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An evaluation of the implementation of ICT Policy for Education in rural Namibian schools

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DECLARATION

I declare that this thesis is my own unaided work. This thesis is being submitted for the Degree of Doctor of Philosophy in the University of Pretoria, South Africa. It has not been submitted before for any degree or examination to any other university.

Elizabeth Ndeukumwa Ngololo
15th September 2010

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DEDICATION

This thesis is dedicated to my daughter,
Tulihaleni Naukongo Mary

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ABSTRACT

Many governments across the world have invested a lot of resources in information and communication technology (ICT) development with an aim to enhance teaching and learning using technology in schools. New educational ICT policy issues emerged and new patterns of ICT related practices are observable in education. This initiative has necessitated the development of National ICT Policies that will guide the implementation process in schools. Namibia has adopted the National ICT policy for Education in 2005 and the National ICT Policy Implementation Plan in 2006. Since the adoption no study was done to evaluate the implementation process, especially in rural schools where the teaching has been proven difficult. This study evaluates the implementation of the National ICT Policy for Education in Namibian rural junior secondary schools, especially in science classrooms.

The thesis is a mixed methods study, undertaking survey and case studies. The study was conducted in the three educational regions, namely, Ohangwena; Oshana; and Oshikoto in Northern Namibia were 163 schools were sampled. The purpose of the study was to describe how ICT is being implemented in science classrooms and also explore factors that affect ICT implementation in rural schools.

The study’s findings indicate that the rural schools in Namibia are in the initial phase of ICT implementation. ICT use and pedagogical use is low due to lack of professional development courses, pedagogical support and lack of ICT related resources. However, the few schools with high pedagogical use of ICT have shown an entrepreneurial leadership style and vision of the science teachers. The relational analysis suggests three main predictors of ICT implementation in rural schools. These findings were confirmed through case studies of successful schools. In addition, the findings were legitimised by the participants of the ICT use conference.

The Kennisnet model (2009) was adopted and adapted as a conceptual framework for this study. The Howie model (2002) provided the frame within which the structure of input, process and outcome could be identified. The data was consistent with the adapted Kennisnet model (2009) and added five more constructs namely, entrepreneurial leadership, science curriculum goals, entrepreneurial science teachers' vision, general use of ICT. The general use of ICT and attitudes of the science teachers influences the pedagogical use of ICT as added to the Howie model (2002).

The results of this research suggest ways to improve the pedagogical use of ICT in rural schools; enable policymakers to make informed decision about resource allocation to the rural schools; and on teacher professional development in order to improve the current rural situation regarding ICT use.

Key words: Evaluation, Information Communication Technology (ICT), national policy, rural schools, Namibia, developing countries, pedagogical use of ICT, expertise, digital learning materials, infrastructure.

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AISI	African Information Society Initiative
CECS	Community Education Computer Centre
EMIS	Education Management Information System
ETSIP	Education and Training Sector Improvement Programme
GeSCI	Global eSchool and Community Initiative
HIGCSE	Higher International General Certificate for Secondary Education
ICDL	International Computer Drivers License
ICT	Information Communication and Technology
IGCSE	International General Certificate for Secondary Education
IMTE	Intergrated Media in Technology Education
iNET	Initiative for Namibian Educational Technology
MBESC	Ministry of Basic Education, Sports and Culture
MHETEC	Ministry of Higher Education, Training and Employment Creation
MOE	Ministry of Education
NCQ	National Context Questionnaire
NETA	Namibian Education Technology Alliance
NETSS	National Education Technology Service and Support Centre
NPC	National Planning Commission
SADC	Southern African Development Community
SCM	Success Case Methods
SITES	Second Information Technology Education Study
SWAPO	South West Africa People's Organisation
UNAM	University of Namibia
UNESCO	United Nations Education and Science Community Organisation

USAID	United States Agency for International Development
VET	Vocational Education and Training
VTC	Vocational Training Centre
XNET	XNET Development Trust

CHAPTER 1

INTRODUCTION

This chapter introduces the study on the evaluation of the implementation of the ICT Policy for Education in Namibian rural junior secondary schools. In Section 1.1 of this chapter, the research problem is introduced. Section 1.2 elaborates on the research problem and aims of the study, culminating in the main research question. Section 1.3 presents the research approach, further presented in a schematic form illustrating how the research questions will be answered. The significance of the research is presented in Section 1.4 and conclusions drawn in Section 1.5.

1.1 Introduction

This section explains why it is important to evaluate the extent to which the intended ICT policy of Namibia has been implemented in the junior secondary schools in rural areas. A brief background of the history of education in Namibia is presented, leading to the rationale for introducing the national ICT Policy for education.

Access to formal schooling was severely limited in Namibia before independence as under colonial rule education had been developed and modelled in a way that Africans were trained for specific functions, especially to make them submissive to the established order and prepare them for semi-skilled and unskilled labour (Cohen, 1994). Since 1990, when Namibia attained its independence from South Africa, education has been perceived as potentially important for obtaining national, social, political and economic objectives (Amukugo, 1992). The Namibian Government has thus embraced education as one of the pillars for the national development strategy in the hope of using it as a transformative institution (Burns, 2001). The disparity has necessitated the development of policies that would narrow the gap between the previously advantaged white communities and disadvantaged black majority (MEC, 1993).

In 1993, the Ministry of Education (MoE) produced an educational brief "*Towards Education for All*" to guide educational development in the country, in which three important goals were emphasised: access, equity and equality. Achieving these in education has been a challenge for the Government, as they required all schools to have the same resources, including well-qualified teachers and well-equipped laboratories by 2010 (MEC, 1993). However, rural schools do not have the necessary infrastructure and modern equipment, for various reasons (Clegg, 2004; Hamunyela, 2008; Matengu, 2006) and few learners from rural secondary schools enter higher education in the country or abroad.

With about 60% of the population living in regions along the northern frontier of the country (Caprivi, Okavango, Ohangwena, Oshikoto, Oshana, Omusati and Kunene), the North Central region consists of four political regions, Ohangwena, Omusati, Oshana and Oshikoto. These are home to about half of the population of 1.8 million people and are amongst the most disadvantaged of the thirteen administrative regions, in terms of such indices as per capita income, mortality rates, life expectancy and food security (UNDP Human Resource Development Report, 2000). These regions were heavily militarized during the 1970s and 1980s, when they were the focus of the liberation war fought between the South African apartheid regime and the South West African People's Organization (SWAPO). In addition, they were deliberately undeveloped, so that they could be used as a reservoir of migrant labour for the rest of the country.

In order to redress the challenges of inequity, the Government of the Republic of Namibia introduced Information Communication and Technology (ICT) to the education system in 1999, the primary objective being to enhance the teaching and learning of Mathematics, Science and English as critical subjects and so redress equity and quality issues inherited from the colonial past. A review of the National ICT Policy (1999) took place and the new national policy was adopted in

2005. The Permanent Secretary of the Ministry of Education appointed the National ICT Steering Committee, comprising educational stakeholders, to advise the Ministry of Education on the best practices of ICT provision and pedagogical usage. The ICT Policy for Education was developed to enhance the use and development of ICT in the delivery of education and training in the five distinct areas: investigation and development of appropriate pedagogical ICT solutions, i.e., deployment, maintenance and support, literacy, and integration into subject areas of which the latter is elaborated in Chapter 2 (National ICT Policy for Education, 2005). The document also stipulates pre-service and in-service teacher education institutions as priority areas for ICT deployment, followed by schools with secondary grades (Ministry of Education, 2005).

The adoption of the National ICT Policy was followed by that of the National ICT Implementation Plan (2006). In order to ensure that the implementation plan would be effected, the Ministry of Education created a National Budget from 2006/2007 onwards. In addition, stakeholders such as the Global e-School Initiative (GeSCI), SchoolNet Namibia, Namibia Education Training Academy (NETA) and Computer Education Community Service (CECS) have been supporting this activity by donating ICT resources to schools mostly located in the rural areas. These non-governmental organisations (NGOs) also provide teacher training, and receipt of ICT supplies at schools is encouraged by the Government (MoE, 2005).

The National Education Technology Service and Support Centre (NETSS) in Windhoek, a refurbishment centre was established to assemble and deploy ICT in schools in 2006. Since 2005, approximately 345 schools (including primary, combined, and secondary schools) have received several types of ICT through donor agencies. These varied from up-to-date computer laboratories with 10 to 20 networked PCs, laser printers and connectivity, to out-dated, redundant equipment in need of replacement by donor agencies or NGOs. To enhance efficiency, the XNET Development Trust was formed in 2003 to address issues of providing reliable and cost-effective Internet connectivity. Thus far, XNET has provided affordable connectivity to over 250 schools throughout the country at a flat rate of

N$ 3.00 per month per school. In the same light, the technical support system to schools is also centralised from the NETSS Support Centre in Windhoek. The first level of support is resolved electronically or by telephone, where the request is rooted through the help desk to the relevant support capability (MoE, 2006). However, the long distances between the capital Windhoek and the northern regions remain an obstacle for proper communication with schools and regional centres, and for organisation of teachers' support structures (Clegg, 2004; Hamunyela, 2008; Matengu, 2006; Ottevanger, 2001). This study found that the situation for rural areas had not changed by the time of conducting this research.

The major problem is that the effects of services related to ICT implementation in the Namibian education system are unknown. A few studies conducted in Namibia have focused on ICT deployment and technical maintenance (Clicherty and Tjivikua, 2005; Matengu, 2006). However, ICT deployment does not guarantee use and integration in the school curriculum. There is a need to evaluate the implementation of the ICT at national and school level for purposes of accountability and transparency to educational stakeholders, in this case teachers, principals, curriculum developers, school boards, and educational planners.

It is important to address this problem in order to ensure that the ICT policy does not become neglected but rather should be used to advance the delivery of equitable quality education, and thereby provide an opportunity to improve the livelihoods of the people. Specifically, it is important to evaluate the extent to which the educational goals have been achieved by the year 2010, especially in the rural areas where a shortage of qualified teachers has been detected and schools are isolated, lacking access to communication and generally not as well-equipped as their counterparts in urban areas (Clegg, 2004; Matengu, 2006; Ottevanger, 2001; Worldbank, 2000).

Evaluation of the ICT implementation plan may lead to taking informed decisions by the various stakeholders. Also, the findings from this study will add to the scientific body of knowledge of ICT implementation in rural schools, with particular reference to the description of ICT and factors influencing the implementation of ICT in rural schools. However, this study had to overcome some challenges both in the search for literature and the method adopted to find answers to the research questions posed below. For example, finding literature on ICT implementation in the developing world is a challenge, and conducting evaluation studies through survey methods in such a vast country requires financial and human resources. Another challenge was determining ICT deployment in schools as the Educational Management Information System (MIS) of the Ministry of Education gives inconsistent information due to the incompleteness of its database on ICT information.

