool to enhance the teaching and learning process. However, teachers' attitudes towards ICT usage and their competence level have not been well received by most educators (Rastogi & Malhotra, 2013).

In addition to this, it is perceived that there is an absence of dedicated technology champions to initiate electronic education and to implement new technologies. Owning a computer is also seen as a status symbol of one's hierarchy in the society (Dzidonu & Reddy, 1997). Educators that are using ICT in the process of teaching and learning are interested because they see the importance of ICT resources in teaching to be better educators and improve their teaching as well (Higgins & Moseley, 2001).

2.3.2.2 Teachers' attitudes towards the use of ICT

According to Rogers (1995, p.161), people's attitudes towards a new technology are basically elements in its diffusion. Rogers's (1995) Innovation Decision Process study postulate that the process occurs through stages: Knowledge, Persuasion Decision, Implementation and Confirmation. This process makes the individual pass through the following:

1. From first knowledge of an innovation;
2. to forming an attitude towards it;
3. a decision to adopt or reject;
4. implementation of the new idea; and finally,
5. to confirm the decision.

Rogers's (1995) idea that individuals shift from knowledge about technology to forming attitudes towards it and then adopting or rejecting it creates a general and widely accepted belief that attitudes affect behaviour (Ajzen & Fishbein, 1980; Zimbardo et al., 1977). The issue of identifying educators' attitudes has not been easy. Watson (1998) considered educators' attitudes as the most misread one.

A major part of a study from Spain (Instituto de Evaluacion y Asesoramient Educativo, 2007) reported that teaching staff have a positive attitude towards the use of ICT, with a significant proportion judging it to be helpful for their teaching. In Slovenia, educators think that learners are motivated by using ICT in the classroom and their interest in the content of the subject increases (Gerlic, 2006). A similar study in France (Societe-Pragma, 2006) revealed that teachers have a positive attitude towards ICT and have identified it as a value in creating motivational frameworks and increasing learners' dependency.

Given that there is evidence of correlation between attitudes and behaviour, (Ajzen, 1998; Shrigley, 1990), it follows that teachers' attitudes towards the use of technologies in teaching may influence their behaviours and activities where they have to use ICT tools to perform. Collins (1991) reported that beliefs were a better indicator of career interests. Researchers (Koohang, 1987, 1989; Loyd & Gressard, 1986; Hunt & Bohlin, 1993) found the importance of teachers needing to believe in ICT literacy which is vital for living in today's society. However, teachers do or may not perceive that they need a good command of ICT for their future profession and generally had negative attitudes towards its usage. Similarly, Brunner and Tally (1999) claimed that ICT is an expensive and creative medium of learning. Since teachers will be expected to play an essential role in identifying technologies in their classrooms (Albion, 2001), It becomes necessary that they are not only comfortable using ICT but also able to engage with issues around ICT in the classroom.

The use of ICT in education has been an important concern for many countries. Many developing countries are embracing the idea. However, ICT tools are provided to teachers without taking into consideration their attitudes towards ICT. It is assumed that potentially the new technological tools are to revolutionise technological tools that are outmoded in the education system (Albrini, 2006). In the definition of ICT in education, there are mainly four key elements which consider ICT as an object, an assisting tool, a medium for teaching and learning, and a tool for organisation in schools (Monnen & Kommers, 1995).

The use of ICT in education seems to have blended the issue between those who have a positive attitude as distinguished from those with a negative attitude toward ICT use as a tool of teaching. The depiction of negative attitudes towards the use of

ICT has been found to arise due to teachers' lack of confidence in using technology and the shortage of pedagogically driven and motivated training provided. The teacher is an effective factor in contributing to improve education. The teachers' effectiveness depends solely on the attitudes of the teachers. Albrini (2004) carried out a study titled where he discovered that many teachers did not think that computers were part of their curriculum programmes. They also felt their time slots for lessons were very limited for computer use. In another study, Yusuf (2011) stated that there are a number of factors which determine the attitudes of teachers towards ICT such as an inequity of access to education between males and females.

Teachers' long experience of using ICT was a major factor in influencing their attitudes towards the use of computers and other tools such as projectors, scanners, etc. Savenge (1993) found that teachers' participation in courses in ICT literacy reduced their anxieties and gave them more confidence, and therefore they valued ICT more. Similarly, Watson's (1997) study showed that many teachers had low self-efficacy with learning ICT and had negative attitudes towards the usage of ICT. Teachers with different levels of ICT and with much knowledge about the usage in teaching had different self-efficacy. The novice teachers appeared to have been the most negative, while the more experienced were the most positive towards technology usage. As Mumtaz (2000) pointed out:

> "The implications of the studies are that teachers' theories about teaching are central in influencing teachers to use ICT in their teaching. Even if teachers are provided with up–to–date ICT in and supportive networks, they may not be enthusiastic enough to use it in the classroom. Teachers need to be given the evidence that ICT can make their lessons more fun, more interesting, and fun for their learners, more enjoyable and much more of a motivation" (p. 338).

2.3.2.3 Teacher ICT skill

Teachers' ICT skills are becoming widely known and as a determinant of the quality of education provided to learners. The integration of ICT into the Environmental Education curriculum depends on the teachers' skills that have been acquired from ICT (Mean, 1997; Poole, 2000). The US National Council for Accreditation of Teacher Education (2000) defined teachers' skills as "the ability to use content and

pedagogical knowledge effectively and be ready to change the teaching methods in such a way that all learners will benefit from the learning process" (p. 56). Finger et al. (1999) stated that teachers' skills enable a teacher to have access to a class and use this form of motivation to employ different techniques, for example projectors to illustrate a process, and may improve and assist in the teaching and learning.

ICT skills refer to familiarity with technologies such as computers and equipment including printers, scanners and familiarity with installing and using Microsoft Office. However, Higgins and Packard (2000) contended that teachers and their ICT skills acquired with knowledge and motivation do not improve their productivity. ICT skills consist of the basic and advanced. Hefzallah (2004, p. 30) explained that the basic level user should have a comprehensive knowledge of a broad range of applications and should be able to manage computer operations.

The lack of ICT related knowledge of teachers is still one of the generally recognised obstacles that prevent the realisation of their ICT-related goals (Pelgrum, 2001). The persistent influx of ICT in education will make teachers life-long learners. This may mean that the traditional model of teaching needs to be replaced by new models which are supported by ICT. Teachers in most South African public and rural schools have been engaged in ICT workshops to equip themselves with basic computer skills they need to integrate into their subject teaching (PanAf, 2008-2011).

Recently, UNESCO (2009) came up with a comprehensive method for teachers to apply ICT knowledge. The aim of ICT Competency Framework for Teachers (ICT-CFT) is to help improve teachers' practice by considering recent practices in the curriculum and pedagogies. The framework is designed for professional development for teachers to use ICT skills to improve their teaching.

The objectives of the project are:

- To develop a common core syllabus training that providers can use to develop learning materials.
- To provide a basic set of qualifications that allows teachers to integrate ICT into their teaching and to extend their professional development.

• To provide a harmonisation for different views and vocabularies, regarding the use of ICT in education.

2.4 ICT in Rural High Schools and Communities in South Africa

2.4.1 ICT in township and rural communities in South Africa

The apartheid legacy of racial divide in the South African society has had an impact on creating two economies in one country; the first economy being advanced, skilled and globally competitive (Talton, 2012, p. 3). The second one, which is mostly informal, marginalised and unskilled, is unable to have access to the benefits of the first economy. The second economy is known to lag behind, of which the government is trying to intervene to avoid the risk of further receding (Fourie, 2008). This explains why there are inequalities in the development of education as well as the usage of ICT in most rural schools in the country.

In order to determine how people from disadvantaged communities in South Africa are trained in word processing, Blignaat et al. (2007) found that these people showed limitations of low background and were mainly not familiar with the language of computers. They could hardly open a document because of their inability to comprehend the basic concepts of computer usage.

2.4.2 ICT in rural high schools in South Africa

Mfum-Mensah (2003) strongly argued that there is persuasive evidence about the benefits of ICT in schools, especially for developing countries, as ICT is seen as a tool that will prepare learners for the information society they will inherit. The Department of Basic Education (2004) indicated that ICTs are seen as resources that can reduce poverty in developing countries by overcoming the obstacle of social and geographical isolation and accelerate access of to education for many people. The ICT in rural high schools is seen as a political issue, as in most instances the aim is to redress inequality with regard to access to opportunities (Pedro et al., 2004). Rural schools have enormous challenges in integrating ICT into their teaching. In the South African context they are seen to be addressing access, equity and imbalances of the past system. In South Africa, rural high schools constitute a larger proportion of the schools in the country. However, as Mfum–Mensah (2003)

pointed out, the lack of resources is a major characteristic of rural schools as compared with their urban counterparts.

2.4.3 Problems encountered in using ICTs in rural high schools

Rural schools at the moment, face numerous challenges that do not occur in urban schools. According to Naidoo (2002), research showed that rural scholars are seven years behind their urban counterparts in basic computer skills and its usage. These problems have been discussed below.

- Lack of school building and resources

There are so many rural high schools that do not have adequate school buildings and resources for teachers and learners to use. Jenkin (1995) stated that most rural high schools are located in areas with extreme poverty, and therefore there is unlikely to be extra funds for buildings and provision of resources (Jenkin, 1995).

- Lack of computer hardware and software

According to Furlonger (2002, p. 2), most rural high schools lack computer laboratories, let alone someone who is skilled with the knowledge of ICT and the Internet. This result in most rural schools not being able to offer computer courses, and this becomes difficult for learners in disadvantaged schools to find gainful employment since most jobs now require some knowledge of computers and the Internet.

- Remotely situated rural schools

Jenkin (2005) stated that most rural high schools are in isolation, located in inaccessible remote areas, which makes it difficult for resources and facilities to reach them. There is also limited transport to these areas, which makes scholars walk long distances to schools. The roads are usually dangerous to travel on, especially during rainy months (Jenkin, 1995). In response to these problems, there have been some initiatives by the government and some NGOs to develop ICT in rural parts of South Africa.

2.4.4 Initiatives to bridge the urban and rural digital divide

Private organisations and non- governmental organisations (NGOs) are all making immense contributions in supplementing the government's effort to integrate ICT into education. In South Africa, ICT integration in schools has become a key objective for government – both national and provincial – as well as everybody associated with education. The Department of Basic Education (2004) sees integration of ICT into the school system as a way of providing quality education for all.

Some projects are provided to support the integration of ICT into education, e.g. the South African School Nets which started in some provinces and is now connected to communities. The Mind– set Learn ,a satellite channel that broadcasts educational content to schools in South Africa which is made up of a decoder and a television, is trying to set up orientation to help teachers use the broadcast optimally. There is also the Sentech Project, Khanya Technology in the Western Cape Province, and Gauteng On–line. Microsoft Partners in Learning (PiL) is a global initiative that was launched in September 2003 to target countries and educational institutions. It established partnerships with local institutions on the implementation of ICT in education. In South Africa, the (PiL) program partnered with SchoolNet South Africa in the localisation of face–to–face teacher training materials and delivering in schools. These include basic ICT skills for teachers, ICT integration, and ICT leadership for education managers. To date, the programme has reached more than 8600 teachers and Department of Education officials (DoE, 2005), to mention a few. However, almost all of these projects are situated in the urban areas. This can be attributed to the fact that urban schools have good infrastructure. This is a contrast to what actually happens in rural schools. According to Mdolongwa (2012), there is still a struggle among rural schools.

The table below shows the disparities that exist in terms of acquisition of ICT tools. The Eastern Cape, being a predominantly rural province, is the least ICT providing province.

Table 2.3: Schools with computers according to provinces (2000) (DoE, 2004)

Provinces	Schools with computers	Schools with computers for teaching and learning
Eastern Cape	8.8%	4.5%
Free State	25.6%	12.6%
Gauteng	88.5%	45.4%
Kwazulu Natal	16.6%	10.4%
Mpumalanga	22.9%	12.4%
Northern Cape	76.3%	43.3%
Limpopo	13.3%	4.9%
North West	30.5%	22.9%
Western Cape	82.4%	56.8%

2.5 The Importance of School Culture on ICT in Rural Schools

School culture is made up of the vision, mission, plans, norms and values that are shared by school members (Maslowski, 2001). Focusing on the importance of school culture for ICT integration, Pelgrum and Law (2009) indicated that effective integration depends on the perceptions and vision of the school leaders rather than teachers with ICT skills. The school has a mediating role that motivates teachers' actions, beliefs and attitudes (Chai, Hong, & Teo, 2009).

In order to explore teacher perceptions related to the ICT usage, Tezci (2011b) examined Turkish teacher perceptions from both technical and motivational perceptive. The results on both sides were not positive because majority did not believe they would receive adequate technical and motivational support from their school. Ward and Parr (2010) stated that teachers need to feel confident in their ability to facilitate teaching with technology in order to integrate it in their classrooms.

Kadel (2005) added that, despite the numerous quantity of technology that are available in the classrooms, it is very important for teachers to have competency . Competence is the ability to apply the necessary attributes to a particular concept or content. These may include capabilities, skills, values and to put them into practise. According to Ertmer (2010), more professional development is suggested with a focus on increasing teachers' skills. Above all, implementation of effective teaching with technology integration needs teachers to change their beliefs (Ertmer, 2010).

2.5.1 The role of teachers in technology mediated environment

The integration of ICT, as predicted by Borg in 1980, may have a remarkable effect on the work of teachers, if it is considered as tool in education (Borg, 1980). Not only do teachers need to change their roles, but they have to put in much effort and energy to introduce and adapt these new learning methods for the benefit of their learners. It has been anticipated that major methods of teaching would involve the use of modern technologies like computers by the year 2000 (Borg, 1980). However, Crook (1994) opined that this prediction could not to be true. Vygotsky (1978) developed the concept of zone of proximal development (ZPD) that has had a great effect on how we regard teachers' instruction in motivating learners to achieve optimally. This is reinforced by appropriate use of instructional materials. This concept of ZPD is defined as:

> "The distance between the actual development levels as determined by independent problem solving and the level of the potential development as determined through problem solving under adult guidance" (Vygotsky, 1978, p. 86).

Teachers can play an important role in disseminating knowledge and creating awareness about the environment and also assist in tackling local and international environmental problems. The teacher should be motivated so that he/she becomes committed to the cause of realising the objectives of Environmental Education and gets initiated in compiling programmess for such environmental issues. However, for teachers to become successful in spreading environmental awareness, it is very important that schools as well as the Department of Basic Education provide incentives and conditions which will be conducive. Teachers should be well equipped with the concepts and skills to be imparted to learners. They should acquaint

themselves with the methodology of the teaching that will inculcate these positive attitudes about the environment into learners (DoE, 2004).

As technology has created change in virtually every sphere of life, including the role of an educator, it is also changing expectations of what learners must learn in order to function effectively in the new knowledge economy. Learners have to learn how to navigate through large amounts of information to analyse and make decisions, and to master new knowledge domains in an increasingly technological society. A radical shift from teacher–centred instruction to learner–centred activity is necessary to enable learners to acquire the new 21st century knowledge and skills. The following table (adopted from Sandholfz, Ringstaff, & Dwyer, 1997) identified the shift that will take place in changing from a focus on teaching to a focus of learning.

Table 2.4: Teacher Centred and Learner Centred Learning Environment (Santholfz, Ringstaff, & Dwyer, 1997)

	Teacher–centred learning environment	Learner–centred learning environment
Classroom activity	Teacher centred, Diadatic	Learner- centred, Interactive
Teachers role	Fact teller, always expert	Collaborator, sometimes a learner
Instructional emphasis	Facts memorisation	Relationship, Inquiry and Invention
Concepts of knowledge	Accumulation of facts	Transformation of facts
Technology use	Drill and practice	Communication, access and expression

The new environment also involves engaging learners to be more interactive and have a greater responsibility of their learning.

Teachers have recently found themselves in uncertainty where there are rapid changes in their professional practice. These have arisen due to a number of factors including technological innovations and political initiatives. One of the most predominant changes in the professional practice is the global influx of the implementation of ICT. Teachers have always wondered if the introduction of ICT into education will make a great impact and whether teachers need to acquire the necessary skills to support their teaching. The debate is about how and the extent to which teachers should adapt their traditional and longstanding pedagogical methodologies to accommodate the modern ICT-driven teaching and learning. Most teachers have accepted the new educational technologies, some have welcomed these technologies, while a few have ignored them. Teachers that have not welcomed the ideas of new technology in the classroom have adequately damaged the reputation of ICT by poor classroom practice, for instance using technology for the sake of its novelty value (Littlejohn et al., 1999).

Teachers have been polarised in their acceptance of new technologies. Some have begun to integrate it in their teaching, whilst others have been cautious in their welcome. A shift in the role of a teacher utilising ICTs to that of a facilitator does not obviate the need for teachers to serve as leaders in the classroom. The existence of ICTs does not transform teacher practices in itself. However, ICTs can help teachers to transform their practices, given a set of enabling conditions.

With the inevitable introduction of ICT in the classroom, the role of the teacher must change from being the centre of the teaching process to becoming organisers and enablers (Sinko & Lentinem, 1994, p. 143). This will motivate teachers to encourage critical thinking skills, promote information literacy and collaborative working practices to prepare learners for entry into the world of work. Teachers must also reappraise the methods of teaching which will meet learners' learning needs. The teacher will become a supervisor of the learning process and also a transmitter of knowledge, but will also fulfil a broader range of roles. The tasks are varied which include coaching, training, advising and testing. Subject matter and the didactic knowledge of Environmental Education will not be enough, they must have supervisory and guidance skills as well.

The question as to how the integration of ICT into education will affect the teaching profession and the labour market has been reviewed in various literatures on computer technology, the teaching profession and the market. In the Netherlands, however, the discussion on integration of ICT is currently linked to another type of question concerning the teaching profession. Partly as a result of the rapid shortage of teachers, it is increasingly putting forward possible solutions to the problems in the educational labour market as a contributory factor to the professionalisation and attractiveness of the teaching profession (Boer, 2001).

As much has been mentioned on ICT and teachers in the rural schools, ICT can also help develop the curriculum that has to be carried throughout the school years. The next section deals with ICT and curriculum development in relation to Environmental Education.

2.6 ICT on Curriculum Development

2.6.1 The concept of curriculum development

Philosophy has played an important role in the curriculum and teaching in the past and will continue to be vital for making important decisions in future (Ornesein & Hunkins, 1998). What is curriculum? Below are some definitions of what curriculum is:

1. A specified course of study in a school to lead a person to a career; the whole body of courses offered in an educational institution (Webster's New International Dictionary 2nd ed.).
2. A plan programme for all experiences with which the learner has the guidance of the school (Jackson, 1992a).

Social reconstructionists believe that learning is a social practice and that learners should make it a habit to build a sense of responsibility for the society. Educational ICT is understood as the development of a set of systematic techniques with accompanied practical knowledge for designing and testing schools as educational systems. Petrinia (2004) argued that it is necessary to identify what knowledge is important and what technologies are selected. According to Petrinia (2004, p. 2):

> "Curriculum designs are negotiations in the politics of knowledge, identify and identification and representation which may differ accordingly. They lend from to, and chart provisions for the process of teaching and learning and become

concrete at various stages of educational practice. The very true nature for learners experiences are shaped by the way we choose to design, or not to design curriculum. In other words, different curriculum designs provide varied powers of experiences and knowledge."

2.6.2 ICT on the curriculum development

Anderson (2002) identified 28 countries that have integrated ICT into the curriculum. His findings indicate that computer integrated activities allow learners to work independently and constructively. The teacher is responsible for organising his or her activities and acting as a facilitator. The integration has been proposed in various countries depending on the long-term goals of the country. Earlier studies indicated that the integration of ICT into the curriculum remains a big challenge in the context of the schooling system (John, 2005). Chief among the problems that have been identified in the integration is teachers' perceptions of ICT usage. As Loveless (2003, p. 315) explained, teachers' perceptions of ICT usage in education are not only influenced by official guidelines but also by their own experiences.

A study that was carried out in Italy (Nesler, 2004) also looked at developing an innovative curricula proposed on the use of ICT in schools. It analyses the advantages as well as the technical methodological problems related to the introduction of ICT at a level of instruction. In Estonia, ICT is part of the framework curriculum (as an integrated theme) for general education. Reiska (2008) also sought to find out how ICT is integrated in the curricula of different schools and how it provided guidance to meet learners needs.

However, Gibson (2001) stated that most teachers, in order to improve their pedagogy, have to make amendments in their teaching by making full use of ICT in the teaching and learning process (Fabry & Higgs, 1997). In the Environmental Education curriculum, ICT acts as a supplement to classroom activities. Currently many programmes are designed at education levels with the effective use of ICT for the purpose of contributing to the attainment of sustainable education. There is the need for educators to be trained of the new curriculum alongside the development of ICT programmes to create and develop different activities for different individual learners.

Paas and Creep (2008) indicated that the current uses of ICT in the curriculum include the information resource tools which provide important links to information on ICTs in education. The platform enables teachers to exchange knowledge, read and prepare lesson notes. Early proponents of the use of ICT in educational curricula were from the civics field promoting media awareness (Adu & Tella, 2010). For example, regarding the content of geography in Environmental Education, educators are increasingly using ICT tools as central to the curriculum, including mapping and graphics software such as Geographic Information Systems (GIS).

2.6.3 Cross–curricular teaching of Environmental Education in South Africa

The Constitution of South Africa states that every South African has a right to an environment that is not detrimental to his or her health or well-being (Republic of South Africa, 1986). Every educational institution has been mandated by this statement. This therefore implies that if environmental education can be integrated across the curricula effectively, learners in the local and global community will be saved from a number of environmentally related problems. This can be addressed by educators who are empowered through programmes of Environmental Education to educate learners who are environmentally literate.

Defining the term ‘environment’, the South Africa Environmental Education Policy Initiative (EEPI) in 1995 stated that the environment is a matter of social and economic policies. This definition explains why Environmental Education can be integrated into any subject, be it natural science, social science, geography or arts and culture. Powers (2004) described an Environmental Education integrating a model which includes a process of infusing EE concepts and skills throughout the existing curriculum. In South Africa, it means integrating EE across all the eight learning areas at the GET level.

In view of reshaping learners with regard to EE, educators should be given enough training and support. This is motivated by the Environmental Education Curriculum Initiative (EECI, 2000) which stated that higher education institutions will have to use the method and knowledge in resolving the environmental issues. South African schools have chosen this integration approach and, as stated by Loubser (1997), is one of the most important focal points, especially in the GET phase.

2.6.4 ICT curriculum models in relation to Environmental Education

Nicholson (1995) identified two kinds of curriculum models in relation to ICT: techno-centric and humanistic computing. In the techno-centric model, curriculum emphasis is placed on equipping learners with necessary skills that will be important for their lifelong learning and future. This model that dominated in the 1980s emphasised learning the technology to better meet the requirements of an industry. The humanistic computing model is when the computer and the Internet serve as a pencil, not as an isolated class, but a tool which motivates learners with knowledge as well thinking skills.

Voogt and Pelgrum (2005) found three curriculum models:

a) Single subjects curricula focus on the ICT-supported innovative pedagogical practices were integrated within discipline-based subject. ICT was mainly used to improve understanding the subject contents and concepts.
b) Thematic curricula focus curriculum content was offered through themes and ICT was used to facilitate the implementation of life- long goals.

School-wide curricula focus on the ICT–supported innovative pedagogical practices were integrated throughout the school curriculum

Implementing ICT in the curriculum will imply funds that need to provide these technological tools and make them available for teachers to use them in the teaching and learning process. The next session highlights on the cost and implementation of ICT resources.

2.7 Cost and Implementation of ICT Resources

2.7.1 Availability, cost and implementation of ICT resources

Literature suggests that as computer systems become integrated in the field of education, teachers will become more reliant on the resources and communication will be more available through the use of ICTs (Bloom et al., 2002). The media traditionally used for instructional purposes will be outdated, as computers become increasingly available and schools become more dependent on technology. However, the degree of implementation and use of computers are affected by the level of wealth of individual schools between rural and urban schools (Ishaq, 2001). It therefore becomes apparent, as technology continues to progress more rapidly,

that learners that are not exposed to technology stand at a disadvantage (Ishaq, 2001). Seemingly, some teachers see ICT as a tool that reduces workload (Granger et al., 2002). Edward and Roblyer (2000) stated that in the 1960s the inventors of computers predicted that computers will replace many teacher positions.

The integration of ICT into education and teaching can only be successful if carefully planned, managed and supported. Bates (1997) emphasised that new technologies are likely to remain marginal despite high levels of capital investment, and will merely add cost to the system, if structural changes in schools are not dealt with at the same time. Twigg and Oblinger (1996) supported this by stating that management, technical support, curriculum development and training expenditure are essential to ensure sustainable ICT access and use in education. The introduction and sustainability of ICT in education are also expensive. The capital cost of the equipment needed to begin the process is obvious. Less obvious is the high level of recurrent costs associated with the effective use of ICT, which results in a more accurate analysis of the total costs. All attempts must be made to optimise the benefits of such large investments and to develop cost effective implementation and maintenance procedures.

Given the global enthusiasm for applying ICT in teaching in rural high schools and national education systems, it is essential to put in place appropriate costing, financing and planning processes to aid budgets, and financial allocations to ICT must properly take into account the full cost of sustainable ICT systems as well as address the challenge of providing ICT on an equitable basis. The cost of ICT hardware has fallen since personal computers were introduced. A few hundred Rand will but entry level device that will run a wide range of software. It may be that these prices continue to fall, however, past reduction in the cost of basic devices which provide access may not be a good guide to the future.

In many though not all developed countries, these technological and cost advantages have accounted for mass access to and the use of computers in education. The same is not evident in developing countries largely because the cost barriers to supplying ICT hardware, software and connectivity in these education environments. In developed countries, there is growing realisation of what Oberlin

(1996) called the financial mythology of information technology which he described as follows:

> "While the per unit price of information technology is declining rapidly, the total cost of owing and maintaining systems is steadily rising. This was largely because of consistent underestimation of the support" (p.43)

ICT as a global reference for information and communication technology is an umbrella that encompasses many aspects of computing communications and technologies. It deals with the use of electronic computers and computer software to convert, store, protect, process, transmit and retrieve information securely. Resources that fall within this wide scope are classified under ICT resources. Human expertise that provides intellect layers to supplement the right usage of these resources can be qualified under this classification and considered as an important ICT resource development. Availability of these ICT resources does not entirely count when considering their tangible significance, but comes when resources are prioritised effectively and efficiently (Komza, 2005).

According to Anderson (2008), digital ICTs are quickly becoming accessible; it is important to note earlier ICTs continue to play a critical role in education worldwide. Accesses to films, video tapes, telephones are still far more common place than access to a computer or the Internet and the World Wide Web. The new digital ICTs are not single technologies but combinations of hardware media and delivery systems. Today ICT in education encompasses a great range of rapidly evolving technologies such as desktop, notebook and handheld computers, local area networking, the Internet, CD–ROMs and the applications of word processors, spread sheets, tutorials, electronic mail, digital libraries, etc. It should be noted that the use of new ICTs is being integrated with the use of older technologies, for example it is uncommon to find textbooks sold with CD–ROMs, containing multimedia materials, or links to related websites.

The application of ICT tools in education is profound to changes occurring worldwide in communication and information industries. The ability to digitise analogue signals and transmit them over telecommunication networks is resulting in the reconstruction of the radio, telephone, television and computer industries that create digital

products combining voice, video, text and graphics and deliver these signals electronically (Bane, Bradley, & Collins, 1995).

Although the number of people with Internet access is difficult to estimate in rural areas, one estimate places the total number at around 150 million in late 1998 and increase of over 60% since early 1997 (Nua Internet Surveys, 1998). Internet access at present is strongly concentrated in a small number of countries, providing services to a fraction of the world's population. Over 90% of Internet hosts are located in the world's richest 29 countries (Cukier, 1998). However, this may be expected to change over time as telecommunications costs continue to drop precipitously. In Africa, it is estimated that there are between 800 000 and 1 million Internet users. The current ratio of Internet users to people in Africa is estimated to be one for every 5000 compared to a world average of about one Internet user to every 40 people.

However, Naisbitt (2008) dismissed this by pointing out that 'whenever a new technology is introduced, there must be a balance in human capital' (p.__). To buttress this argument, Goodison (2003) opined that it is in the classroom that the fundamentals of education and what it means to know and understand are explained by the teacher (Goodison, 2003). Teachers are sometimes unable to make use of technology because they lack the time needed to fully prepare materials for lessons, particularly where this involves multimedia content (Fabry & Higgs, 1997; Manternach- Wigans et al., 1999).

In addition to this group of teachers who do not fully utilise technology because of the time to deal with multimedia content, there is also another group of teachers which Russel and Bradley (1997) described as having "cyberphobia" because of their fear of getting stuck with technology. Russel and Bradley (1997) suggested that any strategy to reduce computer anxiety among teachers deserves serious attention and complete redress. It was expected that this study would come up with recommended strategies to support teacher development in the use of ICT such as school based strategies and external environmental strategies.

2.7.1.1 School based strategies

An important step towards the successful integration of ICT in schools is to facilitate their capacity to develop a school-based ICT policy which will result in an ICT policy plan. Such a plan can be defined as a school document containing elements

concerning the integration of ICT in education. Several strategies have been mentioned in previous research literatures. Recently attention has shifted to school-based programmes that emerge into successful ICT integration (Tonduer et al., 2008). Examining school characteristics such as leadership or school conditions, infrastructure is very important in identifying which factors best explains the successful integration of ICT in education. Hew and Brush (2007) identified one important school level condition as having a shared vision and ICT policy plan.

Schools need to facilitate their capacity to develop a local ICT policy (Hew & Brush, 2007). This policy has to be grounded in a vision of teaching and learning and ICT integration (Vanderlinde et al., 2009). A school-based ICT policy can be defined as a comprehensive school document containing a variety of operational elements concerning the integration of ICT in teaching and learning (van Braak, 2003; Frazier & Bailey, 2004). It describes the overall philosophy of ICT use and explores how ICT will improve teaching and learning (Baylor & Ritchie, 2002).

In an ICT policy plan, a school describes its expectations, goals and content concerning the integration of ICT in education. This may include elements such as professional development, ICT curricula and ICT planning and evaluation (van Braak, 2003). Bryderup and Kowalski (2002) argued that creating an ICT plan is a crucial step towards the implementation of the integrated use of ICT. Research showed that schools that are successful at integrating ICT in teaching and learning are mostly guided by an ICT plan (Baylor & Ritchie, 2002).

Much more recently, Tondeur et al. (2007) found that educators in schools with a ICT policy plan emphasise shared goals and tend to use ICT more in their classrooms. ICT policy planning is a way of solving problems that will emerge during the process and implementation of ICT integration in teaching and learning (Gulba–har, 2007). According to Gulba–har (2007), such planning is not about hardware and Internet connections, but about how an ICT is integrated within the curricula content.

It is important for school leadership to show appreciation for increasing significance of ICT in the school curriculum in general and Environmental Education in particular. Therefore, school management should create an enabling environment for the integration and promotion of ICT in teaching and learning of Environmental Education in rural high schools. Where the ICT infrastructure has been adequately

provided, it becomes the duty of the leadership to ensure that both teachers and learners get along with this innovative tool.

2.7.1.2 External environmental strategies

Schools working together with other schools in the same community can benefit each other by sharing ICT resources, expertise and support. External support may also be provided in the form of locally based training. Ross et al. (1999) highlighted the advantages of involving teachers in the design of such training courses, providing training expertise in the form of continuous professional development.

according to the World Health Organization (WHO, 2002), environmental pollution, especially regarding air and atmospheric pollution, is limited to situations in which the ambient atmosphere contains material in concentration which are harmful to man and his environment. Learners can therefore undertake other Environmental Education lessons outside the classroom in the course of learning. These include planting of trees to check loss of vegetation, construction of contours to check erosion, provision of waste baskets to the market people. Umozurike (1993) observed that the categorisation and weighing of prescribed activities for teaching Environmental Education topics revealed that 77.3% are indoor activities and 22.7% are outdoor activities. The analysis reveals that EE teaching is limited to the classroom most of the time.

How then is Environmental Education offered in the classroom? Below is a discussion of the history and concepts of Environmental Education.

2.8 History of Environmental Education in South Africa

Environmental Education has in existence since the years of Second World War (1939-1949).This was as a result of human suffering. Out of these concerns there flowed recognition of the need for public awareness about the environment and environmental issues that have emerged (Carson, 1962). From an international environmental education perspective, the most fruitful partnership was that with UNESCO. UNESCO was initially concerned only with education in a developmental context, but gradually through its contact with bodies such as IUCN, it became part of the process of developing Environmental Education.

The 1992 Earth Summit also focused on the role of Environmental Education as an educational response to the environmental crisis. Chapter B6 of Agenda 21 is one of the documents which emphasised the need for wide-scale Environmental Education and capacity building, and aimed at responding to a wide range of environmental issues. Agenda 21 described the process as those that involve teachers and learners in promoting sustainable development and improving the capacity of individuals to address environmental issues (UNCED, 1992, Chapter 36, p. 2), illustrating the link between changes in the field of Environmental Education.

2.8.1The development of Environmental Education in South Africa

Having discussed the history of Environmental Education, its development can now be traced in South Africa up to and after 1994. Contemporary forms of Environmental Education first reached South Africa in the mid-1970s, stimulated by the Belgrade Charter of 1975 and the 1977 Tbilisi Principles. Back then, Environmental Education was termed ‘conservation education, with great concentration of soil erosion, until the late 1970s. Conservation education later became subsumed within Environmental Education, of which it continues to be an integral part.

In the 1990s, Environmental Education shifted its focus on sustainability. For example, it was a cross-curricular theme adopted into the national curriculum in Britain. Many schools practised the model of interdisciplinary teacher cooperation where the teacher uses different disciplines and works together through planning courses, organising teams and teaching, etc. Environmental Education is best done by the interdisciplinary teacher who is able to embody the plan of integrating. The teacher guides learners to resolve environmental issues by aesthetic, social, economic, political and cultural activities. Therefore, the interdisciplinary teacher embodies the idea of Environmental Education for sustainability. As a result, Environmental Education for sustainability contributes to the education of the whole person (Tilbury, 1995). This acknowledges that the investigation of any environmental issue must involve the study of the intersection and interaction of these elements.

A holistic Environmental Education would not be considered as a subject in itself but rather be treated as a whole concept that needs input from all parts of the curriculum (Worldwide Fun for Nature, 1990). For example, when solving some environmental problems, it may bring out questions like how poverty sometimes causes environmental exploitation, and which forms of social organisation may best contribute to sustainable development (Beddis & Johnson, 1998).

For many years, most Environmental Education in Southern Africa took place in the non-formal education sector. It was understood and interpreted clearly as programmes of Environmental Education in institutions. During those days it was focused on outdoor activities and experiential learning. Although some merits could be identified in the methodology of these approaches, it was difficult to determine the real purpose of many of these programmes. The understanding of Environmental Education gradually changed and it grew to include a more holistic understanding of how to educate (Fien, 1993, p. 12). This new understanding of Environmental Education had significance on curriculum development in formal education.

Despite efforts being made to include Environmental Education in formal education, there is still no clarity on how Environmental Education should be implemented. Theories have been criticised by those advocating critical curriculum theorising (Schreuder, 1995, p. 21). However, the best way to address environmental learning through the formal curriculum is still fiercely debated today. The NEEP (National Environmental Education Programme) process in South Africa includes research processes that are supposed to provide answers to this burning issue. Whilst these programmes focus on a certain cluster- based approach, (Sguazzin & Du Toit, 2000), the EEPI (Environmental Education Policy Initiative) (1995, p. 2–3) suggested that there are four main policy options for introducing Environmental Education in the formal education system:

1. Environmental Education as local problem–solving curriculum actions.

2. Environmental Education as an integrated approach to Environmental Education.

3. Environmental Education as a separate subject.

4. Environmental Education as a component within a subject.

Once a good curriculum process is in place, teachers and facilitators will have to choose the strategies and methods to use in their teaching. These have been widely discussed in many publications. The question is: Which of these methods are appropriate to Environmental Education? Generally, strategies and methods should include:

- •Questioning including tests and examinations
- •Discussion including debates and teaching by peers
- •Investigation and problem–solving
- •Demonstrations
- •Cooperative group work
- •The experimental method, including exploratory learning excursions (Fraser, Loubser, & Van Rooy, 1993; Trowbridge & Bybee, 1996).

The development of Environmental Education in South Africa has not, however, been a smooth process. A concept which emerged in the early 1980s and was confused with Environmental Education was that of “outdoor education” which focused on out-of-door activities (UNCED, 1992, Chapter 36, p. 2). After 1982, this point gradually declined in South Africa and is now in complete eclipse. Stimulated by the increasing interest by the international community in Environmental Education, there was a large conference on outdoor education held in Pretoria at Treverton College, Mooi River in Natal. This conference gave birth to the formation of the Environmental Education Association of Southern Africa (EEASA) which has subsequently played a role in the growth of Environmental Education in South Africa (Environmental Education Bulletin).

2.8.2 South Africa Environmental Education policies

South Africa’s Environmental Education visions are found in the various policies which begin with the 1996 Constitution of the Republic, the 1997 Urban Development Strategy, the 2000 Rural Development Strategy, The National Environmental Management Act of 1998, Curriculum 2005, and the National Curriculum Statement of 2002. South Africa has been considered as one of the countries with a profusion of environmental pressures, which includes air and water

pollution from industrial areas that are close to residential areas, unplanned urbanisation which has increased to 58 %, and increasing poverty levels, to name a few (Southern African Institute for Environmental Assessment, 2003).

Environmental Education policies have been in the process of becoming inculcated into the curriculum (DoE, 2004). However, the processes of funding have not been established by the South African government, but initiatives are largely funded externally by overseas donor agencies (UNESCO, 2004). For instance, the World Bank has been one such international body that has supported the funding of the integration of curriculum through the Environmental Support Program (Lupele, 2002).

The teaching of Environmental Education takes place within the curriculum, the teacher and the learner. It consists of two fields: education and the environment. The education field has been well established and it is being studied and practiced. This process has led to a strong focus on formal education. The education field has strengthened its policies which include teaching methods to identify the effectiveness of different styles and teaching tools (Giddens, 2001)

Outdoor education has been positioned within the Environmental Education curriculum. Outdoor Education Activities (OEA) consists of two definition elements which are: teaching and learning that take place outdoors, and a method of teaching. The role of outdoor education and Environmental Education has been established over the years with numerous studies to support the impact on personal and social development of learners (Smith, 2002). The role also suggested that learners participate in activities outside the classroom and not only increase their physical well-being, but also there are measurable improvements in their self-esteem, self-worth and confidence, as well as reducing their stress levels (Davidson, 2001). Other studies have revealed how exposure to nature improves mental ability which can translate into academic success (Berman, Jonides, & Kaplan, 2008).

Teachers are therefore encouraged to use outdoor educational activities in teaching environmental issues and concepts, instead of staying in the classroom to deliver the contents of the curricula. Learners should be taken on field trips, avoiding risks and obtaining approval from the Department of Basic Education (Adu, 2006). In support of the Environmental Policy Initiative, Molapo (1999) suggests that schools should

have a clear environmental policy that caters for all outdoor activities within the school.

2.8.3 The teaching models, concepts of environmental education and ICT

Weiser states that “You don’t know the power of a motivated, excited teacher until you see one in action”. Many teachers are now incorporating Environmental Education activities into all sorts of recycling programmes at their schools. They change the way they do things in their personal lives and pass the enthusiasm along. Models of teaching like patterns represent the steps in teaching which will bring the desired outcomes in both teachers and learners. According to Joyce and Weil (1985), a teaching model is a pattern that can be used to shape the curriculum and to design instructional materials so as to guide teachers. Thus the model of teaching comprises guidelines for designing educational activities. It also specifies the methods of teaching and learning, and the intended goals to be achieved.

The integration of ICTs as an approach to teaching and learning need the accommodation of new tools into the teachers’ practice for it to be described as quality. The teachers’ ability to choose and manage the teaching and learning processand using different media has a great impact in the development of new ideas that are relevant to the learners’ performance. The principles of teaching and learning should be prioritised when ICTs are being used in the classroom if quality education is the aim.

The selection of ICTs should reflect in the teaching and learning process and not necessarily what makes the learners excited. That is to say, the technology chosen should be based on the content of the curriculum. This will have enormous influence in determining whether the goals of the lesson have been achieved or not. Lim and Tay (2003) suggest the following tools that can be used to support an achievement of specific learning objectives.

a) Situating tools are settings where learners get first-hand experience of the content and context of the learning process. These can be simulation games and virtual reality. Hogle in Lim and Tay (2003) proposed that simulation and games can improve cognitive learning styles like, memory, organisation and especially critical thinking. The main purpose of the game should depict the lesson content.

b) Constructive tools are devices used to manipulate information and also to construct new forms of knowledge in Environmental Education. Examples are databases, spreadsheets, etc. They do not take the responsibility away from the teacher but promote higher order thinking skills (Jonassen & Carr in Lim & Tay, 2003, p. 430). Learners are given the chance to access, analyse, connect and solve problems with ICT tools.
c) Communicative tools are tools used for teacher-learner or learner-learner interaction outside the classroom. Examples are e-mails and social networks. Such tools can be used to argue meaning in a given context. These provide a wide range of aids to the personal or professional work of teachers. For example, lesson plans and learner handouts are stored as word processor files. They are easily modified and brought up to date. Teachers can also have access to professional development and training through distance learning, as well as communicating with learners.