1.2 The research problem and questions

Governments around the world are recognizing the critical importance of education for economic development and the high quality of life of all citizens. In Namibia, however, achieving these goals is faced with obstacles, as pre-independence problems continue to hamper teaching. The number of qualified science teacher has increased but a poor school infrastructure and lack of basic equipment remain problematic, especially at junior secondary schools and in the domain of teaching science (Clegg, 2004). Teachers use traditional approaches to teach science (Kapenda, 2008), and as a result, the government faces challenges about whether and how to integrate ICT into teaching and learning. These choices are complex, technically demanding, and the effects not always known (Anderson & Plomp, 2009). In order to realise these demands, teachers are required to have a deep knowledge of national policies and social priorities, and be able to design, modify, and implement classroom practices that support them (UNESCO, 2008b).

The successful implementation of ICT into a classroom will depend on the abilities of the teachers to structure the learning environment in innovative ways, to merge new technologies with new pedagogies, to develop socially active classrooms, and encourage cooperative interaction, collaborative learning and group work. Such an innovation requires a new set of classroom management skills to be developed (UNESCO, 2008a). In other words, new technologies require teachers' roles to change and to include new pedagogies and new teacher training. Ainley, Enger, Searle (2008), Boateng (2007) and Gaible (2008) note that there is currently little understanding of the way in which ICT is used in schools and classroom around the world. It is important for the national policy to state what ICT should be used in schools and at classroom level.

To date, no study has been conducted in Namibia aimed at evaluating how ICTs have been used by the teachers since the introduction of ICT Policy (2005) in schools. What schools are doing with ICT in accordance with the policy requirements have not been investigated (Matengu, 2006). What little literature exists on ICT implementation in Namibia focuses on infrastructure and assessment and how it can benefit schools (Hesselmark & Miller, 2004; Matengu, 2006). In addition, the country lacks large-scale data sets to illustrate how ICT is being used in schools in both urban and rural areas.

In the National ICT Policy for Education, the monitoring and evaluation component is listed as part of the ICT Implementation Process, but neither has been conducted since 2005. Deferring evaluation as an important integral part of the programme, when designing and implementing a national programme like the National ICT Policy implementation, may result in difficulties of reaching sound and reliable decisions about effective implementation (Rossi, Lipsey & Freeman, 2004;). Currently in Namibia, there is insufficient evidence based on information about how ICT is being implemented in schools, more so in rural areas, nor are the factors that affect the implementation of ICT known. Given these reasons, it is worthwhile to conduct an evaluation in rural schools, especially at junior secondary school level. Upon completion of this school level, many learners end their school career or advance their education further. According to the ICT policy, this school level is a top priority in terms of ICT deployment and it should be used for advancing the teaching of mathematics, science and the English language. In addition, the decision to focus on the teaching of science is based on the National ICT Policy's (2005) emphasis on enhancing the teaching of science for purposes of economic development, as well as the researcher's experience in the area of science teaching. Consequently, this study evaluates the implementation of ICT Policy for Education in rural junior secondary schools and focuses on the teaching of the sciences. The main research question has been formulated as follows:

How and to what extent is the intended ICT Policy implemented in the junior secondary schools in Namibian rural areas?

This question aims to determine how the ICT Policy for Education is being implemented, as this is essential in order to evaluate and understand the current status of ICT implementation in rural areas. To be able to address the main research question, there is a need to understand the context of the policy interpretation and also to obtain a description of the situation in the rural schools, before digging deeper into the factors that contribute to the current situation. In this context the following specific questions are phrased to address the general research question stated above:

1. *What is the national context with regard to the implementation of the ICT Policy for Education in rural junior secondary schools?*

Research Question 1 aims to investigate the context and understand the intentions of ICT Policy implementation.

2. *How has the national ICT policy been implemented in the science classrooms?*

Research Question 2 aims to ascertain the extent to which the ICT Policy has been implemented in the rural areas of Northern Namibia. Reasons for choosing to focus on science classrooms have been described above.

3. *What factors affect ICT Policy implementation in rural schools?*

Research Question 3 aims to identify the factors that affect the policy implementation process in an attempt to improve the rural situation.

Research questions provide guidance in terms of research methodology and control the direction of this study. They also indicate the type of data and information to be generated.

1.3 The research aims and objectives

In line with the research questions presented above, the aims and specific objectives of this study are:

1. To evaluate the implementation of the ICT Policy for Education in rural schools.
   - To obtain a descriptive context of ICT Policy implementation in rural schools.
   - To ascertain the infrastructure available in rural schools.
   - To ascertain the extent of ICT use in general and for pedagogical use of ICT.
   - To ascertain the leadership styles applied in rural schools.
   - To ascertain the extent to which the National ICT Policy objectives have been attained in rural schools.
   - To determine the collaboration and general support offered to rural schools.
   - To determine the level of professional development and expertise available in rural schools.
2. To explore how science teachers integrate ICT in science classrooms in Namibian rural schools.
   - To identify innovative practices followed in the science classrooms.
3. To identify factors that affect ICT implementation in Namibian rural schools

- To obtain an in-depth analysis and exploration of factors affecting the implementation process.

4. To contribute to the knowledge about the implementation of ICT in rural schools in developing countries.

- To legitimate the findings before conclusions are finalised.
- To make recommendations for consideration by policymakers.

The study is designed to provide useful data for the Namibian policymakers to evaluate the current status of ICT implementation in rural areas, providing descriptive and exploratory information and the relationships that exist between the variables, as well as other background information. The data will also yield useful information towards ICT implementation and integration in rural science classrooms.

1.4 An overview of the research design

This section presents a brief description of the research, including SITES and the rationale for adopting the SITES 2006 as an inspirational model for this study approach. The research approach is presented in a diagrammatical format, illustrating the research methods adopted for each sub-research question. This study adopted a pragmatic evaluation research approach.

For research question 1, document analysis and interviews with the National ICT Coordinator have been used and the results presented in Chapter 2.

Research question 2 is inspired by the Second Information Technology in Education Studies (SITES 2006), an international comparative study conducted under the auspices of the International Association for the Evaluation of Education Achievement (IEA). The SITES were intended to serve as a basis for participating countries to compare developments in ICT in education and to provide benchmarks (Howie, Muller & Paterson, 2005), and they consist of three modules: SITES Module 1 (M1), SITES Module 2 (M2) and SITES 2006. SITES M1 aimed to provide an overview of ICT in education in primary and secondary in 26 countries and used a survey method. SITES M2 was an in-depth case study of ICT in selected schools that had implemented ICT-based curriculum innovation in the participating countries. SITES 2006 focused on evaluation of educational opportunities offered by teachers and schools in ICT in education (Plomp, Anderson, Law & Quale, 2009). The details of the series of SITES studies are presented in Chapter 3 (Sections 3.5).

Plomp, Pelgrum and Law (2008) explained the major aims of SITES 2006 as being to provide international benchmarks of (i) how in the information society pedagogical practices are changing; (ii) the extent to which ICT is used in education; and (iii) how the use of ICT is associated with (changing) pedagogical practices. The SITES 2006 followed a survey approach in order to build upon the large number of case studies of innovative pedagogical practices supported by ICT studied in SITES M2, and to investigate the factors associated with the use of ICT in schools and among teachers. The outcomes of the SITES 2006 are used to inform policymakers in the participating countries to make informed judgments about developments in their national education systems, as compared to other countries.

The inspiration for choosing the SITES 2006 research design as the example was the need to conduct large scale studies in Namibia's rural secondary schools. It is noted that the SITES 2006 focuses on both mathematics and science, however, for reasons presented in Section 1.2, the focus has narrowed down to science classrooms. In addition, the aims of the SITES 2006 study are similar to those of this study, i.e. describing the context of the Namibian educational system, to ascertain the availability of infrastructure; to ascertain the extent of ICT use and pedagogical use; to ascertain the extent of implementation of policy objectives and identify innovative practices related to ICT. The research will examine problems encountered and identify future expectations.

Research question 3 employed exploratory case studies to identify the factors that affect ICT implementation in rural schools. The research approach used in this study is aligned to the specific research questions of this study as outlined in Figure 1.1 (below):