Appreciation of one's environment is nothing new. Since the early writings of John Muin and Aldo Leopold, amongst others, concern over humankind's impact on the environment has been well discussed. Carson (1962) released a seminal work documenting the effects of pesticides in the environment, which brought a new sense of urgency in how humans interacted with the environment. This was noted by Daniel Einstein as Silent Spring (1995). Silent Spring quickly became a catalyst for an environmental movement. From this movement emerged an awareness of human complicity in environmental decline, as well as the involvement of public values that emphasise the quality of the human experience and the human environment (NEEAC, 1996).

Environmental Education must not merely be to create another professional cadre. It must be able to instil the moral values from early childhood that would engender deep respect for nature and the environment. In other words, the focus of Environmental Education must be to instil in the young strong moral values regarding the environment. Environmental Education tends to develop a world that is mostly concerned about the environment and its problems which embodies knowledge, skills attitudes and motivation, as well as commitment to work. It has set objectives which were stated in the behaviourist approach at a conference in 1977 at Tbilisi in the USSR. They focus on the following:

- The inculcation of awareness of the total environment and its problems**.**
- The gaining of sound knowledge and understanding of how the environment functions.
- The establishment of positive attitudes toward the environment.
- The participation of skills needed to identify, investigate he environmental issues and problems.

The term 'Environmental Education' has been in common use in educational circles for several decades. In 1979, the International Union for Conservation of Nature and Natural Resources (IUCN) and UNESCO held an international working meeting on Environmental Education in the school curriculum at Foresta Institute, Carson City, Nervads, USA. Below is a definition of Environmental Education:

> "Environmental education is the process of recognizing values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate in the inter–relatedness among man, his culture and his biophysical surroundings" (IUNC, 1970).

2.9 Environmental Education Learning Strategies

There are multitudes of learning strategies, but some are more appropriate for environmental learning. A hands-on, experiential approach is preferred where learners are actively involved and focused on environmental problems and challenges (EETAP, 1998; 2001). This is simply because learning about the environment does not automatically lead to action. Learners need to experience the fact that they can make real contributions to their environment through meaningful activities which are respected, and that they can influence the reality in which they live (Centre for Education Research and Innovation, 1991, p. 7). Some of the more appropriate learning strategies in environmental learning, therefore, are active learning, critical thinking and involvement of real issues (authentic learning) (Lotz–Sisitka & Raven, 2001, p. 94), and learning through problem- solving (Evans, 2002, p. 1–6; EPA, 1999, p. 2).

2.9.1 Active learning

Learners should not only learn about the environment but should be active participants in the learning situation in Environmental Education. They must be given the opportunity to be critical and creative, as well as be able to discover things on their own. The purpose of the learning must be to enable learners to develop as individuals and to acquire knowledge, understanding skills, attitudes and values that will help them to understand and face the many challenges in the environment (Morris & Stoney, 1998).

Active learning requires learners to act on information by transforming it into new meaning. (Campell, 1990). In this instance they should be able to use the technological tools to ascribe meaning to what they have learnt.

2.9.2 Critical thinking

Many outcomes for Environmental Education are “Learners should be critically engaged with…” This implies a higher dimension of thought and requires learners to acquire a lot of information on different perspectives associated with an environmental problem, issue or risk if their critical engagement is to be meaningful (Lotz–Sisitka, 2002, p. 118).

According to Wals and Van der Leij (1997, p. 20), environmental learning, as seen from a social-critical paradigm, consists of four dimensions -- its purpose is to enable learners to construct, critique and transform their environment. Wals and Van der Leij (1997) explain this as follows:

> “Construct in the sense of building upon the prior knowledge, experiences, ideas of learners; critique in the sense of investigating underlying values, assumptions, world views, morals, etc., as they are part of the world around the learner and as a part of the learner him/ herself; emancipate in the sense of detecting, exposing and, where possible, alerting power distortions that impede communication and change; and transform in the sense of changing, shaping, influencing the world around them, regardless of scope or scale” (p.23).

2.9.4 Problem solving

Problem- solving and decision- making are critical to ensure meaningful experiences (Evans, 2002, p. 5–6) in Environmental Education. Evans (2002) stated that investigating environmental issues with a focus on specific problems in the local community can be used with great success, as long as learners are provided with a variety of tools they can use to effect change. With correct guidance and support, learners will make a genuine effort to solve problems if they are real and especially if adults are unable to find a solution (Conti, 1999, p. 112).

2.9.5 Authentic learning

Because of nature, learning in Environmental Education should have an applied focus and should be authentic. This implies learning about real environmental threats and problems, and looking for real solutions to these challenges. Where possible, learning should consist of authentic (real-life) activities and should take place in real-world contexts. The environment actually presents educators with a wide range of subject matter and a variety of learning contexts which can make learning interesting and enjoyable (Morris & Stoney, 1997). Authentic learning tasks help learners to understand the interaction of environmental, social and economic processes, and to cope better with the complexity of sustainable development (Gurevitz, 1998).

How then is ICT implement in the curriculum, for teaching, to be effective? Below is a discussion on the implementation of ICT in the curriculum, with regard to some developed and developing countries.

2.10 ICT Implementation on the Curriculum

Some researchers suggest that there is no direct link between the use of ICT and a positive impact on learners' outcomes (Cuban et al., 2001; Newhouse, 2002; Waxman et al., 2003) unless ICT are used effectively (Becta, 2002). ICT has to be used in an effective way otherwise it will be a waste of time (Romeo, 2006). For example, according to Leach and Moon (2000), using computers only for word processing does not indicate good implementation.

According to them:

> "Implementation is not substituting 30 minutes of reading for 30 minutes of computer skills development. It is, however, using computers to teach 30

> minutes of a lesson. Implementation is not providing application soft–wares like spread sheets, without a purpose. It is not pre–packaged programs that are often unrelated activities clustered around a particular topic that addresses a concept. Defining technology implementation is not the first step in deciding how to integrate [it] into the classroom" (p. 73).

Secondly, for effective ICT implementation, educators should start with the identification of educational problems. The use of ICT will support the educational process and a way to strive for better implementation (Newhouse, 2002). Educators should not focus on technology itself, but instead be able to do an analysis of educational problems that need to be rectified (Van Melle et al., 2003). For example, educators should begin asking questions like "What are the educational problems that our learners face?" and "Do our learners need to improve their educational skills?" Then educators carefully choose ICT, paying attention to the advantages as well as the limitations (Collin & Berge, 2000).

ICT implementation is not a product but a process (Yalin, Karadeniz, & Sahin, 2007). The success of ICT implementation in education means implementing ICT effectively and efficiently in all dimensions (Yalin et al., 2007). This includes ensuring that the process requirements are met. Educators, in choosing ICT, should pay attention to well supported and well-defined educational objectives (Collins & Berge, 2000). Collins (2001) suggests that teachers cannot use ICT until they know which ICT is relevant. Furthermore, ICT is less effective when educational set objectives are unclear (Honey, Culp, & Spielvogel, 2005). Honeyet al. (2005) agreed that instead of concentrating on ICT use itself, those who successfully implement ICT show a clear, meaningful connection between technology and educational goals.

Another area of interest worth considering is the teachers as resources in the implementation of ICT in the curriculum and the teachers' empowerment in terms of the knowledge they have acquired and their skills in teaching with ICT. Empowerment is a process whereby school participants develop the competence to take charge of their own growth and resolve their own problems (Greer & Melvin, 1994). The study emphasised teachers' knowledge development in ICT to enhance education. Teachers who feel incompetent in their content areas fail to teach.

2.10.1 ICT Implementation in the developed world

Many authors have researched greatly on the implementation and spread of ICT in education within the developed world (Cecchini & Scott, 2003; Fullan, 1993, 2001; Kozma, 2005, 2008; Pelgrum, 2001). The majority of the research indicated that IT tools can be successful to extend available education opportunities (Kozma, 2008). However, the dream of promoting their effectiveness remains elusive in many cases (Reeves, 2008). This problem has developed in research studies over the past years.

The European e-Learning Forum for Education (ELFE) project was initiated by the European Trade Union Committee on Education (ETUCE), with the aim of understanding strengths and weaknesses of using ICT in primary and secondary schools, studying good practices of pedagogical use of ICT, and identifying lessons that could be learnt in a number of European countries (Fredriksson et al., 2008). It was conducted between January 2004 and December 2005 where investigations were made in different schools with ICT usage, whether ICT was used intensively for instructional purposes and how it influenced the lives of the learners as compared to the traditional way of teaching in the classroom. The study identified two areas where the use of ICT seems to have made a difference.

Finland

Finnish teachers and principals have developed a negative attitude towards ICT use at school, despite the rapid increase of ICT access in all schools (Kankaanranta, 2009). There was great evidence that the use of ICT as a tool for instructional development is not important and the impact of ICT on communication is only moderate. Thus, Finnish schools do not make use of ICT and more so the pedagogical use is not important (Kankaanranta, 2009). The findings pose questions on how to support and motivate schools to become competent members of the Finnish knowledge society.

Lithuania

In Lithuania, members of the school board and the management made decisions about ICT management and its usage at the schools. Teacher training includes technical, social, pedagogical, information related and management competencies.

The standard for teacher training is based on the modules of the European Computer Driving License (ECDL), plus additional modules related to the use of ICT in schools. The ECDL syllabus consist of seven modules which define the skills and competencies necessary to be a proficient user of a computer and computer applications (EDCL Foundation, 2007). By 2007, only 24% educators were ICT literate (Markauskaite, 2009).

2.10.2 ICT implementation in the developing world

The section presents an overview of ICT developments made in the developing world. The developments are focused on the national systems which further stretch toward achieving educational goals in South Africa, Mozambique and Chile. These countries are examples of a developing world based on the fact that Chile is known to be a successful case because the Chilean government's ICT initiative was fully taken over by the Ministry of Education by 2005. South Africa and Mozambique are from the same block of countries aiming to achieve the African Union goals which have been set for ICT. In addition, Trinidad and Tobago in the Caribbean region are also cited as good examples for ICT implementation in rural schools. The developments are normally measured against the time ICT was implemented and its' achievements.

2.10.3 ICT implementation at national level

The core of this research, as stated in the title, is how ICT is being implemented in rural high schools. Little has been written about ICT use in the developing world. Most of the articles that exist focus on ICT provision (Ali, 2009; Cossa & Gronje et al., 2006), and some professional development in the colleges (Lipinge, 2010) have discussed various benefits of implementing ICT in schools.

The national goals of South Africa were summarised by Blignaut and Howie (2009). The government of South Africa implemented Phase 1 of its roll-out plan in 2004-2007. The programme was aimed at providing an education system that would support ICT integration in teaching and learning to acquire confidence in using ICT in the curriculum, to ascertain the availability of ICT, use quality education content, and connect schools to the Internet. The second phase, which was between 2007 and 2010, encourages teachers and managers to integrate ICT into the curriculum. The third phase (2010-2013) expects that all provincial Departments of Education will use

ICT in their planning and communication, and all institutions use the educational part of teaching, given that teachers are capable of using ICT.

In 2007, a baseline survey was conducted to determine the availability of resources for the Department of Basic Education to make decisions in terms of resource allocation. South Africa relies on donor funding for the provision of computer laboratories, moreso than motivating more teachers qualified to integrate ICT into teaching. Curriculum and content development is government's responsibility. In South Africa, universities have not been given any role in professional development in ICT training for teachers. Farrel and Isaacs (2008) reported universities in South Africa are developing their own internal ICT policies. Rather, the researcher agrees with Howie (2010) that a lot can be learnt from the Chilean strategy where universities are given a specific role to train teachers in ICT.

2.10.4 ICT Implementation at school level

This section summarises the case of ICT implementation at school level in developing countries. Examples of ICT use in a number of African countries in order to present the African rural context are South Africa and Mozambique. Cossa and Gronje (2004) conducted a study on "lessons learnt from introducing computer into schools in Mozambique between 1997 and 2001". The aims of the research were to extend the concept of the global phenomenon of using ICT in secondary schools to enhance knowledge and to contribute to the formal use of ICT learning in secondary schools through aspects and the challenges of teachers in ICT implementation. The project was conducted through a case study on the Acacia project, designed to work with rural areas that were extended from ICT networks to which their urban counterparts had access. The project managed to network 13 schools with access to e-mail and the Internet and was later changed into a national programme now run by the Ministry of Education. Both teachers and learners were trained how to use computers for teaching and learning.

Several authors agree on the introduction of ICT into South African schools (Brandt, Terzoli, & Hodgkinson-Williams, 2008; Langmia, 2006; Mentz & Mentz, 2003), all favouring introducing computers into schools to a certain extent, but pointing out the various problems experienced in different parts of rural South Africa. According to Brandt et al. (2008), there are many schools which are still disadvantaged after

apartheid and are still lacking the basic infrastructure such as electricity, telephone lines and libraries where information could be readily available. To overcome these challenges, a number of projects have been initiated: The Ulwazi project was introduced to five schools ,of which four are situated in the township of Mamelodi and one in Lynwood Glen, Pretoria. In Grahamstown, Eastern Cape, a similar project was introduced to one third of the secondary schools beyond the range of DSL, and the poorest schools in the area.

The aim of the project was to develop programmes that educate and train teachers to integrate ICT effectively in their teaching. In addition to these challenges, Brandt et al. (2008) reported on a recent survey undertaken by the Education Policy of the University of Western Cape and the International Development Research Centre, which found that South Africa has low numbers of Internet users in some rural areas, sometimes less than 5%. As a result, it becomes difficult to connect to schools that do have computers. Effective use of the Internet for instructional purposes needs learners to have the necessary skills to find the relevant information.

2.11 THEORETICAL FRAMEWORK

2.11.1 Cognitive theory

An aspect of Vygotsky's theory is the idea that the potential for cognitive development is limited to a "zone of proximal development" (ZPD). This zone is the area of exploration for which the learner is cognitively prepared, but needs help and social interaction to fully develop (Briner, 1999). A teacher or more experienced peer is able to provide the learner with "scaffolding" to support the learner's evolving comprehension knowledge. The implications of Vygotsky theory are that learners should be provided with socially rich environments in which they have to explore knowledge domains with their peers. ICT can be used to support the learning environment by providing tools for discourse, discussions and providing online support systems to scaffold learners' evolving understanding and cognitive growth.

The basic principles underlying cognitive learning theories include thought as an active pursuit, a foundation of experience used to organise new information, a personal perspective regarding new information, and as a social environment to

acquire knowledge. Using cognitive theory, the teacher offers a variety of experiences to approach information, assess understanding and summarise the information. The learners are active in the exploration using social interaction and feedback to stimulate the individual thinking process. Cognitive evaluation theory is a theoretical perspective that sheds light on the interaction between classroom goal structures and the integration of ICT (Deci et al., 1999).

The cognitive theory infuses the integration of ICT into Environmental Education curriculum with meaningful interaction. Teachers will use the multimedia to bring the real world to the classroom through the use of sound and video. Such connection should sense a factor in motivating learners and also experience modes of presentation. Meyers and Wilson (2000) explained that without these tools, the interactions that teachers produce may not assist or motivate the teaching and learning process.. Therefore, technology in this teaching theory is a piece of the learning environment that helps to bring about cognition.

2.12 Cognitive Theory and ICT Integration

ICT in singular does not produce learning, but it can be used to enhance and motivate the learning process. Studies generally describe three major categories of instructional use for computer aided technologies. These are learning from ICTs, learning about ICTs, and learning with ICTs.

2.12.1 Learning from ICTs

Learning from ICTs allows the teacher to use technologies to convey information to learners without their active participation in the lesson. This reflects on the traditional mode of teaching, where there is passive interaction between the user and the technologies. This results in acquiring facts through repeated practice and rote learning or from technology (Ross et al., 2010).

This traditional approach of the traditional mode of teaching underpinned the cognitive theory. People learn from forming knowledge through thinking, and therefore learning is a product of thinking.

2.12.2 Learning with ICTs

Learning with technology improves much of the thinking in the learning process (Jonassen & Reeves, 1996). In view of this, technology becomes an integral part of

the teaching and learning process. Both the teachers and learners make adequate use of technologies to enhance learning.

Learning with ICT tools promotes learning of higher-order thinking skills (Jonassen et al., 2010). This makes it far easier to recollect facts or information. The role of the teacher and technology does not actually lead to thinking, but to tools to support and enhance learning.

2.12.3 Learning about ICTs

Another use of technology is learning about the technology itself (Jonassen & Reeves, 1996). In this context, the computer is studied as a subject where learners learn specific skills such as particular programming, keyboard skills, etc., but these skills are not connected to any other content. Here the computer is not used as a learning tool.

2.13 Summary

Much research has been conducted on the use of ICT in education with the help and benefits of technology, and how it can change education to make contributions globally and to the current digital economy. Educators have always been recognised as elements of change and transformation, and if they are well trained in the aspect of technology and become well-equipped, they will be able to help transform the educational process. Teachers' ICT competence, technology skills and their attitudes to the use of ICT tools depend solely on the type of professional training they acquire.

Literature suggests that when used properly, ICTs enable new ways of teaching and learning, depending on the availability of the resources, rather than simply allowing teachers and learners to mix ICTs with the traditional method of teaching and to improve on what they do in the classroom. These new ways of teaching and learning are underpinned by cognitive theories of learning, which shift the process away from teacher-centred to learner-centred approaches.

The chapter analysed research conducted on the integration of ICTs in education, its benefits, and the challenges that limits its implementation. The problems are mostly with educators and infrastructure. It is clear from research that the use of ICT in education is a concurrent issue and must be attempted within a coexisting context.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

Research methodology has been described as a systematic and objective process of gathering, recording and analysing data for the purpose of resolving problems (Bless & Higson, 1995; Babbie et al., 2001). Similarly, Bailey (1982, p. 4) defines research as a systematic and organised effort to investigate a specific problem that requires a solution. In quite a number of definitions of research, there is an assumption that the researcher has to find out or make an original contribution to a phenomenon.

This chapter describes the research methodology applied in the study, including the data collection methods, the instruments, the research population, and the method of sampling used. The research paradigm adopted in the study is discussed. The methodology seeks to outline and explains the relationship between the research problem and the data collecting instrument and the analysis of the research. According to Cohen, Marion, and Morrison (2000), the aim of the methodology is to help researchers to understand the processes and the outcome of the study. This is done through diverse ways of collecting data. The chapter concludes by addressing the ethical issues that were considered in the study.

3.1 Research approach

As briefly described in Chapter One, the research strategy for this study was a quantitative survey. Slavin (2007) referred to quantitative research as research whereby numeric data is collected and statistically analysed.

According to Tashakkori and Teddlie (2003), research methods refer to ways, techniques or tools for acquiring thoughtful, accurate as well as correct data about a study and ways, technique or strategies to be used to manipulate the data. Cohen et al. (2000) also agreed with Tashakkori and Teddlie but opined further that methods are to be used as a basis for inferring and interpreting. In addition to this, Creswell (2003) said a researcher using the quantitative method uses a post positivist approach to develop knowledge. The study therefore follows a quantitative method as well as a survey and correlation research design using a positivist paradigm. It

answers the “how many” questions and provides results that can be projected onto a broader population.

A quantitative method approach is used in the study, focusing on the relationship between the use of ICT tools and how effectively they are used in teaching Environmental Education. According to Aliga and Gunderson (2000), quantitative research explains phenomena by collecting numerical data that are analysed using mathematically based methods in particular statistics. The specificity of quantitative methodology lies in the fact that numerical data is collected and analysed using mathematical methods.

Quantitative methodology tends to control for bias so that facts are understood in an objective way, looking to first-hand experience to provide meaningful data (Laws & McLeod, 2004, p. 2). It is a type of educational research that relies on the collection of data subjected to quantitative analysis. It is generally a means for testing objective theories by examining the relationship among variables (Creswell, 2009; Johnson & Christensen, 2004). The researcher in quantitative research often decides what to study, asks specific, narrow questions, collects quantifiable data from participants, and analyses these numbers using statistics – like finding the cumulative frequency, the mean, median and mode (Creswell, 2008, p. 46).