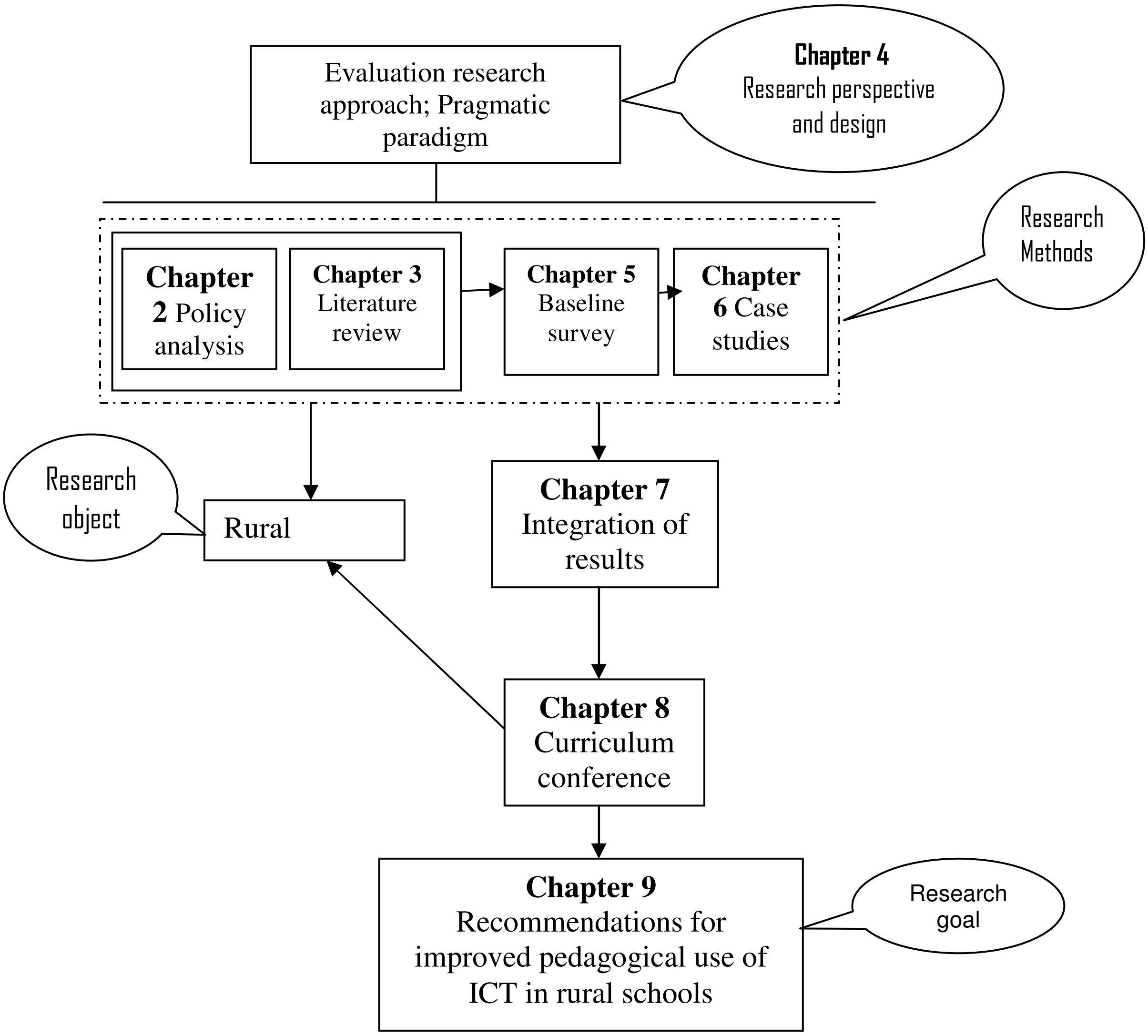


Figure 1.1: The Research Model for this study

Figure 1.1 (above) presents the chapters in this study and characteristics of their content. The chapters are arranged in the sequence of how the research questions are addressed. In order to understand how this study is structured, the research model offers a diagrammatical representation of the events as they follow one another and also the research questions they address. The operational research questions are therefore addressed as follows:

Research question 1: What is the national context with regard to the implementation of the ICT Policy for Education in rural junior secondary schools?

The research approach adopts descriptive, analytical and exploratory components to answer all three research questions in the following way.

Research question 1: *What is the national context with regard to the implementation of the ICT Policy for Education in rural junior secondary schools?* This was tackled through a literature review and document analysis. The literature review covered the most recent publications (1999-2010) from the developed countries and a few from developing countries, such as Chile and South Africa, Ghana and Namibia. Arguments that the two developing countries (Chile and South Africa) are not a true representation of most developing countries are noted with concern, but attempts to obtain relevant literature from more developing countries proved futile (see Chapter 3).

The document analysis approach was informed by the SITES 2006 National Context Questionnaire (NCQ) and provided a framework for developing the national context (Chapter 2). This approach was complemented by interviewing the National ICT Project Manager and the relevant people in areas of specialisation to enhance the data obtained through document analysis. Also, this approach provided a critique of important activities and policy statements articulated in the policy document, in order to give a better insight into the national context which was needed before the survey was conducted.

A survey approach was adopted to answer research question 2 of this study: *How has the national ICT policy been implemented in science classrooms?* In an effort to determine how ICT is being implemented in schools, three self-administered questionnaires were distributed to principals, science teachers and ICT technicians in three educational regions located in rural areas. Three out of four North Central Educational regions (all rural) were selected as the sample for this study. The population of secondary schools is 247, of which the target sample in selected regions is 163, and of which 136 schools at least participated. The samples of schools per region were purposively selected to include those with electricity and functioning ICT. It is believed that the three regions are sufficient to give a representative view of the rural areas in Namibia. The selection criteria are explained in detail in Chapter 4. The findings of research question 2 sequentially lead to the research approach of research question 3.

Research question 3: *What factors affect ICT Policy implementation in rural schools?* is addressed through evaluative interviews and classroom observations in three purposively selected schools (Shaw, 1999). Semi-structured interviews and observation methods were used in the three schools to find answers to research question 3. The case studies analysis aims at generating suggestions and recommendations for improving the teachers' pedagogical practices using ICT, and to make recommendations to the government about improving implementation of the policy on ICT in education in rural areas. Three science teachers were observed using ICT in target classrooms. The selection for science teachers is based on the earlier argument for science education in Section 1.2. In addition, three principals and three laboratory technicians were interviewed to explain or verify some findings from the survey. Analysis of the outcomes of the case studies led to suggestions and recommendations for improvement of ICT pedagogical practices in rural schools.

In order to legitimate the findings of this research, a curriculum conference approach (Mulder, 1994) was employed for deliberative ICT decision-making, where the National ICT Coordinator and a number of principals, science teachers and ICT technicians were brought together as a consultation group to discuss issues on ICT implementation. In this forum, the consultation group analyses the findings from the research, takes their stance on proposed solutions, suggests courses of action, argues for and against an opinion, and weighs these against their educational goals, values and standards (Mulder, 1994).

The research approach of this study employs a pragmatic viewpoint to interpret the ICT use in rural schools. As explained above (see also Figure 1.1, above) the model has four components, viz, policy analysis, literature review, baseline survey and case studies. Two of the components are independent, namely literature review and policy analysis, while the other two have dependent characteristics whereby (i) the literature review and the policy analysis influenced both the survey and the case studies, and (ii) the survey influenced the selection for case studies. Both the survey and case studies drew participants from the schools in the identified educational regions. It is assumed in this model that findings on all three components will contribute to improving pedagogical use of ICT in rural schools, which is the aim of this study.

The data analyses of the findings have been presented in Chapters 5 and 6 respectively. The analysis of the survey used a Statistical Package for Social Science (SPSS) to give a descriptive account of the data. Processing of data used frequencies; mean, maximum and minimum values, standard errors and also factor analysis for data reduction, Pearson's correlation analysis and regression analysis were conducted.

The qualitative data employed manual coding for analysis, with cases analysed individually then cross-analysed to obtain findings per constructs and a group of principals, science teachers and ICT technicians respectively. In order to determine a collective finding, the frequency count of emerging themes was considered.

The reliability of the questionnaire was found to be 0.943 for the principals' responses; 0.890 for the science teachers' responses; and 0.754 for the ICT technicians' responses. In order to test the data for the interviews, the researcher ensured credibility and transferability of the instruments.

1.5 Significance of the research

This study is significant for the Namibian context for several reasons. Firstly, it is the first study of its kind in Namibia to evaluate ICT implementation and integration in science classrooms that are rurally based. The findings should help to inform policy decision-making in ICT deployment and professional development. Secondly, few studies if any on ICT have focused on science classrooms in the rural areas located in the developing countries (Boateng, 2007; Brandt, Terzoli & Hodgkinson-Williams, 2006; Howie & Blignaut, 2009; Kozma, 2006). A number of studies on ICT implementation and integration placed their focus on towns (Ali, 2009; Cossa & Cronje, 2004, Ibrahim, 2009; Matengu, 2006) and on schools leadership (Katulo, 2010). Findings should provide policymakers, principals and science educators with information about the status of ICT implementation in rural areas and where to improve on professional development. This in turn should impact on science teachers' use of ICT.

Moreover, this will contribute to education research, particularly education evaluation research in Namibia, as this is the first study that ventured into evaluation research. The use of the SITES instrument makes it comparable to other studies conducted in the developing world, such as South Africa and Chile. The path followed to analyse the data marks another level of capacity-building in the Namibian education sector for large scale studies, which is relevant to national, regional and international studies.

In addition, the adoption of the curriculum conference approach used in the ICT conference is also unique to Namibia, and possibly also Southern Africa. It was necessary that the respondents verified, legitimised and negotiated the findings for this research before publication. The findings should influence ICT related decision-making.

1.6 Overview of the thesis

Chapter 1 has presented the research questions and background against which they are posed, as well as outlining the potential significance of the research to education in Namibia.

Chapter 2 presents the geographic, political and socio-economic status of Namibia in order to describe the context. The Namibian education system is described with a focus on realising the Namibian Vision 2030 through the Education and Training Sector Improvement Programme (ETSIP). A description of the Namibian ICT Policy for Education is presented and the contents thereof are summarised in the adapted typology of curriculum representation (Van den Akker, 2003). The research problem is conceptualised and related to the importance of the study to Namibia.

Chapter 3 is a review of the literature on ICT in education. In order for the reader to understand the formation of the conceptual framework, the definition of concepts and keywords are presented, followed by the rationale for ICT in education and possible ways of ICT use. Subsequently, consideration is given to ICT implementation at national systems and at school-level in the developed world and in the developing world respectively. In order to conceptualise the framework that guides the study, the relevant concepts are summarised and thereafter the factors that may affect ICT implementation at national and school levels are also discussed, before the chapter is concluded with the presentation of the conceptual framework for the study.

Chapter 4 presents the research design and procedures chosen for the survey, case studies, and the curriculum conference. Firstly, the research paradigm is presented, followed by the research design for the respective research questions in this study. Issues of validity and reliability are discussed before the conclusion.

Chapter 5 presents a description of ICT implementation in rural schools based on the findings of the baseline survey. The profiles of the participants and the participating schools are described before the findings of the baseline survey per construct. The conclusion is then drawn.

Chapter 6 presents the factors affecting ICT implementation in Namibian rural schools based on the quantitative findings and those from the case studies per construct. A summary of what the respondents present as factors affecting ICT implementation is presented before the conclusion.

Chapter 7 presents findings from the ICT use conference. The aims of the ICT use conference as well as the programme followed to generate data for the conference are presented, the results emanating from ICT Conference are discussed. A summary of negotiated findings for the study is presented.

Chapter 8 draws the conclusions and makes recommendations. An introduction to the chapter is presented, followed by a summary of the research project and subsequently the research findings. Reflections on methodology as well as on the conceptual framework are discussed. Finally, the implications for policymakers, education practitioners and researchers are discussed, before suggestions for improvement of ICT implementation in rural schools are presented.

CHAPTER 2

CONTEXT OF THE STUDY

This chapter is a response to research question one of this study: 'what is the national context with regard to implementation of the ICT Policy for Education in rural junior secondary schools?' This research question aims at providing the national context of the Namibian current situation with regard to the National ICT Policy implementation in rural schools. In response to this question, this chapter adopted a document analysis approach and where the information was deemed missing, the National ICT Coordinator was interviewed in order to fill in the gaps.