Babbie (2010) stated that the quantitative research approach provides objectives and results that are unbiased and have not been influenced by the researcher. Furthermore. the quantitative research approach is based on its original plans and the results are analysed and interpreted. Below is a summary of the characteristics of this approach (Burns, 2000, p. 6–7):

- There is reality that can be defined by careful measurement which is usually concise;
- •The sample should be representative of a large population;
- •It describes, examines relationships and determines causality among variables;

- Statistical analysis is conducted to reduce and organise data, determine significant relationships, and identify differences or similarities within different categories of data; and,
- •It provides an accurate account of characteristics of particular individuals or groups.

According to Burns (2000, p. 6-7), the strength of quantitative research approach lies in the following:

- •Precision through reliable measurement;
- •Control through sampling and design; and
- Ability to produce causality statements, through the use of controlled experiments and statistical techniques.

However, its limitations include the following (Burns, 2000, p. 6–7):

- It is difficult to rule out or control all variables because of the complexity of human experience;
- •Its mechanism and ethos tend to exclude notions of freedom, choice and moral responsibility; it fails to acknowledge people's experiences and the construction of their own meanings; and,
- It leads to assumptions that facts are true and the same for all people at all times, and it often produces banal findings of little consequence.

3.1.1 Research paradigm

In a positivist paradigm the assumptions are based on the social world which can be studied in the same way as the natural world. Reichardt and Rallis (1994) wrote that this type of positivist position was discredited before World War II and was replaced by post-positivism. In early positivist thinking, the researcher and the subject of the study were assumed to be independent (Lincoln & Guba, 2000). The positivist paradigm, stemming from the enlightenment views of Comte and Spencer (Turner, 2003), developed in the 19th century in the wake of the apparent success of natural or physical sciences in advancing our understanding of the world (Benton & Craib, 2001).

The positivist belief is that the approach of natural sciences could be applied in the social world. It assumes that the social world exists in the same way as the natural world (Yates, 2004; Evans & King, 2006). Individual behaviour is influenced by various pressures such as the norms and values held by the social groups to which they belong. Positivists believe that the structures that create the apparent order in social life can be discovered and investigated in the same objective way as the natural world. Structures can create the apparent order in social life which can be discovered by research. The approach is empirical in that it shows something exists through observations, namely data. Some educational research uses this method; however, for much social research it is not possible to create experimental control groups and alter variables in a controlled way.

Positivists believe that reality should be stable and observed from an objective point of view. Yin (2003) stated that the phenomenon should be isolated and there should be a repetition of it. Reality is often manipulated (knowledge) with variations in the selected variable (technology) in order to find out relationships between teaching and learning. Table 3.1 below is a comprehensive display of the tenets of positivism according to Yin (2003).

Table 3.1: Tenets of Positivism (Yin, 2003)

Tenet	Meaning
Naturalism	The principle of the natural sciences should be used for social sciences.
Phenomenalism	Only observable phenomena provide valid information.
Nominalism	Words of scientific value have fixed and single meaning.
Facts and values	Facts are to be sought. Values have no meaning for science.

In order to show relationships between variables, researchers frequently use the comparative method. This is where groups are compared and differences are noted (McNeill & Chapman, 2005). The purpose is to identify the significant variables which can explain the differences between them. The main aim ultimately is to show the cause and effect of relationships. This strategy is felt to be more reliable than the greater numbers that are used in the comparison. In a positivist paradigm, size does not matter. Also important is the sample's representativeness of the whole population. The findings take on greater significance when data is larger and can be categorised and compared in a number of ways. The most effective positivist research will be able to be replicated by others as experiments or at least compared closely with other similar subjects. For these reasons the paradigm prefers structured methods of data collection which can be carried out on a large scale. The data favoured a quantitative approach, usually presented in statistical tables, enabling others to see how the data have been interpreted and allowing for more accurate comparisons. The aim is to be able to generate from findings.

3.2 Research Design

A research design is the conceptual structure within which research could be conducted. It deals with logical problems through logical plans for getting from the initial set of questions to be answered to the set of conclusion about questions.

3.2.1Survey and correlation study

A survey is well suited to descriptive studies (Muijs, 2004; Mare, 2010) and it allows the researcher to look at relationships between variables which occur in real-life contexts. McMillan and Schumacher (2001, p. 602) defined a survey as an assessment of the present status, beliefs and attitudes by questionnaires or interviews to a known population. Similarly, Slavin (2007) explained that the objective of a survey is to record the opinions of a population of interest. It is a survey study because it gathers data at a particular point in time with the intention of describing the nature of the existing conditions, or identifying standards against which existing conditions can be compared (Johnson, 1994). The study could undergo theory-based evaluation because the evaluator constructs a model of how

the programme works using the stakeholders' theory. Chen and Rossi (1992) view theory–based evaluation as a way to mitigate problems encountered.

Creswell (2009) defined correlation research design as a design in which the researcher is interested in the extent to which two or more variables co-vary, where changes in one variable are reflected in the changes of the other. The two variables are measured without manipulation to determine whether there exists a relationship. A quantitative correlation design was an effective method for this study as it offered non-obstructive approach, and resulted in identifying the relationships between the study variables (Finlay, 1999; Creswell, 2009). In this study, the two main variables that are being compared are ICT and Environmental Education. The use of correlation design provided information that addressed the research questions and objectives of the study.

As the study is investigating the impact of ICT in teaching Environmental Education in rural high schools in the East London district of South Africa, with this kind of evaluation more informed decisions can be taken, which will make a great contribution to the use of ICT in teaching in rural high schools.

A survey is flexible because it allows the researcher to study a wide range of research questions which include aspects such as describing a situation (Muijs, 2004). It also allows the researcher to study real-life situations and therefore generalisations are made easier. Large quantities of data can also be collected at a low cost when you compare to other research designs. It is extremely easy to guarantee the participants anonymity, especially when anonymous questionnaires are used as research instruments.

During the design phase, the researcher should begin to articulate the purpose(s) of the survey, state specific objectives, consider the types of information needed, and evaluate design options. Surveys can be used for a wide variety of purposes such as:

- Many surveys have been conducted to examine the relationship of participation in a variety of educational placements for a variety of populations.

- Salisbury and McGregor (2002) used a survey to examine the administrative climate in elementary schools with a policy of inclusion for children with disability.

In a survey research design, the researcher has a choice between simple descriptive, cross–sectional, and longitudinal approaches. The researcher will therefore employ descriptive survey design which is cross–sectional in nature. A descriptive survey is deemed more appropriate for the study because it basically deals with obtaining data to determine specific characteristics of a group (Fraenkel & Wallen, 2000). This study seeks to obtain information about the status of implementation of ICT into the curriculum of Environmental Education in terms of teachers' attitudes, acquired content knowledge of ICT, as well as the availability of ICT resources.

3.3 The Setting

The study took place in the Eastern Cape Province of South Africa. The Province hosts many disadvantaged rural schools which are under resourced and lack ICT resources. The Department of Basic Education, through the initiative of the Policies of the White Paper, has introduced ICTs in schools for teachers to facilitate effective teaching and learning. The onus, therefore, lies on educators to integrate technology into teaching and learning processes so that it supports learners' ICT use to meet their information needs.

3.3.1 Population

Seaberg (1988, p. 240) defined population as the total set from which the individuals or units of the study are chosen. According to Polit and Hungler (1999, p. 37), population refers to an aggregate or totality of all the objects, subjects or members that conform to a set of specifications. A study population is the totality of persons, events, organisations, units or other sampling units which concern the research problem (Mohlokoane, 2004, p. 8). In addition to this, Monyatsi (2002, p.176) defined it as a population in research which is a discrete group of units of analysis such as organisations or schools. This is why most schools are chosen as samples for the study instead of educational institutions. From these perspectives, the target population in this study refers to the 60 male and female educators who offer Environmental Education in some selected rural high schools in the East London

district of the Eastern Cape Province. A research population is the total target group who would be subjects of the study and about whom the researcher is trying to say something (Punch, 2009).

Therefore the population for this study consists of all teachers in rural high schools within the East London district, Eastern Cape,.

3.3.2 Sample and sampling techniques

According to Vockell and Asher (1995, p. 170), sampling refers to strategies that enable the researcher to pick a subgroup as a basis for making inferences about the larger group. Reasons for sampling are numerous, some of which are convenient to work with, and working with a subgroup to generate data is also easy to work with. A sample is a subset of the larger population selected by random probability methods.

Chikuya (2007, p. 91) also defined a sample as a unit that provides a practical, efficient means to collect data since it serves as a model of the population of the study. Sampling can be classified into probability and non-probability sampling (Panneerselvam, 2008, p. 192). He further stated that in a quantitative study, the main sampling strategy is the probability which depends on the selection of a random sample. This research used simple random sampling, which is discussed briefly. Sampling in quantitative research is the actual group of people in the study from whom data is collected. The study therefore focuses on simple random sampling and a total of 60 educators, both male and female, were selected at random for this study.

3.3.2.Simple random sampling

Saunders et al. (2007, p. 206) stated that probability sampling is normally connected with surveys. Mugenda and Mugenda (2003, p. 50) discussed that simple random sampling is where the subjects in the population are given random numbers, then they are made to sect by random. Generalisations about the population from the data collected are based on statistical probability (Saunders et al., 2007, p. 210; Panneerselvam, 2008, p. 192). In the current study, the probability samples are those that had been selected from the target population. 60 educators, both male and female, were selected to participate in the survey.

3.4 Data Collection Methods

3.4.1 Research instruments

This is a summary of the description of the instruments used for data collection. Gay and Airasian (2000, p. 9) explained that the choice of research instruments depends on the nature of the research questions. The instrument used in this study is the questionnaire. Questionnaires allow each of the respondents to read and answer identical questions which ensure consistency in the responses (Saunders et al., 2007, p. 357). Furthermore, questionnaires generate standardised data, which makes processing of responses easier.

Questionnaires were delivered personally to the teachers of Environmental Education. This method was chosen to avoid a low response rate. Additionally, the involvement of teachers in the study was voluntary. Randomisation was employed to ensure that each school had an equal chance of being selected.

3.4.1.1 Questionnaire

A structured questionnaire with Modified Likert responses was used. These range from Strongly Agreed (SA), with the highest numerical value of 4, to Strongly Disagree (SD), with the lowest numerical value of 1 as below:

SA = 4

A = 3

D = 2

SD = 1

Questionnaires are the most convenient and inexpensive way of gathering information from people and can cover a large geographic area. Quantitative questionnaires are the best way to gather numerical data and can be confirmed by hypotheses about occurrences. A questionnaire is a form of data collection in which all the respondents are asked the same set of questions in a pre-set order (de Vaus, 2002).

The questionnaires for this study were based on Christensen and Knezek's (2001) instruments for assessing the impact of technology in education, but were

contextualised for some rural high schools in the East London district of the Eastern Cape Province.

The questionnaire was arranged in the following format:

A – Availability of Resources

The questions focused on the availability of educational technology in some selected rural high schools. Availability here does not imply abundant usage, but lack of them will contribute to the effective usage of ICT tools.

B – Effective use of ICT in rural high schools to improve teaching EE

The questions focused on how the use of ICT tools made teaching effective, and whether it enhanced learners' participation and if educators were able to get tangible feedback from them.

C – The usage of educational technology in the classroom

The questions are based on the extent to which educators are making effective use of technology resources in their classrooms and for what purposes. They also asked how ICT tools are used so that their importance could be realised.

D – Educators' attitudes about the use of technological resources

These questions were based on educators' understanding of preconceived ideas about educational technology.

E – The efficient usage of ICT tools

The questions are based on the strategies that exist to enable teachers to learn how to use ICT tools and whether the necessary professional help is offered. The questions also focus on technological competence displayed by teachers, as indicated by Zhao and Frank (2003), in using ICT tools in their content subject – in this case Environmental Education.

3.5 Data Analysis

Data analysis is the process of developing understanding and making sense and meaning from the data collected in the study (Merriam, 2009). In the analysis process, data is made manageable by categorising them, interpreting it, determining

important information, and identifying recurring patterns that emerge (Marshall & Rossman, 1999). Before the questionnaire was distributed, the respondents were briefed on the nature of the study, expectations from them, and the responsibility of the researcher.

In quantitative study, data can be analysed using computer software packages. These computer software packages analyse numeric data which are pre-coded by the researcher. The data was analysed using a statistical computer aided software programme. Descriptive and inferential statistics were used. Descriptive statistics summarises raw data in order for it to be visualised and enables the study to present the data in a more meaningful way, which allows simpler interpretation of data. The researcher found the central tendency of a variable, meaning the average score of a participant on a given study measure. These are ways of describing the central position of a frequency distribution for a group of data by using the mode, median and mean. Analysis of data wwas also represented in tables because it is easy to identify outliers. Cross tabulation may also be used to compare the relationships between nominal variables such as computer skills and teaching.

To address this generalisation, a Chi-square test was used to measure the effect between variables that are studied in the population. Chi–square refers to a statistics method used to compare frequencies of two or more groups. Maree (2007, p. 246–248) explained that Chi-square belongs to the type of non-parametric testing and therefore is suitable in a study where the relationship between two variables is investigated. In this study, Chi-square is used to examine the relationship between the impacts of ICT in teaching environmental education.

3.5.1 Reliability

Any good researcher uses an instrument which is valid. Maree (2007) explained that reliability may be assured by a researcher by using the same instruments at different times. The questionnaire for this study was administered as a once- off cross-sectional study influenced by factors such as cost, distance and time. Given the limited scope of the survey, cost and time are not practical to apply in this study.

To ensure reliability of the questionnaire, it had to be pilot tested. Pilot testing is a “trial run of the study done for the purpose of testing the instrument and coming up with issues that have to be addressed before the actual study is conducted” (Slavin,

2007, p.107). Cronbach alpha was used to measure the reliability and internal constituencies. It is commonly used when multiple Likert questions appear in a survey.

The alpha option provides an effective tool for measuring Cronbach's alpha which is a numerical coefficient of reliability. Computation of alpha is based on the reliability of a test relative with the same number of items, and measuring the same construct of interest (Hatcher, 1994).

3.5.2 Validity

De Vos et al. (2002) and Maree (2007) proposed that an instrument can only be valid if it measures what it is supposed to measure. For this study, validity has been motivated by availing the instruments to an expert and supervisor opinion: Their comments and advice helped the researcher to shape the items in the questionnaire to collect data that increased its relevance, reliability and validity to answer the research questions for this study.

3.6 Ethical Considerations

This section discussed the handling of ethical issues during and after the research. There are many reasons why it is important to adhere to some norms in research. These include promoting the objectives of the study, such as knowledge and truth, and social values, such as mutual respect and human rights (Shamoo & Resnik, 2009). Ethics are considered to be dealing with beliefs about what is right and what is wrong (McMillan & Schumacher, 2009).

The involvement of human subjects in research requires that ethical issues are observed. On observing ethics, Slavin (2007) proposed that it is important for the researcher to avoid public concern over potential abuses of participants and data by the researcher. This study and ethical considerations helped the researcher to be honest throughout the process and trust the educators. The researcher's understanding of ethical considerations is that it protects both the researcher and the participants.

In this study, educators were informed about their voluntary participation and their right to withdraw from the study at any time without any penalty. Teachers were asked not to write their names, initials or apply any signature which may lead to

personal identity. Teachers were informed that the findings would be presented anonymously without making their identities known. The participants were fully informed about the procedures and risks involved in the study.

Information as received from participants was treated with absolute confidentiality and will be kept as such at all times (Denzin & Lincoln, 2000; Shamoo & Resnik, 2009). Participants were assured that the responses they provided were to be stored securely for a specific number of years, after which electronic records would be deleted.

The research was applicable in public schools and as such, it was necessary to obtain the approval of the Department of Basic Education. The study also adhered to the prescripts of the University of Fort Hare ethical clearance policy.

3.7 Summary

In this chapter, quantitative research adopting a non-experimental study as a research design was discussed. The research design was discussed. The research design was a survey, which is suitable when a researcher explores phenomena in a more natural environment. Research design is influenced by the research questions that need to be answered.

In the process of developing an instrument for the data collection, the issues of reliability and validity are very important. Ethical issues such as informed consent, voluntary participation, right to withdraw, anonymity, and the right to refrain from answering any question(s) were accounted for, while permission to carry out the research was obtained from relevant authorities and institutions.

The next chapter is a representation and comprehensive analysis of data from the questionnaires.

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

4.0 Introduction

The previous chapter reported on the methodology of the study, the paradigm that shaped the research, the population and sampling procedures, as well as the selection of a sample. The chapter also included a discussion of the approach of the research as well as a discussion and justification of the quantitative methodology as a choice for data collection. This chapter discusses and analyses the data by means of the questionnaire. The questionnaire was structured in sections namely: knowledge, attitudes and effective use of ICT resources provided by the school, and the integration of ICT in the teaching for understanding, skill building and quality teaching and learning of Environmental Education. The data was obtained through the responses from the questionnaire.

The use of computers in the rural high schools uner study is not different from any other developing countries. Earlier researches of computer usage in developing countries have revealed that these countries have more challenges in their ICT integration than the developed countries (Herselman, 2003; Cox, Webb, Abbot, Blakely, & Rhode, 2003).

The analysis was conducted through looking at educators' effective use of ICT in rural high schools to improve teaching Environmental Education, the availability of ICT resources, teachers' attitudes towards the use of ICT resources, and how efficiently educators make use of ICT tools. Tables, figures and description of data through t- tests were used to present the findings. Occasionally inferential statistics was used. The chapter begins with a brief presentation of the characteristics of the educators who participated in the study.

4.1 Background Information of Educators/ Teachers

Three different rural high schools were visited around the East London district . A total of 52 educators participated in the study. Thus, 86.76% participation of educators was obtained. All educators were Black, but not from the same ethnic

group. Participants' approach towards the integration of ICT was determined by their socio-demographic characteristics. The data revealed that most of the educators were born before ICT resources were introduced to enhance the education process. Therefore, they found it problematic to depart from the traditional method of teaching. Most of the educators that participated in the study do not have computers at home; they depend on the computers that the schools have. The data also revealed that educators' academic status gives a good reflection of how these factors impact on their attitude to using ICT in teaching.

A total of 52 participants returned the questionnaire distributed to the 60 targeted participants as stated in Chapter Three. These comprise of educators both male and female who offer subjects which have a component of Environmental Education in their curriculum. The respondents acknowledged the role the "blackboard" plays towards teaching and learning; however, the design of its services does not actively motivate learners in the acquisition of knowledge that reflects their comprehension of the content of Environmental Education.

The following research questions were used to collect the data:

i. How can ICT be used effectively in the selected rural high schools to improve the teaching of EE?
ii. What ICT facilities are available for teaching EE?
iii. What are the attitudes of teachers towards the use of ICT tools in teaching EE?
iv. Do teachers use ICT tools efficienly in teaching EE?

4.1.1 Response rate educators/ teachers

The response rate for the survey was 86.67%. This figure was arrived at by comparing the number of respondents who provided feedback during the survey. In order to continue with the analysis and interpretation of data, the response rate should be above 50% (Babbie & Mouton, 2010). This is done in order to ensure validity and reliability of the data. If the response rate is below 50%, the results will not be trusted to give a true reflection of the outcomes of the subject being investigated. For the purpose of this study, the response rate was satisfactory to

allow data analysis and interpretation to make conclusions. Table 4.1 presents the response rate.

Table 4.1: Response rate of educators/ teachers

No. of questionnaires sent out	No. of questionnaires returned	Response rate (%)
60	52	86.67 %
Response Rate		**86.67 %**

Table 4.1 above presents the response rate as 86.67%. The response rate was calculated as the total of questionnaires completed and returned as a percentage of the total number of the questionnaires issued.

4.1.2 The normality of the data

Coakes (2005, p. 35) asserted that every research should ensure that the data is normally distributed before conducting a statistical analysis. Furthermore, Coakes (2005, p.35) suggested that the Shapiro-Wilk test be done to define the normality of the data for a sample size less than 100 respondents. On the other hand, Coakes (2005, p.35) argued that the Kolmogorov-Smirnov test (KMO) test is applicable for sample size greater than 100 respondents. For the purpose of this research, the sample size was 60. As a result, the Shapiro-Wilk test was used to test normality of data. “The normality of data is assumed when the significance level is greater than 0.05” (Coakes, 2005, p. 35). The significance of the Shapiro-Wilk test for this data was greater than 0.05, suggesting that the data assumed normality.

4.1.3 Demographic profiles of respondents

Part A of the questionnaire was meant to establish the distribution of demographic information in terms of gender, level of education, and work experience. The purpose of this section was to establish variations in respondents’ perceptions of ICT variables against the three demographic variables.