2.1 Introduction

The chapter starts by presenting the geographic, political and socio-economic status of Namibia (Section 2.2). Section 2.3 presents the Namibian education system and how to realise the Namibian Vision 2030 through the Education and Training Sector Improvement Plan (ETSIP) (Section 2.3). This is followed by the summary description of the Namibian ICT Policy (Section, 2.4), outlining the critical components of this policy. The conceptualisation and rationale of the problem statement of this study are outlined in Section 2.5. Section 2.6 discusses the importance of the study for the Namibian context. Finally, the conclusion is drawn in Section 2.7

2.2 Geographic, political and socio-economic status of Namibia

The Republic of Namibia, previously known as South West Africa, is a vast, sparsely populated country situated along the south Atlantic coast of Africa between 17 and 29 degrees south of the Equator. Namibia has a surface area of 824,268 square kilometres, stretching about 1,300 km from south to north and varying from 480 to 930 km in width from west to east. Namibia boarders South Africa to the south, Angola and Zambia to the north-eastern Caprivi strip, which also connects to Zambia and Zimbabwe. The west coast of Namibia comprises the

Namib Desert, the oldest desert in the world, whilst the Kalahari Desert runs along its south-eastern border with Botswana. The country's coastline is foggy and therefore cooler than the rest of the country. Due to the Benguela Cold current flowing from the Antarctic, Namibia is rich with fish.

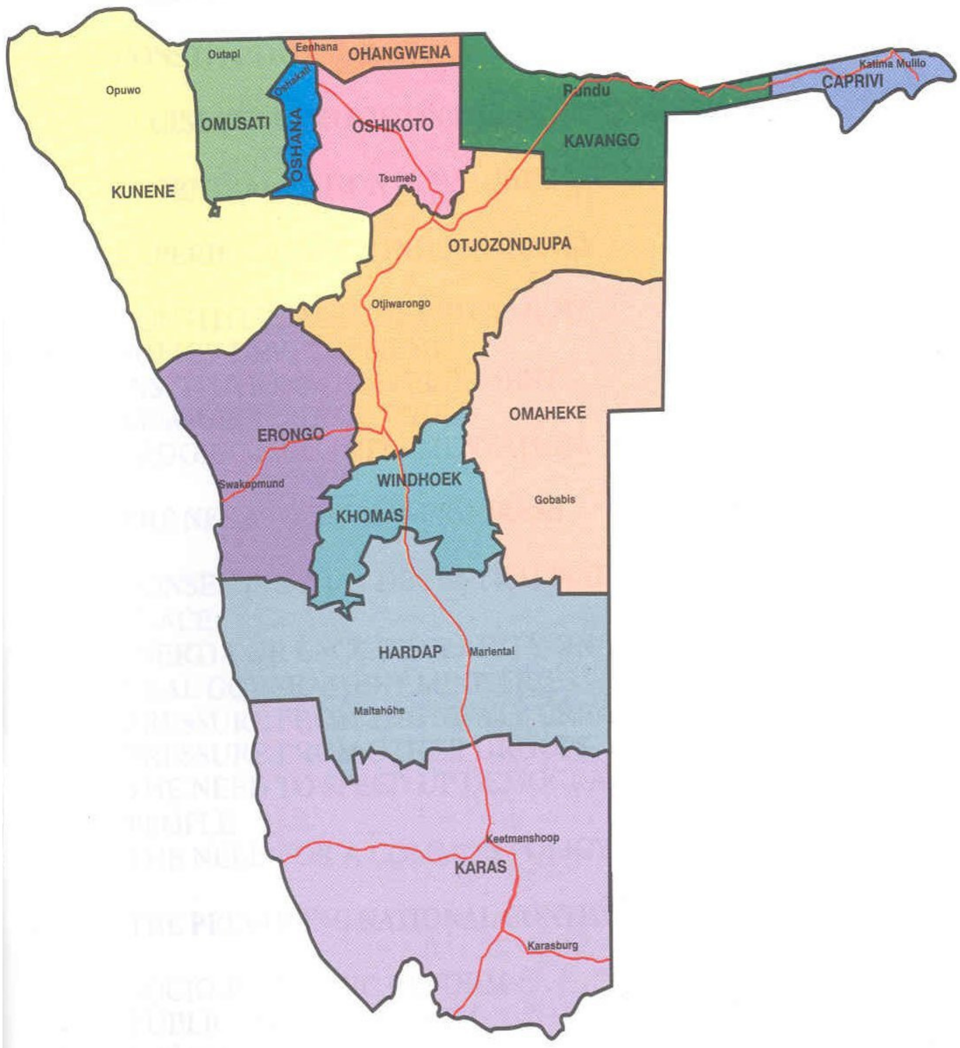


Figure 1.1: Map of educational regions in Namibia

Source: MoE (2009)

Table 2. 1: Namibia profile

The country	**Area of** 824,269 sq. km, date of independence 21 March 1990. The climate varies from arid in the west, to semi-arid and sub-humid in the central and north eastern regions. There are frequent prolonged periods of drought. Rainfall is largely confined to the summer months (November to March).
Government	President Hifikepunye Pohamba has been the president since 2004. Namibia is a republic and adopted a constitution in 1990. The parliament consist of 72-member National Assembly with a five year term, and a 26-member National Council, composed of two members from each of the 13 Regional Councils, with a six-year term.
Capital city	Windhoek with a population of estimated population of 240,000 people
The people	Namibia has a population of 2,088,669 (2008 estimate). Literacy rate is (86.9 female, 88.4, male (1999-2006 estimate), Life expectancy (52.3 female, 51.3 male, 2006 estimate), population density 2.3
Currency	Namibian dollar (NAD). The exchange rate is one to one to the South African Rand (ZAR).
Languages	There are 12 major indigenous ethnic groups. The languages spoken are: English (official), Ethnic groups: Black 87%; white 6%; mixed race 7%. About 50% of the population belong to the Oshiwambo ethnic group, 9% to the Kavango. Other ethnic groups are: Herero 7%, Damara 7%, Nama 5%, Caprivian 4%, San 3%, Baster 2%, and Tswana 0.5%.
Education	Adult literacy rate increased from 84% in 2005 to an expected 90% by 2015 the United Nations Education and Science Community Organisation (UNESCO, 2009).
Economy	GDP: US$7.781bn (2008 estimate), Annual growth: 3.9% (2008 estimate), Inflation: 6.7% (2007 estimate) Major industries: mineral production, tourism, fishing, game and cattle ranching. Major trading partners: South Africa, UK, Spain, Japan, China and USA.

Source: Foreign and Commonwealth Office (2010)

The country's internal boards are demarcated into 13 regions, namely: the Caprivi, Kavango, Kunene, Omusati, Ohangwena, Oshana and Oshikoto regions in the north, the Omaheke. Otjozondjupa, Erongo and Khomas Regions in the central areas and the Hardap and Karas regions in the south (see Figure 2.1, above).

Since the country gained independence in 1990, accomplishment has been made in promoting unity, nation-building and socio-economic development. Apartheid laws have been repealed and provision has been made for the protection and upholding of fundamental human rights in Namibian society. Access to health services and education has improved over the past 20 years.

2.3 The Namibian Education system

At independence Namibia inherited an education system based on segregation along ethnic and racial lines. The apartheid system had led to profound inequalities and disparities in the quality of education provision to the various ethnic groups, a system said to be irrelevant to the Namibian people and in need of reform A new education system was introduced in 1990, grounded on the ideal of *Education for All* (EFA). The education system is built on the four pillars of access, equity, quality and democracy (Education Act of 2001). These were thought to be the principles of investing in human capital to promote socio-economic development. In order to enhance the teaching and learning, the concept of learner-centred education was adopted, which led to the adoption of an instructional policy.

In order to ensure efficiency, Namibia was divided into 13 political regions, headed by Regional Governors. In 2003, these regions were further demarcated into 7 educational regions headed by Directors of Education. The four educational regions in the north were headed by a single Director of Education until 2005, when three more Directors were appointed. Thus, each political region since has had a Director. Like all other government agencies, The MoE follows the Decentralisation Policy and therefore remains responsible for the total administration of the education system. However, the implementation of educational programmes rests with the educational regions.

The formal schooling system consists of 12 years of schooling, as follows:

Table 2. 2: The Namibian school system

School Level	Grade	No of years	Average age of learner	Medium of instruction
Lower Primary	1-4	4	7-11	Mother tongue
Upper Primary	5-7	3	11-13	English
Junior secondary	8-10	3	13-16	
Senior secondary	11-12	2	16-18	

Source: MoE (2009)

The schools are divided into three categories, as follows:

Primary Phase: consisting of Grades 1-4 and Grades 5-7. Grades 1-4 follow a continuous assessment grading system with learners expected to acquire the basic competencies that will prepare them for promotion form one grade to the next. Since 2000, Grades 5-7 followed a different assessment system, with a national Grade 7 examination in Mathematics, English and Science, which upon satisfaction of the requirement sees learners promoted to Grade 8.

Secondary Phase: consisting of Grades 8-10 and or Grades 11-12. Learners write a national examination called the Junior Secondary School Examination (JSSE) at Grade 10 and prior to 2008 Grade 12 learners write the International General Certificate for Secondary Education (IGSCE/HIGCSE) examination. This examination was administered by the University of Cambridge before it was localised in 2008, when the Namibian government adopted the National Secondary School Certificate (NSSC).

Combined schools: These are schools offering both primary and secondary grades, attributed to long distances between both types of school and the population size. In this study, however, the term ‘schools with secondary grade’ is inclusive of combined schools.

A number of education reforms have taken place to address the issues of inequity that existed prior to independence. Amongst the challenges currently faced are: access to education for all, equity of resource distribution to all, building and consolidating a democratic culture, and encouraging the population to become a learning nation. Ideally, by the year 2030 the system should educate nationals who are critical thinkers, scientific and technologically literate and ready for the world of work (Mutorwa, 2004).

2.4 Realising Vision 2030 through the Education and Training Sector Improvement Programme (ETSIP)

In 2004, Namibia adopted *Vision 2030*, a document that clearly spelled out the country's development programmes and strategies to achieve its national objectives. *Vision 2030* focused on seven themes relevant to realising the country's long term vision:

- Equality and social welfare
- Human Resources Development and Institutional Capacity Building
- Macro-economic issues
- Population Health and Development;
- Natural Resources
- Knowledge, information and technology
- Factors of External environment, such as employment creation, access to quality schooling and infrastructure.

In response, the Education and Training Sector Improvement Programme (ETSIP) was developed in 2004, a fifteen year strategic plan (2006-2020) for the Namibian education and training sector. The ETSIP framework aims at equitable social development promoting fairness, gender–responsiveness, care and commitment for all citizens, to enable them to realize their full potential towards developing an industrialised country. ETSIP is also aligned with the EFA goals formulated by the United Nations Education and Science Community Organisation (UNESCO), the

Millennium Development Goals (MDGs) and National Development Programme (NDP3). In order for Namibia to achieve the high rate of economic growth required by *Vision 2030*, it will be necessary to improve on productivity through the use of knowledge and technology (MoE, 2009). However, a full investigation of the education system by the World Bank concluded that, despite government's massive investment, the education system was not producing the right results, due to poor quality, inefficiency, inequity, inadequate management and the impact of HIV and AIDS.

A five-year strategic plan (2006-2011) was developed from the ETSIP document, dedicated to:

- Improving the quality, effectiveness and efficiency of the general education and training systems.
- Systematizing knowledge creation capacity for the production of knowledge to improve productivity growth.
- Improving the effectiveness, quality, efficiency and development-relevance of the tertiary education and training system.
- Strengthening the policy, legal and institutional frameworks to support equitable access to high quality and responsive adult learning.

In an effort to execute the strategic objectives, a budget was allocated to each education sector. Amongst the top priority programmes is the ICT Programme, which ranks third in terms of the ETSIP percentage allocations (see Table 2.3, below).

Table 2. 3: Summary of allocation of funds for ETSIP for 2009/2010

Summary of Allocation of Funds in Namibian dollars (N$) for ETSIP for 2009 / 2010					
Sub-Programme	Percentage of ETSIP	Amount from government	Amount from DP's	Total Allocation	Adjusted Programme Cost due to inflation
		Millions	Millions	Millions	
ECD Pre-Primary	2	2	2	4	7,877
General Education	61	61	54	115	415
VET	10	10	9	19	118.773
Tertiary Education	4	4	4	8	5.786
Knowledge	1	1	1	2	2.594
IALL	5	5	4	9	37.208
ICT's	14	14	13	27	39.171
HIV and AIDS	2	2	2	4	7.959
Capacity Development	1	1	1	2	4.888
TOTAL	**100%**	**100**	**90**	**190**	**655.921**

Source: MoE (2009), p.6.

Based on the information provided in the table above, the ICT National Programme receives a substantial amount of the national budget. This budget is further broken down into allocations for training and usage, as budgeted for and spent in the financial years 2007/2008-2009/10:

Table 2.4 (below) shows there has been an increase in the financial allocation of the ICT Programme in the three years prior to this study. Spending of this vote has also increased. In the budget year 2007/2008, with an under-spending of the budget. In the subsequent years, more money was allocated to training and usage activities. This may be because in the first year most of the training programmes did not take off as planned. Gradually, the government opted to tender training programmes from which training organisations benefited.

Table 2. 4: Total allocation of Training allocation of Training and Usage (2007/2008-2009/10)

Financial year	Budget allocation	Spent as at January
2007/08	2 407 000.00	149 000.00
2008/09	3 404 000.00	1 295 000.00
2009/10	3 800 000.00	3 800 000.00

Source: MoE (2010)

Table 2.5 (below) shows that more than half the ICDL training has been offered to teachers across the country. Generally, ICDL participation was very slow but it gradually picked up as per statistics of August 2009. It is against this background that ICT policy implementation in schools warrants monitoring and evaluation. Depending on the framework adopted for implementation by the government, the implementation process may be influenced by a number of factors at national or system level and at school level. Literature, presented in Chapter 3 of this study, suggests that these factors range from leadership, collaboration, provision of professional and technical support to teachers, infrastructural development and material development required enhancing teaching of science subjects at secondary school level. Some of these concepts were taken into account in the development of the National ICT Policy for Education.

Table 2. 5: Total number of teachers trained in International Computers Drivers License (ICDL) (2007-2009)

ICDL Results after 4 to 12 weeks up to August 2009				Total trainees in years 2007-2009		Total	
	Candidates	Start	Completed	Start	Completed	Start	Completed
Schools	940	205	170	39	18	244	188
VTC's, TRC's Libraries	38	17	13	28	12	45	25
Colleges of Education lecturers	45	7	14	13	31	20	45
Colleges of Education students	0	0	0	0	0	0	0
UNAM	14	0	6	4	10	4	16
Head + Regional Offices	166	38	57	33	17	71	74
Youth Centre	64	23	4	0	0	23	4
TOTAL all Institutions	**1267**	**290**	**264**	**117**	**88**	**407**	**352**

Source: MoE (2009)

2.5 Description of the Namibian ICT Policy for Education

This section presents a description of the National ICT Policy for Education. Firstly, the goals and objectives are described, followed by the levels of categorisation of schools. The description of the framework adopted to implement ICT in Namibian schools is described, based on content development, professional development, collaboration and support, and ICT infrastructure. The developments are reflected in the typology of the curriculum.

2.5.1 Goals and objectives of the National ICT Policy for Education

The National Policy for ICT in education is aimed at supporting the *Vision 2030* in an effort to realise the possibilities of ICT for education; constraints for turning this potential into effectiveness and scenarios of applying these capacities to different environments. The national policy further aims to prepare all Namibia's learners, students, teachers, and communities for the world economy. The policy has it overall goals as follows:

- Produce ICT literate citizens [able to use computers and other technologies to search for and receive information]
- Produce people capable of working and participating in the new economies and societies arising from ICT and related developments
- Lever ICT to assist and facilitate learning for the benefit of all learners and teachers across the curriculum
- Improve the efficiency of educational administration and management at every level, from the classroom, school library, through the school and on to the sector as a whole
- Broaden access to quality educational services for learners at all levels of the education system
- Set specific criteria and targets to help classify and categorise the different development levels of using ICT in education.

The policy also has a set of specific educational goals, such as:

- Providing clear objectives and competencies for learners, students, and teachers to achieve key ICT knowledge and skills
- Monitoring and evaluating curricular goals, indicating exactly what is expected of learners, students, and teachers
- Providing guidance to teachers by clearly presenting the relevant assessment criteria to learners and students.

The strategy to implement ICT in schools is described in the framework below.

2.5.2 Critical components of ICT framework

The purpose of this subsection is to describe the framework used in the ICT implementation process, as depicted in Figure 2.2 (below). Critical components of the framework are explained in line with the information obtained through document analysis and interview with the National ICT Project Manager. In addition, the results of the Working Groups on the critical components of the framework are reflected, to give a description of the national context since the launch of *Tech/na!* or the National ICT Policy for Education Implementation Plan in September 2006. Further, a critical reflection of the situation relating to each component follows the description.

The MoE has adopted the framework below in order to roll out the strategic plan.

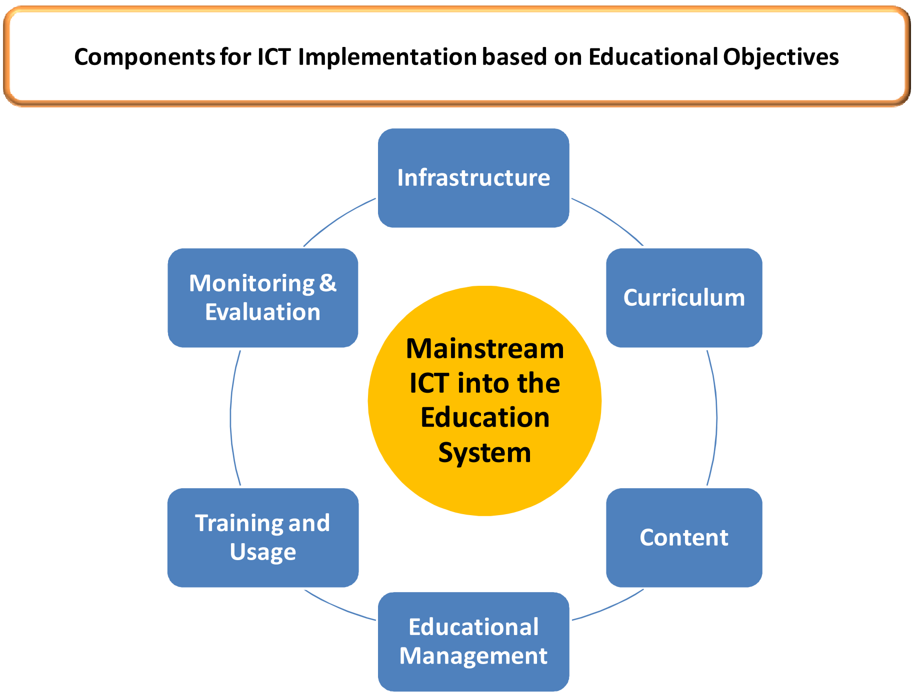


Figure 2. 1: The national ICT policy for education framework

Source: MoE (2009)

This framework influenced the National ICT Policy for Education development by considering the different components as core to the implementation process. These components are: curriculum, content, educational management, training and usage, monitoring and evaluation, and infrastructure. The components are important for the development of the conceptual framework of this study. The policy is considered important for the integration of ICT and the utilisation of the implementation process, whereby the infrastructure should be made available before the curriculum. The curriculum influences the ICT-based materials to be developed and to a certain extent the adoption of the educational management styles that will suit the use of ICT in a particular situation. It will also be considered during teacher training programmes. It is important to note that the coordination, monitoring and evaluation of training of educators in ICT literacy are undertaken by the office of the National Coordinator of the ICT Programme. The National Institute for Educational Development (NIED) on the other hand coordinates the training of educators in their teaching. Also, very important to this framework is the monitoring and evaluation of how ICT is used in all educational settings, and the monitoring and evaluation outcomes will influence infrastructural deployment in educational institutions. In order to achieve these goals, various working groups have been established, consisting of experts in the field of ICT for all educational institutions across the country. The tasks of the respective working groups have been delineated (MoE, 2006) as follows:

Educational Management

It is expected that the principal will be part of the group receiving training in order to motivate the trainees and oversee the trainer. Before the training begins, the trainees sign an agreement to attend at least 20 hours per week. The ICT Implementation plan does not however specify the period in which training should start or end. Initially, training for ICDL took 5 days to complete but had been cut to 3 days due to time, distance and economical restraints. In order to ensure that teachers are prepared for the ICDL examinations, some schools have purchased ICDL dummy test software in preparation for the final test. It is important for the school management to receive training in educational management issues, but the NIED report does not highlight specific expectations other than supervision of the trainer and making sure that teachers attend the training programme.

ICT-based content development

The Curriculum and Content Working Group has a national curriculum framework that guides its operations. For purposes of transparency and representation, the working group conducts consultation with stakeholders on the adaptation of the new syllabus. This activity is still in progress. Particularly, the focus of ICT-based content development is in Mathematics, English, and Science, adopting the open source content for children between the ages of 5 and 12 year old. This activity is followed by the content evaluation done by NIED Research Unit, especially for Mathematics. This working group also develops unit standards, curriculum, and training materials of modules for ICT Integration for Educators. Training on the integration of ICT in all subjects, including Science, is conducted by NIED.