4.1.4 The gender of respondents

Table 4.2 provide a distribution of respondents by gender. The purpose of the question was to establish the proportion of each gender group that participated in the

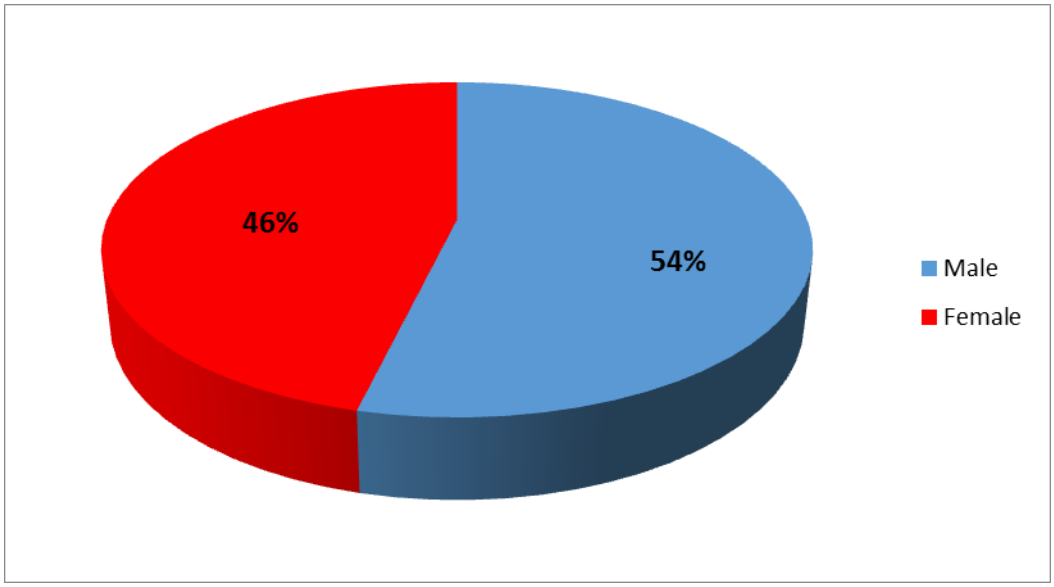
survey, and to determine whether the variable gender have an influence on the respondents' perception of ICT.

Table 4.2: Gender of the teacher/ educator

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	28	53.8	53.8	53.8
	Female	24	46.2	46.2	100.0
	Total	52	100.0	100.0	

Figure 4.1 below presents a visual display of the distribution of respondents by gender.

Figure 4.1: Gender of the teacher



The respondents profile suggests that gender was almost evenly distributed with 54% males dominating the respondents' profile and 46% female respondents of the group.

4.1.5 Qualification of the teacher

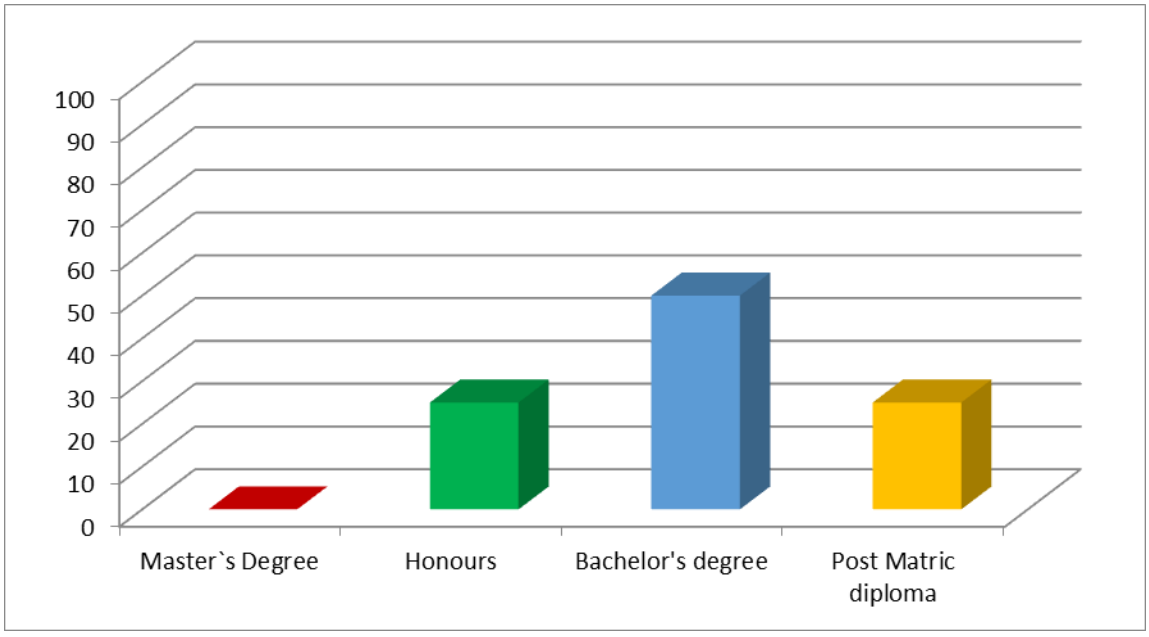
This section sought to establish whether the level of education of the teacher has a significant impact on their views about ICT. As a result the question will assist the researcher to make judgement on the variation of respondents in terms of the patterns of their responses against their levels of education. Table 4.3 presents the classification of respondents in terms of the level of education.

Table 4.3: Qualification of the teacher

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Honours	13	25.0	25.0	25.0
	Bachelor's degree	26	50.0	50.0	75.0
	Post Matric diploma	13	25.0	25.0	100.0
	Total	52	100.0	100.0	

The distribution reveals that majority of respondents have a bachelor's degree as their highest qualification (50%). None of the respondents went as far as master's degree level. 25% of respondents went as far as honours and the remaining 25% hold a post-matric diploma. Figure 4.2 below presents a visual distribution of respondents by their level of education.

Figure 4.2: Qualification of the teacher



The background information regarding the respondents' level of education was meant to establish whether the respondents have the potential to understand ICT as a concept. Furthermore, it sought to establish their propensity to understand the importance of integrating ICT in Environmental Education.

4.1.6 Work experience of the teacher

Work experience determines the level at which an individual understands the field of teaching. The purpose of this question was to establish the variation of teachers' responses against the time they spent in the teaching field. The level of experience also influences the teacher's propensity to adopt new technologies or resist the adoption of new technologies. Table 4.4 below shows the distribution of respondents by work experience.

Table 4.4: Work experience of the teacher

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	6 months to 2 years	3	5.8	6.0	6.0
	2 years to 5 years	9	17.3	18.0	24.0
	5 years to 10 years	14	26.9	28.0	52.0
	more than 10 years	24	46.2	48.0	100.0
	Total	50	96.2	100.0	
Missing	99	2	3.8		
Total		52	100.0		

Figure 4.3 below presents a visual distribution of respondents in terms of the level of teaching experience.

Figure 4.3: Work experience of the teacher

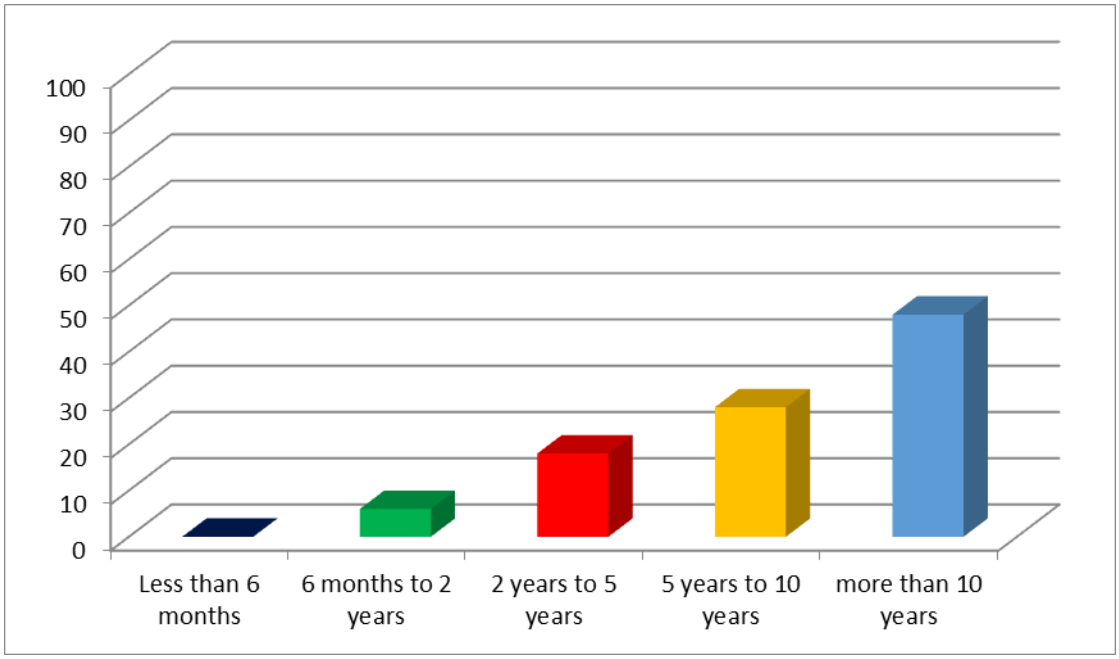


Table 4.4 above reveals that majority of respondents (48%) have more than ten years' experience in the teaching field. Only 1% of respondents are new to the teaching field. About 46% of respondents have two to five years teaching experience.

4.2 Descriptive Statistics on the Adoption and Integration of ICT in Teaching Environmental Education in Rural High Schools

Table 4.5 presents the output from the analysis of descriptive statistics for all the factors that determine the adoption and integration of ICT tools in teaching Environmental Education in rural schools. The mean and the standard deviation are the major determinants of the importance of these factors. The "max" indicates the highest scale and "min" represents the lowest scale selected with regard to that particular factor. The ranking of the factors that influence the adoption of ICT in teaching EE are presented in Table 4.5 below in order of importance.

Table 4.5: Descriptive statistics

	N	Min	Max	Mean	Std. Dev
ICT can improve the teaching of EE	52	3	4	3.94	.235
ICT offers opportunities to educators to obtain resources for EE improvement	52	3	4	3.92	.269
ICT plays a transformative role in teaching EE	52	3	4	3.92	.269
ICT enhances students' participation & feedback to educators	52	3	4	3.88	.323
It is very important to work with ICT tools to teach EE	51	2	4	3.67	.622
Lack of autonomy to evaluate and use ICT in teaching EE	51	1	4	3.10	1.005
Teachers enthusiastically engage in ICT projects in teaching EE	51	1	4	2.78	.879
Readiness and confidence in using ICT tools in teaching	51	1	4	2.73	.918
Strategist exist to help teachers learn how to use ICT in teaching EE	52	1	4	2.62	1.013
Teachers are provided with training & professional development regarding using ICT	52	1	4	2.42	.723
My school has been equipped with computers & connected to the Internet	52	1	4	2.31	.875
My school has been able to acquire suitable software and hardware	52	1	4	2.23	.783
ICT tools are properly equipped in practice and study rooms to teach EE	52	1	4	2.00	.767
Adequate preparation for the effective usage of ICT tools in teaching EE	52	1	4	1.98	.852
Majority of educators have ICT equipment for use in their classrooms	52	1	4	1.85	.638
My school has proper procedure for communicating to students online	52	1	4	1.38	.661
Valid N (listwise)	51				

The most important factor, "ICT can improve the teaching of EE", has the highest mean score (3.94) and the lowest standard deviation (0.235). The least important factor, "My school has proper procedures for communicating to students online", has the lowest mean score (1.38) and significantly higher standard deviation (0.661).

4.2.1 T-Test

An “independent sample t-test” was run to establish if there were differences in perception of males and females with regard to the influence of ICT in improving teaching of Environmental Education. The data revealed that there were no outliers as the engagement of scores for individual levels of gender were normally distributed. This is shown by the Shapiro-Wilk test ($p>.05$). The Shapiro-Wilk test was done to define the “normality of the data” (all variables are equally represented) for a sample size less than 100 respondents. “The normality of data is assumed when the significance level is greater than 0.05” (Coakes, 2005, p.35).

Research Question 1: How can ICT be used effectively in the selected rural high schools to improve the teaching of EE?

4.2.1.1 T-test on effective use of ICT to improve the teaching EE

Table 4.6 below contains the group statistics showing the means and standard deviations and the difference between male and female respondents’ perception of the importance of the use of ICT in improving teaching Environmental Education.

Table 4.6: Group Statistics on how ICT improves teaching EE

	Gender of the teacher	N	Mean	Std. Deviation	Std. Error Mean
ICT can improve the teaching of EE	Male	28	3.96	.189	.036
	Female	24	3.92	.282	.058
ICT plays a transformative role in teaching EE	Male	28	3.96	.189	.036
	Female	24	3.88	.338	.069
ICT enhances students' participation & feedback to educators	Male	28	3.93	.262	.050
	Female	24	3.83	.381	.078
ICT offers opportunities to educators to obtain resources for EE improvement	Male	28	3.93	.262	.050
	Female	24	3.92	.282	.058

Table 4.6 above indicates that the use of ICT was more common to male respondents as indicated by the high mean scores and low standard deviations (m=3.96, SD=0.189) against females (m=3.92, SD=0.282). Although female respondents recorded lower mean score than male respondents, their mean score is above average, revealing that the respondents agree about the effective use of ICT to improve teaching EE. Table 4.7 below shows the independent sample t-test statistics on whether ICT improves teaching EE. The purpose of the t-test is to determine whether the differences will affect the effective use of ICT to improve teaching EE.

Table 4.7: T-test Independent Samples Test on how ICT improves teaching EE

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference
ICT can improve the teaching of EE	Equal variances assumed	2.161	.148	.724	50	.473	.048
	Equal variances not assumed			.702	39.141	.487	.048
ICT plays a transformative role in teaching EE	Equal variances assumed	6.288	.015	1.198	50	.237	.089
	Equal variances not assumed			1.150	34.857	.258	.089
ICT enhances students' participation & feedback to educators	Equal variances assumed	4.782	.033	1.063	50	.293	.095
	Equal variances not assumed			1.033	39.895	.308	.095
ICT offers opportunities to educators to obtain resources for EE improvement	Equal variances assumed	.099	.754	.158	50	.875	.012
	Equal variances not assumed			.157	47.480	.876	.012

Homogeneity of variances was not assumed as revealed by Leven`s test for equality of variances (p=.015) for ICT enhances students' participation and feedback to educators and (p=.033) for ICT plays a transformative role in teaching EE. Therefore, a two-tailed significance test was used. Although there were differences in the mean score of males and females regarding their perceptions of the importance of the use of ICT in improving teaching EE, the difference is not statistically significant because the value "Sig. (2-tailed)" is greater than 0.05. Table 4.7 revealed that "Sig. (2-tailed)" = 0.473 - 0.875 respectively.

The results of this analysis revealed that there is no statistically significant difference in the perceptions between male and female respondents regarding their view of whether effective use of ICT improves teaching EE. Therefore, effective use of ICT improves teaching EE. The results are consistent to conclusions by Chowdhury (2009) and Owusu-Ansah (2013). Their studies revealed that use of ICT improves education and male and females have the same view of the importance of ICT on education.

Research Question 2: What ICT facilities are available for teaching EE?

4.2.1.2 T-test on availability of ICT facilities for teaching EE

This question was meant to establish whether the perceptions of the teachers regarding the use of ICT are influenced by the availability of ICT facilities at their respective workplaces. The group statistics in Table 4.8 below shows the means and standard deviations and the difference between male and female respondents' confessions about the availability of ICT resources in teaching Environmental Education.

Table 4.8: T-test: Group Statistics availability of ICT resources

	Gender of the teacher	N	Mean	Std. Deviation	Std. Error Mean
My school has been able to acquire suitable software and hardware	Male	28	2.32	.819	.155
	Female	24	2.13	.741	.151
My school has been equipped with computers &connected to the Internet	Male	28	2.61	.786	.149
	Female	24	1.96	.859	.175
ICT tools are properly equipped in practice and study rooms to teach EE	Male	28	1.75	.518	.098
	Female	24	2.29	.908	.185
My school has proper procedure for communicating to students online	Male	28	1.25	.441	.083
	Female	24	1.54	.833	.170

Table 4.8 above indicates that the majority of men acknowledge that their schools acquire suitable software and hardware and advance the connection to the Internet to enhance teaching of EE. This is shown by a higher mean score and lower standard deviations as compared to females. On the other hand, female respondents acknowledge that ICT tools are properly equipped in practice and study rooms and there are proper procedures to communicate with students online. This is revealed by the higher mean scores respectively. Table 4.9 below is the independent sample t-test statistics on whether there is a difference between male and female respondents with regard to their position about the availability of ICT resources and tools for teaching EE.

Table 4.9: T-test: Independent Samples Test availability of ICT resources

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
My school has been able to acquire suitable software and hardware	Equal variances assumed	2.021	.161	.901	50	.372
	Equal variances not assumed			.908	49.837	.368
My school has been equipped with computers & connected to the Internet	Equal variances assumed	.341	.562	2.844	50	.006
	Equal variances not assumed			2.824	47.172	.007
ICT tools are properly equipped in practice and study rooms to teach EE	Equal variances assumed	6.519	.014	-2.690	50	.010
	Equal variances not assumed			-2.584	35.294	.014
My school has proper procedure for communicating to students online	Equal variances assumed	9.407	.003	-1.610	50	.114
	Equal variances not assumed			-1.540	33.719	.133

Homogeneity of variances was not assumed as revealed by Leven`s test for equality of variances (p=.014) for the variable “ICT tools are properly equipped in practice and study rooms to teach EE”, and (p=.003) for “My school has proper procedure for communicating to students online”. In addition, a two-tailed significance test was used. The analysis of the two-tailed test also revealed that there were differences in the mean score of males and females regarding their position on the availability of ICT resources in teaching EE; the difference is statistically significant at "Sig. (2-tailed)" is less than 0.05. That is "Sig. (2-tailed)" = 0.006 for “ICT tools are properly equipped in practice and study rooms to teach EE” and "Sig. (2-tailed)" = 0.010 for the variable “My school has been equipped with computers & connected to the Internet”.

Although both males and females acknowledge the availability of ICT resources for teaching EE, the results of this analysis reveal that there is a significant difference in the perceptions between male and female respondents regarding their position about the availability of ICT resources for teaching EE. This conclusion is consistent with studies by Tella (2011) which concluded that availability of resources varies from school to school, departments and areas of education.

Research Question 3: What are the attitudes of teachers towards the use of ICT tools in teaching EE?

4.2.1.3 T-test on attitudes of teachers towards use of ICT tools for teaching EE

This question was meant to establish the level of preparedness of teachers regarding the use of ICT tools and to identify if there is a difference in the attitude of male and female teachers in the use of ICT tools. The group statistics in Table 4.10 below shows the means and standard deviations and the difference between male and female respondents’ attitudes towards the use of ICT tools to teach EE.

Table 4.10: T-test: Group Statistics attitudes towards use of ICT tools

	Gender of the teacher	N	Mean	Std. Deviation	Std. Error Mean
Readiness and confidence in using ICT tools in teaching	Male	28	2.89	.629	.119
	Female	23	2.52	1.163	.242
Teachers enthusiastically engage in ICT projects in teaching EE	Male	28	3.07	.604	.114
	Female	23	2.43	1.037	.216
Lack of autonomy to evaluate and use ICT in teaching EE	Male	28	3.43	.790	.149
	Female	23	2.70	1.105	.230
It is very important to work with ICT tools to teach EE	Male	28	3.79	.499	.094
	Female	23	3.52	.730	.152

Figure 4.10 above indicates that the use of ICT was more common to male respondents as indicated by the high mean scores and low standard deviations (m=2.89, SD=0.629). Although female respondents recorded a lower mean score than male respondents, their mean score is above average, revealing that the respondents agree that attitudes of teachers have a bearing on the use of ICT tools for teaching EE. Table 4.11 below is the independent sample t-test statistics of the difference in attitude of male teachers and female teachers on the use of the ICT tools in teaching EE.

Table 4.11: T-test: Independent Samples Test attitudes towards use of ICT tools

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
Readiness and confidence in using ICT tools in teaching	Equal variances assumed	18.777	.000	1.452	49	.153
	Equal variances not assumed			1.375	32.324	.179
Teachers enthusiastically engage in ICT projects in teaching EE	Equal variances assumed	14.908	.000	2.736	49	.069
	Equal variances not assumed			2.604	33.840	.074
Lack of autonomy to evaluate and use ICT in teaching EE	Equal variances assumed	4.426	.041	2.757	49	.058
	Equal variances not assumed			2.669	38.783	.061
It is very important to work with ICT tools to teach EE	Equal variances assumed	7.576	.008	1.529	49	.133
	Equal variances not assumed			1.474	37.581	.149

Homogeneity of variances was not assumed as revealed by Leven`s test for equality of variances on all tested variables because of the “sig <0.05”. As a result, a two-tailed significance test was used to ascertain whether the differences between the attitudes of male and female teachers were statistically significant. Although there were differences in the mean score of males and females regarding their attitude towards the use of ICT in improving teaching EE, the difference is not statistically significant because the value "Sig. (2-tailed)" is greater than 0.05. Table 4.11 reveals that "Sig. (2-tailed)" = 0.153 - 0.133 respectively.