The ICT-based content to be developed targets the lower grades of ages (5-12 years) and therefore contradicts the objectives of deploying ICT in schools with secondary grades. It is not clear when ICT-based content development for secondary schools will start, nor have specific e-content programmes have been mentioned in the report.

Professional development

ICT is introduced as a subject to all pre-service student teachers at the University of Namibia (UNAM) and all four Colleges of Education (COE), as well as for the in-service teacher training at the National Institute of Education Development (NIED). At NIED a laboratory has been set up for this purpose and training is offered for the International Computer Driver's License (ICDL). In order to achieve the objective of professional development as set out in the national policy, World Teach volunteers were recruited as laboratory assistants to pilot the concept in 16 schools that had some form of computer lab. It was later discovered that the results were discouraging. In the year 2006, another strategy to tackle the problem was introduced by awarding a Finnish government-funded tender to the Community Education Computer Society (CECS), a non-profit making organisation, sufficient for 2006 to 2008.

During 2007, CECS experienced delays on the roll-out of equipment and, as a result, the MoE advised CECS not to work in schools during the third term. The focus was therefore redirected to train the five Vocational Training Centres (VTC) and one Teachers' Resource Centre (TRC) personnel. Additional funding to achieve the new directive was obtained from UNESCO.

Over a period of two years (2007 and 2008), 118 teachers completed four of the seven modules of ICDL and only 88 teachers obtained full certificates. In 2009, 290 teachers completed four modules and 264 obtained full certificates. Thus, a total of 408 started the training and 352 full certificates were obtained throughout the tender process. The awardees came from 57 schools that have been trained and are able to receive the next stage of training that is in ICT integration into lessons.

Cooperation and support

The overall functions of Training and Usage Support Working Group is to provide assistance in the form of training to school principals, teachers and teacher educators, to develop all the suitable ICT skills necessary to fostering the effective use of technology in educational administration, teaching and learning, and assessment. The working group fulfils this major role by coordinating trainings in ICT literacy and integration for all educators.

In terms of technical support, the MoE has established a helpdesk at the refurbishment centre in Windhoek. Prior to this initiative, *SchoolNet* received some funding from the MoE to offer this service to schools by training unemployed youth and equip them with troubleshooting skills. The contract with *SchoolNet* was terminated in 2006 following the establishment of the helpdesk centre.

ICT infrastructure

In 2006, after the adoption of the National ICT Policy and at the beginning of the translation of the policy into practice, the MoE outlined its priorities as follows:

- The closeness of learners to entering the workforce (Grades 11 & 12), places them higher on the priority list
- Schools with secondary grades take precedence over those without secondary grades
- Disadvantaged schools require higher focus and attention
- A minimum development level of 2 should be maintained. Thus, the school should have a least one (1) room with ICT, a projector, all teachers with a Foundation Level ICT Literacy Certificate, at least two teachers with an Intermediate Level ICT Literacy Certificate or higher ICT qualification, one class per week and over 20% of communiqués sent through email.

Other than the considerations stated above, the MoE developed a set of selection criteria for deploying ICT to schools as follows:

- Presence of typing classes: 3,000 points for schools offering typing classes
- Presence of Grade 12: 2,000 points for schools with grade 12
- Cluster centre status: 1,000 points for schools with such status. A cluster centre is a school located centrally in a village, which is better resourced than the surrounding schools, and where the poorly resourced schools collect resources and hold meetings.
- Performance Junior Certificate of Education (JCE): proportionately based on 1,000 points for 100% pass rate
- Performance International General Certificate of Secondary Education (IGCSE): proportionately based on 1,000 points for 100% pass rate
- Absence of Electricity: 200 points for schools without electricity.
- Presence of hostel: 100 points for schools with hostels.
- Absence of *Telecom* services: 50 points for schools with no telecommunications infrastructure.

- Learner to teacher ratio: 30 points for schools with a learner: teacher ratio higher than 30:1

In a separate document from the MoE, another list was obtained, in which the selection criteria for ICT deployment were described. This list was more practical as it explained the steps to be followed before ICT deployment. The selection list is presented below:

Step 1: Data Collection

- Data on schools is collected using various methods, e.g. questionnaires, EMIS, EPI, and GIS
- Information such as JCE and HGCSE examination results, learner: teacher ratio, and proximity from regional capital, is gathered from schools in all 13 educational regions.

Step 2: Priority List

- Data processed using the school selection criteria leads to the compilation of a national priority ranking list for schools in Namibia
- This priority list places the most disadvantaged schools at the top of the list on a per region basis as they require the most attention
- Secondary schools with grade 12 are also elevated to the top of the list, ensuring that deployment starts with those that are ready

Step 3: Deployment List

- The deployment list differs from the priority list, since not all schools at the top of the priority list are ready for deployment, i.e. they lack e-readiness
- e-readiness at a school needs to be established before computers are deployed to them.

The following methods are used in compiling the deployment list:

- On-site visits to establish e-readiness.

- Targeted questionnaires requesting very specific information relating to how ready the school is to take on the ICTs, maintain them and integrate them into lessons
- Primary consideration will be given to schools with a champion principal, staff members or teachers who go out of their way to get ICTs deployed to their schools and illustrate a commitment to support those deployments.

Given the list of criteria to be followed in site selection for ICT deployment, it is unclear which list is to be followed. There are many ambiguities in the processes adopted for ICT implementation and a definition of e-readiness is not provided. Within this confusion, schools are identified and supplied with computers. For example, as of 2010, data was collected on the total number of schools provided with computers, broken down into the number operational, non operational and those connected to the Internet.

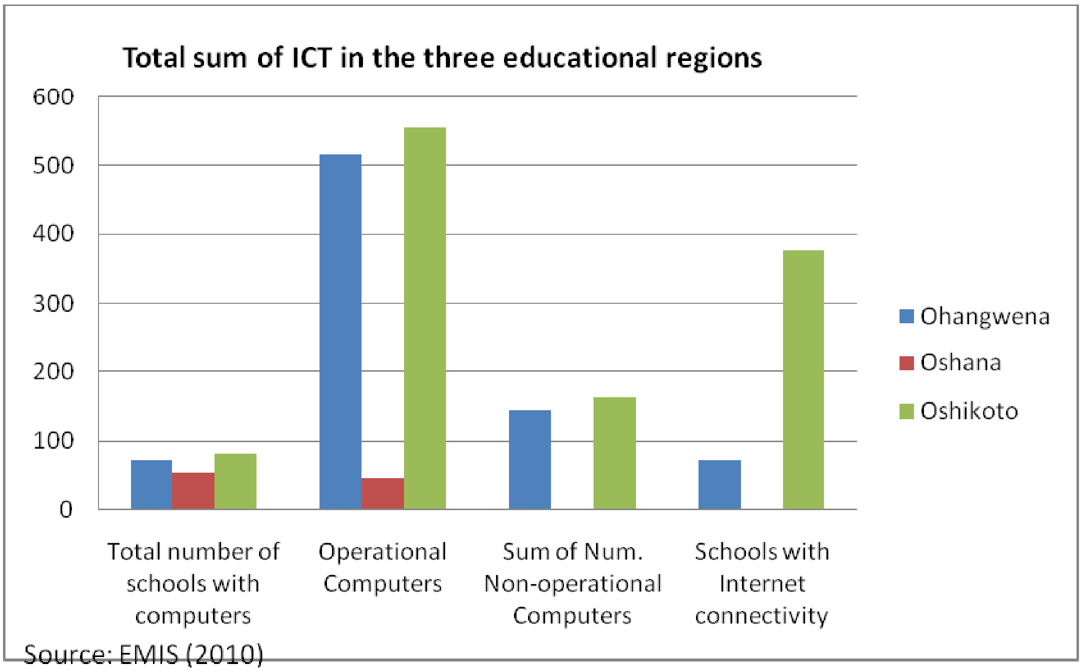
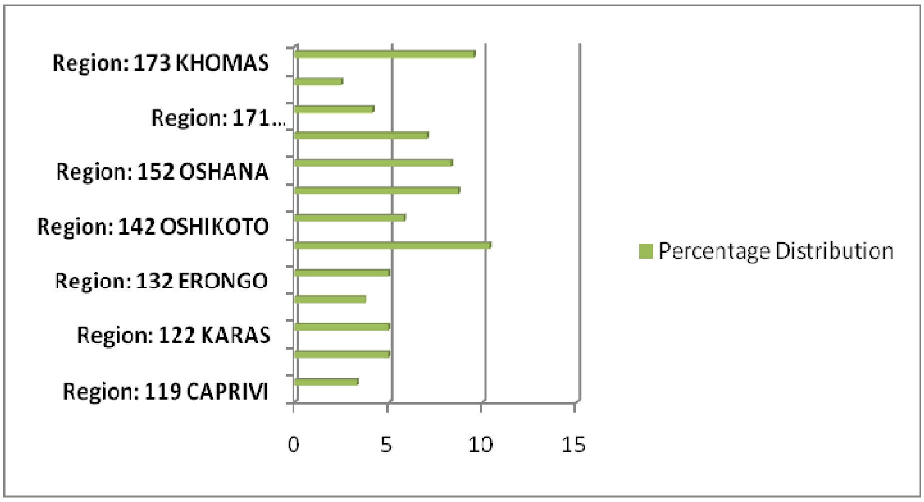


Figure 2.3: Regional distribution as at 2010

Source: EMIS (2010)

Figure 2.3 (above) illustrates the provision of ICT in the three educational regions of interest to this study. Oshikoto has the highest level of ICT provision as well as the highest number of schools with secondary grades, followed by Ohangwena. The information of Oshana was missing from the EMIS (2010). There is evidence that the data in the regions is inaccurate and inconsistent, resulting in the development of specific research question 1, which is oriented towards creating a national context of the Namibian rural area. Besides the missing data in Table 2.1, there is evidence that the MoE is deploying computers to schools.

Table 2. 6: Percentage of ICT distribution per region



Source: MoE (2009).

Table 2.6 (above) shows the regional percentage distribution of ICT as of 2009. The regions of interest to this study are among the highest in terms of receiving ICT from the government project because they are highly populated: Ohangwena (54) with the highest number of schools with secondary grades amongst the three regions, followed by Oshana (44) and Oshikoto (38) described in Chapter 1 of this study.