The results of this analysis revealed that there is no significant difference between male and female teachers’ attitudes regarding the use of ICT tools in teaching EE. Thus respondents agree that attitudes of teachers have a bearing towards the use of ICT tools for teaching EE. These results are also consistent with that of Daraja–Mbili’s (2013) findings which posit that a positive attitude towards the use of ICT helps in the implementation of the biology curriculum. Therefore, the results enable the researcher to test the attitudes of male and female teachers in the use of ICT tools in teaching.

Research Question 4: Do teachers use ICT tools efficiently in teaching EE?

4.2.1.4 T-test on support for efficient usage of ICT tools for teaching EE

This question was meant to establish whether schools provide support mechanisms to enhance efficient use of ICT tools and to identify whether male and female teachers are exposed to different teaching environments regarding the use of ICT tools in teaching EE. The group statistics in Table 4.12 below shows the means and standard deviations and the difference between male and female respondents’ confessions about the availability of support mechanisms to enhance the usage of ICT tools in teaching EE.

Table 4.12: T-test: Group Statistics for efficient usage of ICT tools

	Gender of the teacher	N	Mean	Std. Deviation	Std. Error Mean
Strategists exist to help teachers learn how to use ICT in teaching EE	Male	28	2.61	.916	.173
	Female	24	2.63	1.135	.232
Teachers are provided with training & professional development regarding using ICT	Male	28	2.50	.638	.121
	Female	24	2.33	.816	.167
Majority of educators have ICT equipment for use in their classrooms	Male	28	1.82	.476	.090
	Female	24	1.88	.797	.163
Adequate preparation for the effective usage of ICT tools in teaching EE	Male	28	2.04	.793	.150
	Female	24	1.92	.929	.190

Figure 4.12 above indicates that both male and female teachers share almost similar experiences regarding the availability of a support mechanism to enhance the use of ICT tools in teaching EE. The mean scores and standard deviations are almost equally distributed between male and female respondents. Table 4.13 contains the independent sample t-test statistics to establish whether there is a statistical difference between male and female teachers' view of support mechanisms to enhance the use of ICT tools to improve teaching EE.

Table 4.13: T-test: Independent Samples Test for efficient usage of ICT tools

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
Strategists exist to help teachers learn how to use ICT in teaching EE	Equal variances assumed	2.440	.125	-.063	50	.950
	Equal variances not assumed			-.062	44.148	.951
Teachers are provided with training & professional development regarding using ICT	Equal variances assumed	.898	.348	.826	50	.413
	Equal variances not assumed			.810	43.288	.422
Majority of educators have ICT equipment for use in their classrooms	Equal variances assumed	1.472	.231	-.299	50	.766
	Equal variances not assumed			-.288	36.290	.775
Adequate preparation for the effective usage of ICT tools in teaching EE	Equal variances assumed	.468	.497	.499	50	.620
	Equal variances not assumed			.493	45.561	.625

Homogeneity of variances was assumed on all variables as revealed by Leven`s test for equality of variances (p>0.05). In addition, a two-tailed significance test was used to verify the nonexistence of differences of male and female teachers statistically. The two-tailed test also revealed that there was no significant difference between the respondents' position about the existence of a support mechanism to enhance the use of ICT tools in teaching EE. Table 4.13 reveal that "Sig. (2-tailed)" was greater than 0.05 on all occasions ("Sig. (2-tailed)" = 0.950 - 0.620) respectively.

The results of this analysis reveal that there is no significant difference on the position of male and female respondents regarding their view of the existence of a support mechanism to enahnce use of ICT tools to improve teaching EE. The results are consistent with the findings of the study by Tella (2011) which found that the support mechanism and attitude of teachers improve the adoption and use of ICT.

4.3 Analysis of Variance (ANOVA)

Analysis of variance (ANOVA) was done in order to make comparisons of the differences within groups of demographic variables (academic level and work experience) with regard to factor variables (effective use of ICT, availability of ICT tool, attitude of teachers towards ICT, and availability of a support mechanism to use of ICT tools efficiently). When interpreting the statistical results, there might be differences between group work experience or academic level, which might affect the way the researcher concluded the results. The differences may be statistically significant, with respect to the use of ICT to improve teaching EE variables, if the factor has a p-value of (p<0.05). The F statistics state the strength of the effect of the demographic variable has on the factor variables.

4.3.1 Analysis of variance (ANOVA) educational level

The purpose of ANOVA for education level was meant to establish the similarities and differences within the group level of education regarding the perception of respondents regarding the use of ICT in teaching EE.

4.3.2 Descriptive ANOVA: Education Level and Effective use of ICT

The tables below provide important descriptions of the meanand standard deviation of a 95% confidence interval for the variable (efficient use of ICT, availability of ICT resources, attitude of teachers, and availability of support for efficient use of ICT

tools) in teaching EE for each separate group (Honours, Bachelor's degree, and Post Matric diploma). Table 4.14 below shows the descriptive statistics for effective use of ICT in teaching EE and educational level.

Table 4.14: Descriptive ANOVA: Education Level and Effective use of ICT

		N	Mean	Std. Dev	Std. Error	95% Confidence Interval for Mean		Min	Max
						Lower Bound	Upper Bound		
ICT can improve the teaching of EE	Honours	13	4.00	.000	.000	4.00	4.00	4	4
	Bachelor's degree	26	3.96	.196	.038	3.88	4.04	3	4
	Post Matric diploma	13	3.85	.376	.104	3.62	4.07	3	4
	Total	**52**	**3.94**	**.235**	.033	3.88	4.01	3	4
ICT plays a transformative role in teaching EE	Honours	13	3.92	.277	.077	3.76	4.09	3	4
	Bachelor's degree	26	3.96	.196	.038	3.88	4.04	3	4
	Post Matric diploma	13	3.85	.376	.104	3.62	4.07	3	4
	Total	**52**	**3.92**	**.269**	.037	3.85	4.00	3	4
ICT enhances students' participation & feedback to educators	Honours	13	3.92	.277	.077	3.76	4.09	3	4
	Bachelor's degree	26	3.88	.326	.064	3.75	4.02	3	4
	Post Matric diploma	13	3.85	.376	.104	3.62	4.07	3	4
	Total	**52**	**3.88**	**.323**	.045	3.79	3.97	3	4
ICT offers opportunities to educators to obtain resources for EE improvement	Honours	13	4.00	.000	.000	4.00	4.00	4	4
	Bachelor's degree	26	3.92	.272	.053	3.81	4.03	3	4
	Post Matric diploma	13	3.85	.376	.104	3.62	4.07	3	4
	Total	**52**	**3.92**	**.269**	.037	3.85	4.00	3	4

Table 4.14 above shows that as the level of education increases, so do perceptions of effective use of ICT. Therefore, education does influence teachers' attitude towards adoption and effective use of ICT.

4.3.3 Descriptive ANOVA: Education Level and Availability of resources

The table provides an important description of the mean, standard deviation a 95% confidence interval for the variable (Availability of ICT resources in teaching EE) for each separate group (Honours, Bachelor's degree, and Post Matric diploma).

Table 4.15: Descriptive ANOVA: Education Level and Availability of resources

		N	Mean	Std. Dev	Std. Error	95% Confidence Interval for Mean		Min	Max
						Lower Bound	Upper Bound		
My school has been able to acquire suitable software and hardware	Honours	13	2.08	.641	.178	1.69	2.46	1	3
	Bachelor's degree	26	2.42	.758	.149	2.12	2.73	1	4
	Post Matric diploma	13	2.00	.913	.253	1.45	2.55	1	4
	Total	52	2.23	.783	.109	2.01	2.45	1	4
My school has been equipped with computers & connected to the Internet	Honours	13	2.54	.877	.243	2.01	3.07	1	4
	Bachelor's degree	26	2.23	.863	.169	1.88	2.58	1	4
	Post Matric diploma	13	2.23	.927	.257	1.67	2.79	1	3
	Total	52	2.31	.875	.121	2.06	2.55	1	4
ICT tools are properly equipped in practice and study rooms to teach EE	Honours	13	2.15	.689	.191	1.74	2.57	1	4
	Bachelor's degree	26	1.92	.796	.156	1.60	2.24	1	4
	Post Matric diploma	13	2.00	.816	.226	1.51	2.49	1	3
	Total	52	2.00	.767	.106	1.79	2.21	1	4
My school has proper procedure for communicating to students online	Honours	13	1.38	.506	.140	1.08	1.69	1	2
	Bachelor's degree	26	1.35	.689	.135	1.07	1.62	1	4
	Post Matric diploma	13	1.46	.776	.215	.99	1.93	1	3
	Total	52	1.38	.661	.092	1.20	1.57	1	4

4.3.4 Descriptive ANOVA: Education Level and Attitude of Teachers

The table provides an important description of the mean and standard deviation of a 95% confidence interval for the variable “Attitude of Teachers about the use of ICT in teaching EE” for each separate group (Honours, Bachelor's degree, and Post Matric diploma).

Table 4.16: Descriptive ANOVA: Education Level and Attitude of Teachers

		N	Mean	Std. Dev	Std. Error	95% Confidence Interval for Mean		Min	Max
						Lower Bound	Upper Bound		
Readiness and confidence in using ICT tools in teaching	Honours	13	2.62	.961	.266	2.03	3.20	1	4
	Bachelor's degree	26	2.73	.919	.180	2.36	3.10	1	4
	Post Matric diploma	12	2.83	.937	.271	2.24	3.43	1	4
	Total	51	2.73	.918	.129	2.47	2.98	1	4
Teachers enthusiastically engage in ICT projects in teaching EE	Honours	13	2.69	1.032	.286	2.07	3.32	1	4
	Bachelor's degree	26	2.81	.895	.176	2.45	3.17	1	4
	Post Matric diploma	12	2.83	.718	.207	2.38	3.29	1	4
	Total	51	2.78	.879	.123	2.54	3.03	1	4
Lack of autonomy to evaluate and use ICT in teaching EE	Honours	13	2.69	1.109	.308	2.02	3.36	1	4
	Bachelor's degree	26	3.35	.846	.166	3.00	3.69	2	4
	Post Matric diploma	12	3.00	1.128	.326	2.28	3.72	1	4
	Total	51	3.10	1.005	.141	2.82	3.38	1	4
It is very important to work with ICT tools to teach EE	Honours	13	3.62	.650	.180	3.22	4.01	2	4
	Bachelor's degree	26	3.69	.618	.121	3.44	3.94	2	4
	Post Matric diploma	12	3.67	.651	.188	3.25	4.08	2	4
	Total	51	3.67	.622	.087	3.49	3.84	2	4

4.3.5 Descriptive ANOVA: Education level and efficient usage of ICT

The table provides an important description of the mean, standard deviation of a 95% confidence interval for the variable “Availability of ICT support mechanisms for efficient use of ICT in teaching EE” for each separate group (Honours, Bachelor's degree, and Post Matric diploma).

Table 4.17: Descriptive ANOVA: Education level and efficient usage of ICT

		N	Mean	Std. Dev	Std. Error	95% Confidence Interval for Mean		Min	Max
						Lower Bound	Upper Bound		
Strategists exist to help teachers learn how to use ICT in teaching EE	Honours	13	2.85	1.068	.296	2.20	3.49	1	4
	Bachelor's degree	26	2.65	1.018	.200	2.24	3.06	1	4
	Post Matric diploma	13	2.31	.947	.263	1.74	2.88	1	4
	Total	52	2.62	1.013	.140	2.33	2.90	1	4
Teachers are provided with training & professional development regarding using ICT	Honours	13	2.62	.961	.266	2.03	3.20	1	4
	Bachelor's degree	26	2.35	.689	.135	2.07	2.62	1	4
	Post Matric diploma	13	2.38	.506	.140	2.08	2.69	2	3
	Total	52	2.42	.723	.100	2.22	2.62	1	4
Majority of educators have ICT equipment for use in their classrooms	Honours	13	1.77	.832	.231	1.27	2.27	1	4
	Bachelor's degree	26	1.88	.653	.128	1.62	2.15	1	4
	Post Matric diploma	13	1.85	.376	.104	1.62	2.07	1	2
	Total	52	1.85	.638	.088	1.67	2.02	1	4
Adequate preparation for the effective usage of ICT tools in teaching EE	Honours	13	2.15	.987	.274	1.56	2.75	1	4
	Bachelor's degree	26	2.00	.938	.184	1.62	2.38	1	4
	Post Matric diploma	13	1.77	.439	.122	1.50	2.03	1	2
	Total	52	1.98	.852	.118	1.74	2.22	1	4

The descriptive statistics tables above show that the most importance variable within each group have a higher mean score. In order to determine if statistically significant differences in mean scores exist within different groups, an ANOVA table was generated to reveal the significance level for each group. Table 4.18 below is the ANOVA table for educational level against factors that determine the use of ICT in teaching EE (effective use of ICT, attitude of teachers, availability of resource,s and availability of support mechanisms for efficient use of ICT tools). Therefore level of education does affect the use of ICT tools.

Table 4.18: Analysis of variance (ANOVA) Educational level

		Sum of Squares	df	Mean Square	F	Sig.
ICT can improve the teaching of EE	Between Groups	.173	2	.087	1.598	.213
	Within Groups	2.654	49	.054		
	Total	2.827	51			
ICT plays a transformative role in teaching EE	Between Groups	.115	2	.058	.790	.459
	Within Groups	3.577	49	.073		
	Total	3.692	51			
ICT enhances students' participation & feedback to educators	Between Groups	.038	2	.019	.179	.837
	Within Groups	5.269	49	.108		
	Total	5.308	51			
ICT offers opportunities to educators to obtain resources for EE improvement	Between Groups	.154	2	.077	1.065	.352
	Within Groups	3.538	49	.072		
	Total	3.692	51			
My school has been able to acquire suitable software and hardware	Between Groups	1.962	2	.981	1.642	.204
	Within Groups	29.269	49	.597		
	Total	31.231	51			
My school has been equipped with computers & connected to the Internet	Between Groups	.923	2	.462	.593	.557
	Within Groups	38.154	49	.779		

	Total	39.077	51			
ICT tools are properly equipped in practice and study rooms to teach EE	Between Groups	.462	2	.231	.383	.684
	Within Groups	29.538	49	.603		
	Total	30.000	51			
My school has proper procedure for communicating to students online	Between Groups	.115	2	.058	.127	.881
	Within Groups	22.192	49	.453		
	Total	22.308	51			
Readiness and confidence in using ICT tools in teaching	Between Groups	.298	2	.149	.171	.844
	Within Groups	41.859	48	.872		
	Total	42.157	50			
Teachers enthusiastically engage in ICT projects in teaching EE	Between Groups	.153	2	.077	.095	.909
	Within Groups	38.474	48	.802		
	Total	38.627	50			
Lack of autonomy to evaluate and use ICT in teaching EE	Between Groups	3.856	2	1.928	1.984	.149
	Within Groups	46.654	48	.972		
	Total	50.510	50			
It is very important to work with ICT tools to teach EE	Between Groups	.051	2	.026	.064	.938
	Within Groups	19.282	48	.402		
	Total	19.333	50			
Strategists exist to help teachers learn how to use ICT in teaching EE	Between Groups	1.962	2	.981	.955	.392
	Within	50.346	49	1.027		

	Groups					
	Total	52.308	51			
Teachers are provided with training & professional development regarding using ICT	Between Groups	.654	2	.327	.615	.545
	Within Groups	26.038	49	.531		
	Total	26.692	51			
Majority of educators have ICT equipment for use in their classrooms	Between Groups	.115	2	.058	.137	.872
	Within Groups	20.654	49	.422		
	Total	20.769	51			
Adequate preparation for the effective usage of ICT tools in teaching EE	Between Groups	.981	2	.490	.667	.518
	Within Groups	36.000	49	.735		
	Total	36.981	51			

From Table 4.18 above from the significance level in each group, the measure of significance “sig” is greater than 0.05 at (p=.213, 0.459 - 0.518) respectfully. F statistics state the strength of the effect of the demographic variable has on the factor variables. The strength of the effect is indicated by a higher “F value”. In this case the strength of the effect is indicated by a low “F value” at (F=1.598, 0.790 - 0.667) respectively. This statistical analysis of ANOVA indicates that there is no statistically significant difference within groups (level of education) with regard to factors that determine the use of ICT in teaching EE.

4.4 Analysis Of Variance (ANOVA) Teaching Experience

4.4.1 Descriptive ANOVA: Teaching experience and the effective use of ICT in teaching EE

The purpose of ANOVA for teaching experience was meant to establish the similarities and differences within the group “Teaching experience” regarding the

perception of respondents about the use of ICT in teaching EE. The tables below provide important descriptions of the mean and standard deviation of a 95% confidence interval for the variables (effective use of ICT, attitude of teachers, availability of resources, and availability of support mechanisms for efficient use of ICT tools) for each separate group (“6 months to 2 years”, “2 years to 5 years”, “5 years to 10 years”, and “more than 10 years”). Table 4.19 below shows the descriptive statistics for teaching experience and effective use of ICT in teaching EE

Table 4.19: Descriptive ANOVA: Teaching experience and Effective use of ICT

		N	Mean	Std. Dev	Std. Error	95% Confidence Interval for Mean		Min	Max
						Lower Bound	Upper Bound		
ICT can improve the teaching of EE	6 months to 2 years	3	4.00	.000	.000	4.00	4.00	4	4
	2 years to 5 years	9	4.00	.000	.000	4.00	4.00	4	4
	5 years to 10 years	14	3.86	.363	.097	3.65	4.07	3	4
	more than 10 years	24	3.96	.204	.042	3.87	4.04	3	4
	Total	50	3.94	.240	.034	3.87	4.01	3	4
ICT plays a transformative role in teaching EE	6 months to 2 years	3	4.00	.000	.000	4.00	4.00	4	4
	2 years to 5 years	9	4.00	.000	.000	4.00	4.00	4	4
	5 years to 10 years	14	3.86	.363	.097	3.65	4.07	3	4
	more than 10 years	24	3.92	.282	.058	3.80	4.04	3	4
	Total	50	3.92	.274	.039	3.84	4.00	3	4
ICT enhances students' participation &	6 months to 2 years	3	3.67	.577	.333	2.23	5.10	3	4
	2 years to 5	9	4.0	.00	.000	4.00	4.00	4	4

feedback to educators	years		0	0					
	5 years to 10 years	14	3.79	.426	.114	3.54	4.03	3	4
	more than 10 years	24	3.92	.282	.058	3.80	4.04	3	4
	Total	50	3.88	.328	.046	3.79	3.97	3	4
ICT offers opportunities to educators to obtain resources for EE improvement	6 months to 2 years	3	3.67	.577	.333	2.23	5.10	3	4
	2 years to 5 years	9	4.00	.000	.000	4.00	4.00	4	4
	5 years to 10 years	14	3.86	.363	.097	3.65	4.07	3	4
	more than 10 years	24	3.96	.204	.042	3.87	4.04	3	4
	Total	50	3.92	.274	.039	3.84	4.00	3	4

4.4.2 Descriptive ANOVA: Teaching experience and availability of resources

The table provides important description of the mean and standard deviation of a 95% confidence interval for the variable “Availability of ICT resources in teaching EE” for each separate group (“6 months to 2 years”, “2 years to 5 years”, “5 years to 10 years”, and “more than 10 years”).