The levels of development with regard to ICT implementation is shown in Table 2.7 (below):

Table 2. 7: Benchmark of ICT implementation

Level	Teacher ratio to ICT	Student ratio	Time	Infrastructure	ICT use
1	1 or 2 software		1 hour per month for students	A small computer room available One audiovisual/ broadcast facilities	Teachers trained in word processor, Introduction to Internet and information retrieval, prepare teaching documents, use of school management
2	At least 1 for 5 teachers and administrative staff	1 computer to 10 learners	Students spend 1 hour per two weeks	A classroom equipped with a computer, projector system and or audio visual material	Internet, email availability; word processor; learning material downloaded.
3	Better than 1 computer per 3 staff 30% of teachers with ICT qualifications	Better than 1 computer per 10 learners	2 hours per week for students	A class or more classrooms equipped with a computer and a projector	Internet, email, word processing , learning material downloaded, created and uploaded
4	1 computer per 1 staff member More than 50% have ICT qualification	1 computer per 5 learners/students	1 hour per day	Classrooms equipped with a computer and projector and or ability to display audiovisual materials.	Internet, email, e-content creation, spreadsheet, presentation software, modelling software
5	1 computer per 1 staff member More than 50% of teachers with ICT qualification	--------------	4 hours per day per student	A significant number of classrooms equipped with a computer and protector system and or the ability to display audiovisual materials.	Programming, database design and usage; system configuration, a computer based learning blended approach. ICT use for industrialisation

Source (MoE, 2009)

Table 2.7 (above) shows the five levels of development according to the National ICT Policy requirements. Progressively, the MoE wishes all schools with secondary grades to be at least at Level 4, as shown in the table above. However, improvement in the levels will take time and require plentiful resources. As a result, a priority list for ICT deployment is created to ensure that government institutions receive ICT in this order:

- Colleges of Education and related in-service programme
- Schools with secondary grades
- Teacher education programmes at tertiary institutions
- Vocational training

- Primary schools, libraries and community centres, adult education centres and special needs education centres.

In selecting sites for ICT deployment, factors such as cluster centre status, partnership with distance learning organisation, student: learner teacher ratios, power and telecommunication availability, teacher skills profiles and more are used. However, as stated above, the selection criteria are vague. Statistics available in various documents (Annual Report, 2009, Report by trainers) have been inconsistent in terms of figures provided. Inconsistency with the data makes it difficult to believe that the computers have indeed been deployed to the right schools and are being used for the intended purpose.

The integration and utilisation of ICT has been highlighted as one of the important components to consider in implementation. It is from this point that the main research question started its development, that is by investigating the extent to which ICT is being implemented in rural schools and how it is being done, in line with the national ICT Policy for Education. Tearle (2003) argues that there is still a lack of appreciation or understanding by teachers of the complexity of the processes to achieve the potential of ICT use, thus creating a gap between the 'actual use' and 'potential' use (p. 568). In order to address this problem, Van den Akker (2003) offered a typology that is useful in distinguishing the input, process and output of the ICT national programme, an idea supported by Jansen (2002). The National Planning Commission (NPC) (2002) states that it is important to address discrepancies between what the project was created for and how it is actually being implemented in classrooms. A typology of curriculum representation has been adapted for this study as follows:

Table 2. 8: A typology of curriculum representation adapted for the ICT

Intended	Ideal	Vision in ICT for education (rationale or basic philosophy underlying a curriculum)
	Formal/Written	Intentions as specified in curriculum documents and/or materials, more specifically in the ICT Policy in Education
Implemented	Perceived	ICT use as perceived by science teachers
	Operational	Teaching science with the use of ICT in a natural environment
Attained	Experiential	Teaching practices using ICT
	Learned	Skills and knowledge on the use of ICT.

Adapted from van den Akker (2003)

Table 2.8 above has been drawn up to show the vision of ICT in education in general, intentions as specified in the curriculum documents, ICT use as perceived by the science teachers, teaching science with the use of ICT as a process, and teaching practices using ICT and skills and knowledge the science teachers possess about ICT. The intended vision of the ICT Policy for Education may not necessarily be what is being implemented in the science classrooms and therefore the attained teaching practices, skills and knowledge may be affected negatively or positively.

2.6 Conceptualisation of the problem

In general, there is little research indicating on which arguments or factors to base decisions regarding ICT implementation in schools (Anderson & Plomp, 2009). Dede (2000) claims there is a need for large-scale implementation because without extraordinary resources or heroic efforts, successful-implementation of new educational approaches in typical classrooms has proven difficult (p.298). This claim is supported by Bakia, Means, Gallagher, Chen and Jones (2009) (2009) who surveyed 52 state educational directors; 1028 district technology directors; 4934 teachers by the year 2006-7 in an effort to provide descriptive information about technology practices in relation to the core objectives of the

United States Government Department of Education's Enhacing Education through Technology (EETT) programme. Also in support of this claim is Gaible (2008) who conducted surveys of ICT in education in the Carribean region. Overtime, more schools are receiving ICT and getting connected to the Internet, so there are more demands placed on the working groups to address problems arising from the emergent technology. It is important that the government pronounces clearly its position on the strategic educational ICT policy rationales to be followed. It is noted that national ICT policies have greater impact if aligned with other strategic and operational policies (Kozma, 2008). Further, Kozma (2008) offers a framework that can be used to measure the extent to which the Namibian ICT policy is focused.

Table 2. 9: A summary of the rationales strategic policy for educational ICT

Goals	**Rationales**
Strategic educational ICT policy	Support economic growth
	Promote social development
	Advance educational reform
	Support educational management
Operational	Infrastructure development
	Teacher training
	Technical support
	Pedagogical and curricular change
	Content development

Source: Adapted from Kozma (2008)

Table 2.9 (above) shows the possible categories of goals of the national ICT policy as phrased by Kozma (2008). The strategic educational goals are articulated at national or systems level and these categories can be used to articulate Namibia's national goals as stated in the National ICT Policy for Education. The rationale for introducing ICT in education should be expressed in a very clear statement, so that the implementers at national as well as school level know which strategies to adopt. Kozma (2008) suggests a number of components to be studied in order to determine the level of operation using ICT. Depending on the focus of the strategic educational ICT policy goals, multiple statements can be adopted at one specific time. In order to determine the level of implementation and operation of the ICT programme, a large scale study needs to be done to determine the key indicators for this.

In general, Namibia lacks large scale data sets to illustrate how ICT is being used across educational regions, or which can give indications in a wider context on how the National ICT Policy is being implemented. To date, no study has been conducted to evaluate how ICTs have been used by the teachers, especially rural teachers, since the introduction of ICT Policy in Namibian schools. Policies are often not appreciated due to lack of understanding of the complexity, technicality of the processes required to achieve the national goals, and the fact that the effect of policies are also unknown (Anderson & Plomp, 2009; Tearle, 2003). The lack of pronouncement in the government documents has lead to different stakeholders defining and interpreting the relevance of programme initiatives in different ways (Kozma, 2005). Also, very little money is available for policy-related research in science education that could assist the implementation decisions on an informed basis (Volmink, 1998).

In conclusion, the Namibian government has introduced a range of initiatives in areas such as ICT deployment, teacher training and promotion of affordable access to ICT, and also the promotion and expansion of bandwidth. Lack of policy implementation is mostly felt in the rural areas, where poorer people reside. Reasons often given for this failure to supply out-of-reach rural areas include costs, inappropriate design or lack of infrastructure, poor quality of education, human resources and lack of support from government (Parliament Office of Science and Technology, 2006). If Namibia is to fulfil *Vision 2030*, it is necessary to provide the basic needs to rural areas where the majority of the Namibian people live, and to equip the people with the skills that will enable them to live in world of technology. Education has a role to play in the lives of all people, regardless of where they live. The rural areas need more attention and therefore this study is undertaken.

2.7 Importance of the study for the Namibian context

Within the conceptualisation of the study, the relevance can be summarised as follows.

Firstly, this study provides a background and context to the rural areas of Namibia, with regard to ICT provision to schools and use thereof for pedagogical purposes. This is important in providing a knowledge and value base for policymakers to make informed decisions about cost effectiveness and efficiency of service provision to rural schools, and subsequently achieving the national goal of Namibia being a technologically literate nation by the year 2030.
Secondly, the study can help in understanding the use (or lack of use) of ICT in rural classrooms. It is expected that the pedagogical practices used by the teachers will be an important means of improving ICT policy implementation, and if necessary followed by changes in teachers' curriculum goals and practices. The policymakers are therefore considered to be the major beneficiaries of this study, while teachers need the data generated through it to inform their own pedagogical knowledge.

Thirdly, this study analyses the use of ICT in rural schools, and the results from the research will provide information about the level of ICT provision and competence of science teachers in rural schools. The survey results will inform policies designed to address the issues of equity in rural schools. The national ICT coordinator, school principals, and ICT technicians partake in the process of the support system for teachers in rural schools, and therefore they have been included as participants who can provide the relevant information. The thrust of this component is to improve efficient delivery of support services to the poor rural schools.

Fourthly, this study will provide an analysis of the operational components of the ICT Policy. The operational components include infrastructural development, teacher training, technical support, pedagogical and curricular change and content development (Kozma, 2008). This information is necessary for the policy developers in consideration of the areas for improvement and strengthening the programme in order to effect change at classroom level.

2.8 Conclusion

Chapter 2 has presented the National ICT Policy for Education and the requirement by the Namibian Government to implement ICT in rural junior secondary schools. The goals of the policy are aligned to the Namibian *Vision 2030* through ETSIP as a way to achieve a nation that is ICT literate. A number of schools, including rural ones, have received ICT over several years, however there are inconsistencies in the government statistics on the number of computers received and teachers trained. There are no proper records of ICT availability in schools, nor sufficient information of how ICT is being used in schools or the factors that lead to it. Such information is necessary to inform the decision-making process with regard to ICT implementation in rural schools.

In order to provide a theoretical framework for the research, a literature review is presented in the next chapter.

CHAPTER 3

LITERATURE REVIEW

This chapter reviews the literature relevant to ICT use in education, more especially in the junior secondary school science curriculum and implementation thereof in the rural areas of northern Namibia. Prior to the discussion, the research questions are presented, followed by the sources used to find out what is already known about the topic, the main conclusions and theories related to the topic being addressed. This chapter starts with the introduction to the chapter in Section 3.1. The key words used in this study are presented in Section 3.2. The rationale for ICT use in education is presented in Section 3.3, followed by the general use of ICT in education in Section 3.4. ICT implementation is presented in two sections: in the developed world (Section 3.5) and in the developing world (Section 3.6) respectively. This distinction is followed by the factors affecting the ICT implementation at school and teacher levels respectively (Section 3.7). Finally, the conceptual framework is introduced (Section 3.8).