Table 4.20: Descriptive ANOVA: Teaching experience and availability of resources

		N	Mean	Std. Dev	Std. Error	95% Confidence Interval for Mean		Min	Max
						Lower Bound	Upper Bound		
My school has been able to acquire suitable software and hardware	6 months to 2 years	3	2.33	1.155	.667	-.54	5.20	1	3
	2 years to 5 years	9	2.11	1.054	.351	1.30	2.92	1	4
	5 years to 10 years	14	2.29	.825	.221	1.81	2.76	1	4
	more than 10 years	24	2.21	.658	.134	1.93	2.49	1	3
	Total	50	2.22	.790	.112	2.00	2.44	1	4
My school has been equipped with computers & connected to the Internet	6 months to 2 years	3	1.67	1.155	.667	-1.20	4.54	1	3
	2 years to 5 years	9	1.56	.726	.242	1.00	2.11	1	3
	5 years to 10 years	14	2.43	.852	.228	1.94	2.92	1	4
	more than 10 years	24	2.63	.711	.145	2.32	2.93	1	4
	Total	50	2.32	.868	.123	2.07	2.57	1	4
ICT tools are properly	6 months to 2 years	3	2.67	1.528	.882	-1.13	6.46	1	4

equipped in practice and study rooms to teach EE	2 years to 5 years	9	2.00	1.118	.373	1.14	2.86	1	4
	5 years to 10 years	14	2.00	.392	.105	1.77	2.23	1	3
	more than 10 years	24	2.00	.659	.135	1.72	2.28	1	4
	Total	50	2.04	.755	.107	1.83	2.25	1	4
My school has proper procedure for communicating to students online	6 months to 2 years	3	1.67	1.155	.667	-1.20	4.54	1	3
	2 years to 5 years	9	1.11	.333	.111	.85	1.37	1	2
	5 years to 10 years	14	1.50	.650	.174	1.12	1.88	1	3
	more than 10 years	24	1.42	.717	.146	1.11	1.72	1	4
	Total	50	1.40	.670	.095	1.21	1.59	1	4

4.4.3 Descriptive ANOVA: teaching experience and attitude of teachers

The table provides important description of the mean and standard deviation of a 95% confidence interval for the variable “Attitude of Teachers about the use of ICT in teaching EE” for each separate group (“6 months to 2 years”, “2 years to 5 years”, “5 years to 10 years”, and “more than 10 years”).

Table 4.21: Descriptive ANOVA: Teaching experience and attitude of teachers

		N	Mean	Std. Dev	Std. Error	95% Confidence Interval for Mean		Min	Max
						Lower Bound	Upper Bound		
Readiness and confidence in using ICT tools in teaching	6 months to 2 years	3	2.33	1.528	.882	-1.46	6.13	1	4
	2 years to 5 years	8	2.25	1.282	.453	1.18	3.32	1	4
	5 years to 10 years	14	2.93	.730	.195	2.51	3.35	2	4
	more than 10 years	24	2.88	.741	.151	2.56	3.19	1	4
	Total	49	2.76	.902	.129	2.50	3.01	1	4
Teachers enthusiastically engage in ICT projects in teaching EE	6 months to 2 years	3	2.00	1.000	.577	-.48	4.48	1	3
	2 years to 5 years	8	2.25	1.165	.412	1.28	3.22	1	4
	5 years to 10 years	14	3.07	.616	.165	2.72	3.43	2	4
	more than 10 years	24	2.96	.751	.153	2.64	3.28	1	4
	Total	49	2.82	.858	.123	2.57	3.06	1	4
Lack of autonomy to evaluate and use ICT in teaching EE	6 months to 2 years	3	2.33	.577	.333	.90	3.77	2	3
	2 years to 5 years	8	3.25	.886	.313	2.51	3.99	2	4
	5 years to 10 years	14	3.14	1.027	.275	2.55	3.74	1	4
	more than 10	24	3.17	1.007	.206	2.74	3.59	1	4

	years								
	Total	49	3.12	.971	.139	2.84	3.40	1	4
It is very important to work with ICT tools to teach EE	6 months to 2 years	3	2.67	1.155	.667	-.20	5.54	2	4
	2 years to 5 years	8	3.63	.744	.263	3.00	4.25	2	4
	5 years to 10 years	14	3.71	.469	.125	3.44	3.98	3	4
	more than 10 years	24	3.75	.532	.109	3.53	3.97	2	4
	Total	49	3.65	.631	.090	3.47	3.83	2	4

4.4.4 Descriptive ANOVA: Teaching experience and availability of ICT support and efficient use of ICT

The table provides an important description of the mean and standard deviation a of 95% confidence interval for the variable “Availability of ICT support mechanisms for efficient use of ICT in teaching EE” for each separate group (“6 months to 2 years”, “2 years to 5 years”, “5 years to 10 years”, and “more than 10 years”).

Table 4.22: Descriptive ANOVA: Teaching experience and availability of ICT support

		N	Mean	Std. Dev	Std. Error	95% Confidence Interval for Mean		Min	Max
						Lower Bound	Upper Bound		
Strategists exist to help teachers learn how to use ICT in teaching EE	6 months to 2 years	3	3.00	1.732	1.000	-1.30	7.30	1	4
	2 years to 5 years	9	2.33	1.414	.471	1.25	3.42	1	4
	5 years to 10 years	14	2.64	.745	.199	2.21	3.07	2	4
	more than 10 years	24	2.71	.908	.185	2.32	3.09	1	4
	Total	50	2.64	1.005	.142	2.35	2.93	1	4
Teachers are provided with training & professional development regarding using ICT	6 months to 2 years	3	3.00	.000	.000	3.00	3.00	3	3
	2 years to 5 years	9	2.22	.833	.278	1.58	2.86	1	4
	5 years to 10 years	14	2.36	.497	.133	2.07	2.64	2	3
	more than 10 years	24	2.54	.779	.159	2.21	2.87	1	4
	Total	50	2.46	.706	.100	2.26	2.66	1	4
Majority of educators have ICT equipment for use in their classrooms	6 months to 2 years	3	2.00	1.000	.577	-.48	4.48	1	3
	2 years to 5 years	9	1.56	.527	.176	1.15	1.96	1	2
	5 years to 10 years	14	1.86	.363	.097	1.65	2.07	1	2

	more than 10 years	24	1.96	.751	.153	1.64	2.28	1	4
	Total	50	1.86	.639	.090	1.68	2.04	1	4
Adequate preparation for the effective usage of ICT tools in teaching EE	6 months to 2 years	3	2.33	1.528	.882	-1.46	6.13	1	4
	2 years to 5 years	9	2.11	.928	.309	1.40	2.82	1	4
	5 years to 10 years	14	1.79	.426	.114	1.54	2.03	1	2
	more than 10 years	24	2.08	.929	.190	1.69	2.48	1	4
	Total	50	2.02	.845	.119	1.78	2.26	1	4

The descriptive statistics tables above demonstrates that the importance of a variable within each group has a higher mean score. In order to determine if statistically significant differences in mean scores exist within different groups, an ANOVA table was generated to reveal the significance level for each group. Table 4.23 below is the ANOVA table for teaching experience against factors that determine the use of ICT in teaching EE (effective use of ICT, attitude of teachers, availability of resources, and availability of support mechanisms for efficient use of ICT tools).

Table 4.23: Analysis of Variance (ANOVA) educational level

		Sum of Squares	df	Mean Square	F	Sig.
ICT can improve the teaching of EE	Between Groups	.147	3	.049	.846	.476
	Within Groups	2.673	46	.058		
	Total	2.820	49			
ICT plays a transformative role in teaching EE	Between Groups	.132	3	.044	.572	.636
	Within Groups	3.548	46	.077		
	Total	3.680	49			
ICT enhances students' participation & feedback to educators	Between Groups	.423	3	.141	1.335	.275
	Within Groups	4.857	46	.106		
	Total	5.280	49			
ICT offers opportunities to educators to obtain resources for EE improvement	Between Groups	.341	3	.114	1.564	.211
	Within Groups	3.339	46	.073		
	Total	3.680	49			
My school has been able to acquire suitable software and hardware	Between Groups	.209	3	.070	.106	.956
	Within Groups	30.371	46	.660		
	Total	30.580	49			
My school has been eequipped with computers &connected to the Internet	Between Groups	8.938	3	2.979	4.904	***.005****
	Within	27.942	46	.607		

	Groups					
	Total	36.880	49			
ICT tools are properly equipped in practice and study rooms to teach EE	Between Groups	1.253	3	.418	.721	.545
	Within Groups	26.667	46	.580		
	Total	27.920	49			
My school has proper procedure for communicating to students online	Between Groups	1.111	3	.370	.816	.492
	Within Groups	20.889	46	.454		
	Total	22.000	49			
Readiness and confidence in using ICT tools in teaching	Between Groups	3.341	3	1.114	1.403	.254
	Within Groups	35.720	45	.794		
	Total	39.061	48			
Teachers enthusiastically engage in ICT projects in teaching EE	Between Groups	5.960	3	1.987	3.042	***.038****
	Within Groups	29.387	45	.653		
	Total	35.347	48			
Lack of autonomy to evaluate and use ICT in teaching EE	Between Groups	2.051	3	.684	.712	.550
	Within Groups	43.214	45	.960		
	Total	45.265	48			
It is very important to work with ICT tools to teach EE	Between Groups	3.203	3	1.068	3.022	***.039****
	Within Groups	15.899	45	.353		
	Total	19.102	48			

Strategists exist to help teachers learn how to use ICT in teaching EE	Between Groups	1.347	3	.449	.429	.733
	Within Groups	48.173	46	1.047		
	Total	49.520	49			
Teachers are provided with training & professional development regarding using ICT	Between Groups	1.692	3	.564	1.141	.342
	Within Groups	22.728	46	.494		
	Total	24.420	49			
Majority of educators have ICT equipment for use in their classrooms	Between Groups	1.125	3	.375	.913	.442
	Within Groups	18.895	46	.411		
	Total	20.020	49			
Adequate preparation for the effective usage of ICT tools in teaching EE	Between Groups	1.234	3	.411	.561	.644
	Within Groups	33.746	46	.734		
	Total	34.980	49			

Significance level at p<0.05*

From Table 4.23 above, it is evident that there is statistically significant differences between each group of the variable work experience and the factors: “My school has been connected to internet and computers” (F= 4.904 and p=0.005*), the factor “Teachers enthusiastically engage in ICT projects in teaching EE” (F=3.042 and P=.038*), and the factor “It is very important to work with ICT tools to teach EE” (F=3.022 and p=.039*). Although the results of these three variables show a statistically significant difference, the effect of the difference “F-test” (F= 4.904, =3.042, F=3.022) is weaker, hence it is concluded that there is no significant difference with regard to teaching experience and these factors.

The rest of the factors in the significance level in each group “sig” is greater than 0.05 at (p=0.476 - 0.644) respectfully. The strength of the effect is indicated by a higher “F value”. In this case the effect of the relationship is indicated by a low “F value” at (F=0.846 - 0.561) respectively. The overall statistical analysis of ANOVA indicates that there is no statistically significant difference within groups (teaching experience) with regard to the use of ICT on teaching EE. F statistics state the strength of the effect of the demographic variable has on the factor variables.

The inferences from the ANOVA are consistent with studies by Tella (2011) which conclude that availability of resources depends on school to school, departments and area of education. These results are also consistent with that of Daraja–Mbili’s (2013) findings which posit that a positive attitude towards use of ICT helps in the implementation of biology curriculum. Furthermore, the results are supported by Tella (2011) who found out that the support mechanism and attitude of teachers improve the adoption and the use of ICT; and Chowdhury (2009) and Owusu-Ansah (2013) reveal that use of ICT improves education and male and females have the same view of the importance of ICT on education.

4.5 Chi-Square Test

The study employed the Pearson's chi-squared test for independence in order to determine if there is a relationship between two categorical variables.

Research Question 1: How can ICT be used effectively in the selected rural high schools to improve teaching EE?

In order to determine the association between perception of teachers on the adoption of ICT in teaching EE, the cross tabulation of "respondents’ attitude and effective use of ICT was done and the results are presented in Table 4.25 below.

Table 4.24: Chi-Square

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.359[a]	3	.016
Likelihood Ratio	9.323	3	.025
Linear-by-Linear Association	1.990	1	.158
N of Valid Cases	51		

In order to determine the association between variables, the Pearson chi-squared test was used. According to the reading from Table 4.24 above, there is a statistically significant association between effective use of ITC and attitude of teachers towards the use of ICT. "Pearson Chi-Square" is significant at ($p<0.05$). Therefore "Pearson Chi-Square" is $p = 0.016$. at $p\chi(1) = 10.359$.

As a result, the researcher concludes that the attitudes of the teachers play a significant role in determining their perception of the effective use of ICT tools in teaching EE.

Research Question 2: What ICT facilities are available for teaching EE?

In order to determine whether adoption of ICT is influenced by the availability of resources, the cross tabulation of “respondents’ perception of the effective use of ICT” and availability of “ICT resources in teaching EE” was done and the results are presented in Table 4.25 below.

Table 4.25: Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.926[a]	3	.049
Likelihood Ratio	2.892	3	.041
Linear-by-Linear Association	1.654	1	.020
N of Valid Cases	52		

In order to determine the association between variables, the Pearson chi-squared test was used. According to the reading from Table 4.25 above, there is a statistically significant association between “effective use of ICT” and “availability of ICT resources”. The results of "Pearson Chi-Square" is significant at ($p<0.05$). Therefore "Pearson Chi-Square" is $p = 0.049$. at $p\chi(1) = 11.926$.

As a result, the researcher concludes that the adoption of ICT in teaching EE is influenced by the availability of ICT resources.

Research Question 3: What are the attitudes of teachers towards the use of ICT tools in teaching EE?

In order to determine whether the adoption of ICT is influenced by teachers’ attitudes, the association between “support mechanisms available to enhance efficient use of ICT tools” and “the attitude of teachers towards the usage of ICT in teaching EE” is tested. The cross tabulation of respondents’ attitude and support mechanism was done and the results are presented in Table 4.26 below.

Table 4.26: Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	32.681[a]	9	.000
Likelihood Ratio	38.936	9	.000
Linear-by-Linear Association	3.474	1	.062
N of Valid Cases	51		

In order to determine the association between variables, the Pearson chi-squared test was used. According to the reading from Table 4.26 above, there is a statistically significant association between “support mechanisms available” and “the attitude of teachers towards the usage of ICT”. The results of "Pearson Chi-Square" is significant at ($p<0.05$). Therefore "Pearson Chi-Square" is $p = 0.000$. at $p\chi(1) = 32.681$.

As a result, the researcher concludes that the adoption of ICT is influenced by teachers’ attitudes.

Research Question 4: Do teachers use ICT tools efficiently in teaching EE?

In order to determine the support systems available to support the efficient use of ICT tools in teaching EE, the cross tabulation of “availability of resources” and availability of “support mechanism” was done and the results are presented in Table 4.27 below.

Table 4.27: Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	14.238[a]	9	.114
Likelihood Ratio	14.814	9	.096
Linear-by-Linear Association	4.968	1	.026
N of Valid Cases	52		

In order to determine the association between variables, the Pearson chi-squared test was used. According to the reading from Table 4.27 above, there is no statistically significant association between “support mechanisms available” and “the attitude of availability of resources”. The results of "Pearson Chi-Square" is significant at ($p<0.05$). Therefore "Pearson Chi-Square" is $p = 0.114$ at $p\chi (1) = 14.238$. This indicates that the respondents acknowledge the importance ICT resources, but they cannot make a difference if support mechanisms are not in place. As a result, the results of the descriptive analysis are used to ascertain the support mechanisms available in terms of their mean score.

4.6 Summary

The chapter has provided an analysis of the quantitative questionnaire from the teachers who offer a concept of Environmental Education. The demographic characteristics of the teachers were explored. These include their social and academic status.

It was established that computer mediated communication (CMC) was popular amongst the educators mainly for social use and not for academic purposes. Teachers’ perceptions play a vital role in their integration of ICT in the curriculum.
Efficient and effective integration needs pedagogical transformation for new technologies. The availability of ICT resources could also support teaching and learning and improve conceptual understanding.

CHAPTER FIVE

DISCUSSIONS OF FINDINGS, SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter presents and discusses the research findings that emerged from the questionnaire data. The discussion has been categorised along the major findings of the study. The aim of this chapter is to discuss the multiple perspectives on the elements that influence the delivery of the curriculum such as: ICT integration in education, mastery of ICT integration in teaching, establishment of ICT resources, the educator or the teacher and the general trends in rural high schools.

5.1 Discussions

5.1.1 ICT integration in education

The essence of this section was to assess the adoption and integration of ICT in teaching Environmental Education in rural high schools. This is paramount to this study due to the importance of ICT application in rural schools. There were about 16 sub-variables that characterised ICT integration in rural schools (cf Table 4.5 in Chapter Four for details). Of the 16 sub-variables, the ranking of the factors that influence the adoption of ICT in teaching EE suggested that “ICT can improve the teaching of EE” (M = 3.94; SD = 0.235). However, the least important factor signifying the adoption of ICT was “proper procedures for communicating to students online” (M = 1.38; SD = 0.661). The current result is consistent with the work of Rastogi and Maholtra (2013) in Chapter Two who asserted that different forms of ICTs are sources of powerful tools that are able to help meet some of these challenges. The authors argued that ICTs can help in changing the old methods of teaching, where the teacher becomes the centre of the teaching process. The assertion of Rastogi and Malhotra is consistent with that of Quinot and Tonder (2014). Quinot and Van Tonder (2014) (Ibid) explained previously that the use of ICT in education through the rubric of e-learning can be described as the use of computer network technology. This can be done primarily over intranet or through the Internet.

This result suggested that educators that offer Environmental Education identify technological tools and are able to use them appropriately in their classroom teaching and instruction to bring out the meaning of the curriculum content. There is also the need to pay particular attention to factors such as “participation and feedback to educators”, “evaluate and use ICT in teaching” as well as “readiness and confidence in using ICT tools in teaching”.

This is because introducing technology on its own into teaching may not be sufficient to effect change. Integration of ICTs therefore becomes necessary as a change agent. In view of this, educators have by their professional training acquired the competence and innovative skills to bring about enormous change in the educational system in terms of ICT integration. ICTs have penetrated the educational system and are changing teaching experiences (Rapetti & Cantoni, 2012; OECD, 2012 as cited in Fanni, Rega, & Cantoni, 2013).

5.1.2 Mastery of ICT integration in teaching

Educators’ comprehension of ICT was acclimatised towards teaching from technological tools, rather than with technological tools. Vygotsky’s theory was discussed in Chapter Two which allowed learners to be provided with socially rich environments in which they can explore knowledge domains. Working with technological tools can support the teaching and learning environment in that it will allow learners to take full control of the learning process whilst the educator acts as a facilitator.

The principles underlying cognitive theory, which is a foundation of organising new knowledge, can be linked to integrating ICT in the classroom teaching because the technological tools learners will be exposed to will offer them the opportunity to actively participate through perspectives that shed light on the interaction between classroom goal structures (Deci et al., 1999).

5.1.3 Establish the availability of technological tools

The Action Plan as noted in Chapter Two advocates the need for teachers to be computer literate and to ensure that learners have increasing access to a wide range

of media (including computers) that will enrich their education (DoE, 2003). With regard to “attitudes of teachers towards the use of ICT tools for teaching EE”, there were several variables that explained the usage of ICT tools. These include but not limited to “Teachers enthusiastically engage in ICT projects in teaching EE”. The evidence showed that both males and females mean score was above average, revealing that the respondents agreed that attitudes of teachers have a bearing on the use of ICT tools in improving the teaching of EE (cf Table 4.10). However, there was a difference in the mean score of males and females regarding their attitude towards the use of ICT in effective teaching of EE. That is, the difference is not statistically significant. It can therefore be argued that the current results resonate with that of Kozma (2008) who explained that e-Education views ICT as “a tool for management, a resource for curriculum integration and a learning environment that advances creativity and communication” (p.). However, Tapscott and Knight et al. (1998) warned that most educators are still embracing the old style of teaching because of ineffective use of ICT pedagogical tools.

It was revealed in Chapter Two that ICTs are becoming accessible which importantly plays a critical role in education worldwide. There is access to films, video tapes, computers, the Internet and the World Wide Web (WWW). The ICT tools identified are not single technologies but a combination of hardware media desktop, notebook and handheld computers and applications such as word processors, spreadsheet, tutorials and electronic mail and mobile devices such as smart phones, tablets and the WiFi facility. It has been rightly pointed out that the availability of these ICT resources does not entirely depend on the tangible tools but the effective and efficient exploration of such tools (Kozma, 2005). Mobile learning devices empower learners to embark on finding new knowledge because almost all educators and learners have access to them (Menkhoff & Bengtsson, cited in Singh, 2012) although, more often than not, these devices are not permitted in the classroom.

The findings in this section reveal that ICT and technological tools that are readily available to educators are not copiously used to establish knowledge as well as contextual comprehension, neither are they used for innovative teaching. Education is currently changing into an era influenced by electronic media. It is therefore necessary that teaching methods are changed to accommodate the new method.

5.1.4 The teacher or educator

Various trends also suggest that there is the need to have an efficient use of ICT tools. Amongst them include the available strategies to help teachers learn how to use ICT in teaching EE; provision of training and professional development, and adequate preparation for effective usage of ICT tools in teaching EE. These factors need attention as reflected by various demographics in Table 4.12. The main tenet of the results as reflected in Table 4.12 is that both male and female teachers perceived availability of a support mechanism to enhance the use of ICT tools in teaching EE as essential. It is also important to note that a study in Singapore by Teo (2006) on the use of ICT-mediated lessons identified several barriers to the teacher in ICT integration in the classroom. Such barriers, as mentioned in Chapter Two, included inadequate technical support staff, lack of sufficient time for teachers to prepare for ICT-mediated lesson, lack of support provided by school leaders in addressing ICT concerns, and insufficient training for teachers on how to incorporate ICT into classroom instruction (Teo, 2006).

Teachers' skills are more heterogeneous. There are teachers with high-level technology skills. The large majority of educators have sufficient skills for everyday and routine working practices, but many of them are still experiencing difficulties in finding meaningful pedagogical use for technology. The educator is directly affected by the change with integrating ICT in teaching. In addition, the teacher being in the centre of the education process (Zhao & Frank, 2003; Davis, 2008) has one of the most important roles in the change to ICT integration, as "education change depends on what teachers do and think" (Fullan & Stieglbauer, 1991, p.117).

Integrating ICT in education allows teachers to enrich their teaching with a variety of resources, depending on their ability and confidence to experiment with new tools. Integrating ICTs in education has changed the role of educators who have been encouraged to move away from the traditional mode of teaching, i.e. not being centred in the teaching process, towards facilitating learner-centred learning. The degree of change depends on the teachers' attitude. Some are willing to experiment with new tools and others are not.

Some educators explained that there are several limitations to the degree to which learners can learn independently using ICT tools. Teachers' needs for adequate professional development were increased because of their changing roles. Research has indicated the important role of the teacher in effectively integrating ICT in education (Davis, 2008; Frailich et al., 2001), taking an appropriate approach, and making decisions that will make learners benefit from the advantages.

Law (2009) indicated the importance of teachers' professional development, recommending a greater focus on the pedagogical rather than the technology aspects of ICT use in the classroom. The availability of resources at a school in addition to attitudes of teachers is very important in stimulating change (Zhao & Frank, 2003).

5.1.5 General trends in rural high schools

Significant information worthy of considering entails the correlation between the educational level of the teacher and the extent to which he or she can make effective use of ICT. It was noted that the significant majority of the respondents who hold honours, bachelor's degrees or post matric diplomas held the view that ICT can improve the teaching of EE (M = 3.9; SD = 23). The same group of educational level holders also thought that ICT plays a transformative role in teaching EE (M = 3.9; SD; = 0.26). They also asserted that ICT enhances learners' participation and feedback to educators, as well as offers opportunities to educators to obtain resources for EE improvement. From the cognitive learning theory, it is argued that learning with ICT tools promotes learning of higher–order thinking skills (Jonassen et al., 2010). Though these particular results do not fully support previous studies, there are traces of elements that support the study of Lowther et al. (2008) who, in Chapter Twp, argued that there are three important characteristics that are needed to develop good quality teaching with ICT:

- Autonomy,
- Capability, and
- Creativity.

The authors explained that autonomy means learners take control of their learning through the use of ICT. However, for capability, learners are more confident in the learning process. On the other hand, creativity is enhanced when they are able to discover new multimedia tools and create materials in the styles readily available to them. This supports the view that the basic principles underlying cognitive learning theories of foundation of experience are used to organise new information, which include a personal perspective regarding new information.

In terms of educational level and availability of resources, most educators holding various qualifications ranging from honours, bachelor's degrees and post matric diplomas were mindful of that fact that their schools have been able to acquire suitable software and hardware (M = 2.23; SD = 783). A good number also agreed that their schools have been equipped with computers and connected to the Internet. There were some who supported the notion that ICT tools are properly equipped in practice and study rooms to teach EE (M = 2.0; SD = 767). Moreover, the respondents agreed that "schools have proper procedure for communicating to students online". The results to a large degree revealed that there is a statistically significant association between effective use of ICT and attitudes of teachers towards the use of ICT (<0.05). Additionally, cognitive theory explained that learning with technology improves much of the thinking in the learning process (Jonassen & Reeves, 1996). In fact there was alsoa statistically significant association between support mechanisms available and the attitudes of teachers towards the usage of ICT ($p<0.05$); this is consistent with cognitive theory which suggests the integration of ICT into Environmental Education Curriculum with meaningful interaction.
In contrast, there was no statistically significant association between "support mechanisms available" and "the availability of resources". This might not adhere fully to the policy of ICT integration in schools due to the fact, as noted in Chapter Two , the use technology tools such as computers and the Internet is still in its infancy in South Africa.

5.2 Summary

The aim of this study was to investigate the effective usage of ICT in teaching Environmental Education in rural high schools. Although there educators displayed the urge and willingness to use ICTs in improving teaching EE in the rural high schools visited, there are numerous aspects that need to be investigated. In order to achieve this, the answers to the following questions were needed.

Main question

- How can the integration of ICT improve the teaching of Environmental Education?

Sub–questions

- How can ICT be used effectively in the selected rural high schools to improve teaching of EE?
- What ICT facilities are available for teaching EE?
- Do teachers use ICT tools efficiently in teaching EE?
- What are the attitudes of teachers towards the use of ICT tools in teaching EE?

The literature review in Chapter Two focused extensively on the usage of ICTs in teaching Environmental Education in rural high schools. The readily available literature on the use of ICTs in rural high schools is very limited, which made the reviewing of the teaching of Environmental Education also very limited. The use of ICTs in education is not restricted to developed countries, but most rural high schools are now embracing and still struggling with the efficient usage despite the numerous challenges they encounter (Castello, 2002 in Herselman, 2003; Pedro et al., 2004).

It follows from Chapter Two that the use of ICTs in teaching Environmental Education is believed to support higher- order thinking skills in order for them to solve some environmental problems and also for environmental sustainability which contributes to the education of the whole person (Tilbury, 1995, p. 2000). In Environmental Education, learners are taught to be active and act on information by

transforming it into new meaning (Campell, 1990). In this instance, they should be able to use the technological tools to bring out meaning in relation to what they have learnt.

Integrating ICTs in teaching Environmental Education will also support learning and blending the teaching process, that is a combination of traditional forms of teaching, such as face- to- face classroom sessions (Oliver & Trigwell, 2005). Blended teaching can bring about the motivation to equip learners with the experience they need to critically access the topic being learnt.

As described in hapter Three, the study was a quantitative survey of selected rural high schools in East London district, Eastern Cape, South Africa. The schools were visited for almost two weeks for data collection. The questionnaire for educators was written in English and also was structured with Modified Likert responses. These ranged from Strongly Agreed (SA), with the highest numerical value of 4, to Strongly Disagree (SD), with the lowest numerical value of 1. The questionnaire was explained to all educators. Out of the 60 educators that were sampled randomly for the completion of the questionnaire, only 52 educators returned them.

Data was analysed using descriptive and inferential statistics, and the results were presented in tables and diagrams. The chi-square test was used to generalise and to find the effect between variables that were studied in the target population. Educators were also introduced to the objectives of the study. They were informed about their voluntary participation and assurance was given for not revealing their identities.

Chapter Four presented the data and its analysis. This was completed in accordance with what the study sought to achieve in terms of the research sub-questions and the main question. The chapter began by presenting data on the demographic characteristics of the respondents and their ICT profile. Data was gathered on the way ICT is used in the teaching and learning process and for construction of knowledge and conceptual understanding.

5.3 Conclusions and Recommendations

This section presents a summary of findings and conclusions drawn from the study. Some recommendations have also been included which will serve as a literature for future studies to speed up the usage of ICT in education in South African rural high schools. Based on the results and from the literature, the following conclusions may be drawn.

First, and most importantly, the educational level of an educator does not necessarily influence the teacher's attitudes towards adoption and effective use of ICT tools. There is sufficient evidence that attitudes of the teachers play a significant role in determining their perception of the effective use of ICT tools in teaching EE. There is also ample evidence that adoption of ICT in teaching EE is influenced by the availability of ICT resources and attitude.

Flowing from the above, it can be inferred that ICTs can contribute to improving the quality of teaching. Most rural high schools in South Africa do not have enough ICT resources. ICT was not only an educational pedagogy but also a motivating mechanism for socio-economic development in a globalising knowledge economy.
The implications of Vygotsky's theory to the current study is that learners should be provided with socially rich environments in which they have to explore knowledge domains with their peers. ICT can be used to support learning environments by providing tools for discourse and discussions, and providing online systems to scaffold learners' evolving understanding and cognitive growth.

Bringing ICT into practice has a role to play in facilitating and improving teaching and learning. In this study, it was discovered that South African schools have used traditional teaching methods that have stayed for the last few decades. Meanwhile, the Electronic and Communication Transaction Act No 25 of 2002 was enacted by the Department of Communication (DC) in a bid to regulate all ICT initiatives in South Africa and to develop a five year national e-strategy which would empower all citizens, especially the education sector.

Educators' professional development is necessary in the area of ICT to enable them to be confident and competent and to develop positive attitudes and skills. It may be

extremely difficult sometimes to “change” educators’ belief systems. Some are technophobic to use ICT in the teaching and learning process in their various classrooms. As a matter of fact, the higher the age of the educator, the greater their resistance becomes.

ICT provides opportunities to explore new knowledge and creates a conducive teaching environment. It also furnishes educators with the chance of enjoying effective ways of communication, processing and solving problems. This in turn may allow learners to develop their cognitive skills. However, integrating ICT in education still lags behind in rural schools because of factors such as the inadequate infrastructure (Internet, software, hardware), lack of policies, teachers’ perceptions, and teachers’ attitudes towards the use of ICT.

In this study, it was revealed that most educators are still comfortable with the old teaching methodology. The idea is to push for universal access to ICT through the deployment of networked computers, educational software and online resources to all South African schools. Although ICTs grant many beneficial opportunities for education, they cannot be a substitute for formal schooling. Its main aim and objective is to support and enhance education. This will also enable the development and distribution of electronic learning content so that every educator has the knowledge, skills and support needed to integrate ICT in education.

It is important that the integration process is well managed by educators and that they are guided by policies. ICTs are tools and they are in no position to fix a bad educational philosophy. Choices made by educational personnel must be made in terms of objectives and methodology before any tangible decisions are made about any ICT intervention. Despite the challenges outlined in this study, ICTs are being increasingly used in education in the developed world. In order to reach out to learners from remote areas, there is the need to provide them with adequate and quality education, and equip teachers with a wider range of educational resources.

As policy implementers of ICT education at the coal face, South African educators in rural communities need to prioritise subject content knowledge while at the same time embrace the innovation which comes with the integration of ICT. Capacity-

building training programmes designated for educators in rural schools seem to play a critical role as the skills acquired will alleviate the current poor use of ICT resources in rural schools.

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APPENDIX A: RESEARCH QUESTIONNAIRE- TEACHERS

Date: _____

Email _____

Phone No: _____

INTRODUCTION

This is an M Ed research questionnaire which aims at investigating the impact of Information and Communications Technology (ICT) on effective teaching of Environmental Education (EE) in rural high schools. Kindly be open and free as possible. Be assured that absolute confidentiality will be adhered to, and under no circumstances will your details be revealed to a third party.

INSTRUCTION

Read each question carefully. The questions are followed by possible answers. For each question you read, there are indications on the number of possible choices. Tick in the appropriate box(es) next to the answer of your choice. Kindly respond to all questions to the best of your ability. Your honesty will be appreciated.

BACKGROUND INFORMATION

Please indicate your gender by ticking an (x) in the spaces provided.

Male	
Female	

Please indicate your highest qualification by ticking an(x) in the spaces provided.

Masters Degree	
Honours	
Bachelors Degree	
Post-matric Diploma	

How many years of work experience do you have as offering EE in subject content teaching? Indicate by ticking an (x) in the spaces provided.

Less than 6 months	
6 months to 2 years	
2 years to 5 years	
5 years to10 years	
More than 10 years	

RESEARCH QUESTIONS

Please tick in the appropriate boxes. The responses range from Strongly Agree with the highest numerical value of 4, to Strongly Disagree with the least numerical value of 1.

SA- Strongly Disagree= 4, A- Agree= (3), D- Disagree= (2) and SD= Strongly Disagree (1).

How can ICT be effectively be used in rural high schools to improve teaching EE?

S/N	ITEMS	SA	A	D	SD
1	ICT can improve the teaching of EE				
2	ICT plays a transformative role in teaching EE				
3	ICT enhances learners' participation and feedback to teachers				
4	ICT offers				

	opportunities for educators in obtaining educational resources to improve the teaching of EE				

What are the availability of ICT resources in teaching EE?

S/N	ITEMS	SA	A	D	SD
1	My school has been able to acquire suitable software and hardware				
2	My school is connected to the internet				
3	ICT tools are properly equipped in practice rooms to teach EE				
4	My school has proper procedure for communicating to learners online				

What are teachers' attitudes towards the use of ICT tools in teaching EE?

S/N	ITEM	SA	A	D	SD
1	Readiness and confidence in using ICT tools				
2	Teachers enthusiastically engage in ICT projects in teaching EE				
3	Lack of autonomy to evaluate and use ICT in teaching EE				
4	It is very important to work with ICT tools to teach EE				

How efficiently do teachers use ICT tools in teaching EE?

S/N	ITEM	SA	A	D	SD
1	Strategists exist to help teachers learn how to use ICT in teaching EE				
2	Teachers are provided with training and professional development with regard to the usage of ICT				
3	Majority of educators have ICT equipment for use in their classrooms				
4	Adequate preparation for the effective usage of ICTs in teaching EE				

End of questionnaire. Thank you for your time, which I acknowledge is precious at this time of the year.

APPENDIX B: LETTER OF CONSENT

Dear Colleague,

I am seeking your permission for you to complete these questions on the above topic in relation to your application of ICTs in your teaching of EE. Please understand that your participation in this study is voluntary and you have the right to withdraw at any time. Your responses will be kept strictly confidential and used for academic purposes only. There is no wrong or right answers to any of the questions as such; feel free to express yourself to the best of your knowledge.

I shall return on ---------- to collect the completed questionnaire.

Yours sincerely

Akosua A. Osei

APPENDIX C: ETHIC CLEARANCE CERTIFICATE

University of Fort Hare
Together in Excellence

ETHICAL CLEARANCE CERTIFICATE
REC-270710-028-RA Level 01

Certificate Reference Number:	ADU051SOSE01
Project title:	**The impact of Information and Communication Technology (ICT) in teaching Environmental Education.**
Nature of Project:	Masters
Principal Researcher:	Akosua Agyakoma Osei
Supervisor:	Prof EO Adu
Co-supervisor:	

On behalf of the University of Fort Hare's Research Ethics Committee (UREC) I hereby give ethical approval in respect of the undertakings contained in the above-mentioned project and research instrument(s). Should any other instruments be used, these require separate authorization. The Researcher may therefore commence with the research as from the date of this certificate, using the reference number indicated above.

Please note that the UREC must be informed immediately of

- Any material change in the conditions or undertakings mentioned in the document
- Any material breaches of ethical undertakings or events that impact upon the ethical conduct of the research

The Principal Researcher must report to the UREC in the prescribed format, where applicable, annually, and at the end of the project, in respect of ethical compliance.

Special conditions: Research that includes children as per the official regulations of the act must take the following into account:

Note: The UREC is aware of the provisions of s71 of the National Health Act 61 of 2003 and that matters pertaining to obtaining the Minister's consent are under discussion and remain unresolved. Nonetheless, as was decided at a meeting between the National Health Research Ethics Committee and stakeholders on 6 June 2013, university ethics committees may continue to grant ethical clearance for research involving children without the Minister's consent, provided that the prescripts of the previous rules have been met. This certificate is granted in terms of this agreement.

The UREC retains the right to

- Withdraw or amend this Ethical Clearance Certificate if
  - Any unethical principal or practices are revealed or suspected
  - Relevant information has been withheld or misrepresented
  - Regulatory changes of whatsoever nature so require
  - The conditions contained in the Certificate have not been adhered to

- Request access to any information or data at any time during the course or after completion of the project.

- In addition to the need to comply with the highest level of ethical conduct principle investigators must report back annually as an evaluation and monitoring mechanism on the progress being made by the research. Such a report must be sent to the Dean of Research's office

The Ethics Committee wished you well in your research.

Yours sincerely

Professor Gideon de Wet
Dean of Research

23 October 2014

APPENDIX D: LETTER OF PERMISSION FROM THE DEPARTMENT

Province of the
EASTERN CAPE
DEPARTMENT OF EDUCATION
EAST LONDON DISTRICT

Dr. WB Rubusana Building * NU 1 Mdantsane* Private Bag X9007 * East London * 5200 * REPUBLIC OF SOUTH AFRICA * Tel: +27 (0)43 708 6208 Fax: +27 (0)43 760 0545 *Website: ecprov.gov.za

Date: 13 February 2015 **ENQUIRIES:** MRS A C ESBEN

Prof. Mireku
University of Fort Hare
Faculty of Law
Private Bag X9083
EAST LONDON
5200

Dear Sir

REQUEST FOR PERMISSION TO CONDUCT RESEARCH INVOLVING EDUCATORS IN SELECTED RURAL HIGH SCHOOLS IN EAST LONDON: MS AKOSUA A OSEI

Your letter dated 06 February 2015 has reference.

Approval is hereby granted for **Ms Akosua A Osei** to conduct research with the title ***"The Impact of ICT in Teaching Environmental Education in Rural High Schools"***, in a few selected schools in rural areas in the East London District, as part of her study towards the M.Ed qualification at the University of Fort Hare.

This permission is granted provided that she makes proper arrangements with the affected school principals and to make sure that tuition time is not disrupted.

Yours faithfully

ACEsben

PP **S MNGUNI**
ACTING DISTRICT DIRECTOR

APPENDIX E: INFORMED CONSENT FORM

University of Fort Hare
Together in Excellence

Ethics Research Confidentiality and Informed Consent Form

Our University of Fort Hare Faculty of Education is asking teachers from your school to answer some questions, which we hope will benefit your community and possibly other schools in the future.

The University of Fort Hare Faculty of Education is conducting research regarding THE IMPACT OF INFORMATION AND COMMUNICATIONS TECHNOLOGY (ICT) IN TEACHING ENVIRONMENTAL EDUCATION. We are carrying out this research to help the rural high schools in the East London District of South Africa integrate ICT as a tool in teaching.

Please understand that you are not being forced to take part in this study and the choice whether to participate or not is yours alone. However, we would really appreciate it if you do share your thoughts with us. If you choose not take part in answering these questions, you will not be affected in any way. If you agree to participate, you may stop me at any time and tell me that you do not want to go on with the interview. If you do this, there will also be no penalties and you will NOT be prejudiced in ANY way. Confidentiality will be observed professionally.

Your name will not be recorded anywhere on the questionnaire and no one will be able to link you to the answers you give. Only the researchers will have access to the unlinked information. The information will remain confidential and there will be no “come-backs” from the answers you give.

The interview will last around 45 minutes where you will be asked questions. Be as open and honest as possible in answering these questions. Some questions may be of a personal and/or sensitive nature, and one questions that you may not have thought about before, which also involve thinking about the past or the future. We know that you cannot be absolutely certain about the answers to these questions, but we ask that you try to think about these questions. When it comes to answering questions there are no right and wrong answers. When we ask questions about the future we are not interested in what you think the best thing would be to do, but what you think would actually happen.

If possible, our organisation would like to come back to this area once we have completed our study to inform you and your community of the results and discuss our findings and proposals around the research and what this means for people in this area.

INFORMED CONSENT

I hereby agree to participate in research regarding THE IMPACT OF ICT IN TEACHING ENVIRONMENTAL EDUCATION. I understand that I am participating freely and without being forced in any way to do so. I also understand that I can stop this interview at any point should I not want to continue and that this decision will not in any way affect me negatively.

I understand that this is a research project whose purpose is not necessarily to benefit me personally.

I have received the telephone number of a person to contact should I need to speak about any issues which may arise in this interview.

I understand that this consent form will not be linked to the questionnaire, and that my answers will remain confidential.

I understand that if at all possible, feedback will be given to my community on the results of the completed research.

……..

Signature of participant **Date**:……..

I hereby agree to the tape recording of my participation in the study.

……..

Signature of participant **Date**:……..

APPENDIX F: LANGUAGE EDITING CERTIFICATE

CERTIFICATION

THIS DOCUMENT HEREBY CERTIFIES THAT

"The impact of Information and Communications Technology (ICT) on effective teaching of Environmental Education in rural high schools"

WRITTEN BY

AKOSUA AGYAKOMA OSEI

Has been professionally proofread by

LAUREN WAINWRIGHT

BA Languages and Literature

1 MARCH 2016