3.1 Introduction

The main research question of this study is '*How and to what extent is the intended ICT Policy for Education implemented in junior secondary schools in rural areas in Namibia?'* In order to answer this question the study has been broken down into two components, as presented in Chapter 1. The study first addressed research questions 1 and 2 respectively which followed a descriptive approach. Research question 1 is: '*What is the national context with regard to ICT Policy for Education implementation in rural junior secondary schools?,* which sought a context analysis of the implementation of the ICT Policy. Research question 2 is: '*How has the ICT Policy for Education been implemented in rural schools?'* and requires a baseline survey with the aim to give an overview of a rural situation with regard to ICT infrastructure availed to the schools in the educational regions under investigation.

The second component of the study followed an in-depth analysis and exploration approach in an attempt to find answers to research questions 3. Research question 3 reads: '*What factors influence the ICT Policy implementation in rural schools?'* and aimed to gain an in-depth understanding of the rural situation and meaning of the participants.

The two components of this study were informed by literature. Various sources in electronic format and in printed form were reviewed (see below), in search of what is already known about the topic under study. Concepts and keywords such as 'rural schools'; 'ICT in education'; 'ICT in developing countries'; 'ICT and science education'; 'ICT implementation'; 'IT and education'; 'ICT policy implementation'; 'ICT use in schools' and 'ICT use in classrooms' were used to find information relevant to research questions 1 and 2, particularly in terms of contextualisation of the ICT implementation intentions and also to inform the survey with recent data internationally and regionally. The term 'IT' is included in this literature search because some authors have used it interchangeably with ICT. For example, the term is used as information technology (IT) in North America or Information Communication Technology (ICT) in Europe (Voogt, 2003). Where possible, in this dissertation, ICT is used.

The research questions addressed through the in-depth analysis and exploration approach were also addressed by searching the keywords mentioned above, and in addition by 'teachers and ICT'; 'curriculum and ICT' and 'ICT and secondary education'. Following these terms, there is a general understanding that the transformation towards an information society implies that many countries have to change their curricula and therefore teachers need to develop competencies that are not used in the traditional ones (Kozma, 2005).

Scientific sources were searched through academic libraries, such as the University of Pretoria and University of Namibia, and also through various search electronic engines via the Internet, including: *ERIC*; *Google scholar*; *Science Direct*; *Scirus ETD*; *Tucks* (an electronic journal of which the University of Pretoria is a subscriber); and *Wiley InterScience.* A large number of articles were found from these sources, of which a selection was based according to the date of publication and context. Also, 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 and books considered in this study were published between 1998 to 2009, because the pace at which ICT changes is faster than the rate at which publications are produced.

Table 3. 1: Keywords used in various databases

	Springer	Scirus ETD search	Google scholar	Science Direct	Wiley InterScience	ERIC
Use of ICT			✓	✓	✓	
ICT use in schools	✓		✓	✓	✓	✓
ICT in education			✓	✓	✓	✓
ICT in developing countries			✓	✓	✓	✓
Educational Policy and ICT	✓		✓	✓	✓	✓
ICT Policy	✓		✓	✓		
Rural education		✓	✓			✓
ICT use in classrooms	✓		✓	✓	✓	
ICT use in science	✓		✓		✓	
ICT and entrepreneurship	✓		✓	✓	✓	
ICT and entrepreneurial leadership	✓		✓	✓	✓	

A number of authors appeared to have been quoted by others many times, and these drew the attention of this author for inclusion in the literature review of this study. These are: Anderson (2008); Dede (2000); Law, Pelgrum and Plomp (2008); Kozma (2008); Pelgrum and Anderson (1999); Plomp and Brummelhuis (2001); Plomp (2006); and Voogt (2003, 2005, 2008). Most of these authors provide references to international studies conducted around the world in an attempt to study ICT policy implementation including implementation of policy in the developing world. The literature review also considered current theses in the same field as this study, written both internationally (Boateng, 2007), and regionally (Cossa, 2004; Iipinge, 2010; Matengu, 2006; and Thomas, 2006), but within the context of advancing ICT in developing parts of the world.

The literature review focused specifically on issues related to 'ICT Policy implementation' in 'rural schools' in developing countries, and specifically in the science classroom. Science teachers' use of ICT is therefore being investigated for effective science curriculum implementation. The thrust of most authors is to improve on science teaching using ICT in rural areas.

Having presented the research questions being addressed by the two components of this study, as well as the sources for the literature review, the next sections deal with defining the terms mostly used in the dissertation (Section 3.2).

3.2 Definition of concepts and keywords

The section below presents the definition of concepts and keywords frequently used in this study, as understood and used by the researcher, in particular *rural school*; *Information Communication and Technology (ICT); intended curriculum; implemented curriculum; attained curriculum;* and *policy.*

In a *rural school*, schooling may be interrupted by the demand from school-aged children, their poor health, non-existent sanitation, and difficulties associated with access. The teaching is often of poor quality and poorly supported in terms of attracting high quality teachers, infrastructure and teaching resources (World Bank, 2000).

Information Communication and Technology (ICT) refers to computer technology, multimedia, and networking, including the Internet. In some countries, such as the United States of America (USA), the term "technology" or "information technology" is used, but slowly this appears to be changing to include ICT (Anderson, 2008). ICT has become more accessible to people in both the developed and developing worlds, and more embedded in society. ICT offers the potential to restructure organisations, promote collaboration, increase democratic participation of citizens, improve the transparency and responsiveness of governmental agencies, make education and healthcare more widely available, foster cultural creativity, and enhance the social interaction of individuals with different abilities and cultural background (Kozma, 2005). Czerniewics (2005) distinguish between physical and epistemological access to ICT where not only do users need the physical infrastructure but also need control over what and when computers are used.

Intended curriculum refers to the competencies needed to achieve educational goals. It is noted that there may be gaps between the needs of the society as expressed by policy makers and the way these needs are understood by schools and teachers (Van den Akker, 2003)..

Implemented curriculum refers to what teachers and learners actually do in the classroom (Van den Akker, 2003).

Attained curriculum describes the learning outcomes and experiences of students as well as, when appropriate, the learning outcomes for teachers. The learning outcomes are particularly influenced by what has been taught, i.e., the implemented curriculum. It is a challenge to create a consistency and balance between these different curricular representations (Van den Akker, 2003).

Policy refers to decision-making about whether and how to integrate ICT into teaching. Policy decisions are made at national and/or regional and school level (Anderson & Plomp, 2009).

Given the definitions of concepts and keywords, it is imperative to present the context within which they are presented in the literature that forms part of this thesis.

3.3 Rationale for use of ICT in education

This section presents the perceptions on which the adoption of ICT has been built over the years. The rationale for ICT adoption is summarised, followed by the pedagogical use of ICT as the focus of this thesis. Perceptions created on ICT use by teachers are also presented.

It is generally believed that ICT has potential economic benefits to all and has therefore become part of the daily life. Currently, ICT is widespread across all nations and the education sector, and other sectors have been attracted to utilise its perceived benefits. This has led to most countries subscribing to this notion, and as a result being forced by circumstances to put systems in place to introduce ICT to education. In turn, the introduction of ICT in education has been identified with various applications, with choices of application ranging from the combination of context of use, the possible technologies to select, and the instructional moment in which it could be used. This is a global phenomenon as the world is trying to achieve the MDG goals of becoming a knowledge-based economy. The general use of ICT is expressed through national policies and categorised into the *social rationale*, vocational *rationale* and *pedagogical rationale*, defined by Voogt (2008: 118).

- The *social rationale,* related to the preparation of students for their place in society
- The *vocational rationale,* emphasising the importance of giving students appropriate skills for future jobs
- The *pedagogical rationale,* focused on the enhancement of teaching and learning, and using computers.

The social rationale refers to socio-economic conditions associated with ICT use. The role of ICT in global socio-economic development is well documented in literature (Evoh, 2007; Kozma, 2006, OECD, 2010), with Fullan (1993, 2001) emphasising that education has a moral purpose to make a difference in the lives of learners, regardless of background, and to help produce citizens who can live and work productively in increasingly dynamic complex societies. Thus, all children in all societies need to be prepared for ICT and the communication society (Doornekamp, 2002; Valentine & Holloway, 2001). The paradigm of how ICT can benefit society has manifested itself over the years. It is argued that the more people are ICT-literate the broader the spectrum of achieving the Millenium Development Goal (MDG) of becoming a knowledge-based economy. It can also be interpreted as strengthening the developed world's industry, and creating for the developing countries opportunities for job creation and subsequently poverty alleviation.

In the same light, the vocational rationale came into being. It is argued in this framework that acquisition of ICT skills broadens the spectrum of job opportunities and subsequently alleviates poverty, hence the need to train students' competence, creativity, and entrepreneurship (OECD, 2010, Tárrago, 2009). This idea originated in the developed world and progressively moved to the developing countries, where it is still eminent and where the idea of becoming an industrialised nation is expressed. However, there is much debate as to how to measure the impact of ICT on the livelihood of the people exposed to it. Countries need to be internationally competitive in order to utilise and harness its full potentials, and failing to do so means failing to meet the needs of the people, the country and its economy. These perceptions have placed high demands on the school curriculum, rather than generating answers for the education sector.

The demands for ICT in the school curriculum have become compelling over the years. Hinostroza, Labbe, Lopez and Iost (2008) summarise the arguments for introducing ICT to education. The use of ICT in teaching and learning can improve students' outcomes, as explicitly stated in policy documents and implicitly while reporting on progress of national ICT in education. In addition, the use of ICT may improve curriculum, pedagogy, assessment, teacher development and the quality of the school. However, these statements are not left unchallenged. It is argued that the intentions of using ICT in education has not always been realised (Voogt, 2008) due to a number of factors to be discussed below.

Anderson and Plomp (2009) noted that making decisions about whether and how to integrate ICT into teaching and learning is sometimes complex, technically demanding, and the effects thereof are not always known due to lack of research on which to base the decision. It is imperative therefore for countries to develop national ICT policy to serve as a guide to what needs to be done, when, and by whom, for the smooth implementation of ICT. A number of countries developed their national ICT policy for education, ranging from Global and cross-national policies, national policies and school-level policies. However, It was noted over time that having national policies in place did not guarantee feedback to decision-makers. These policies need to state a developmental strategy that articulates a vision on how this goal is to be achieved (Cecchini & Scott, 2003; Kozma, 2008; Law, 2009). This demanded a lower level of introducing school-level policy to engage the school leadership more in an effort to strive for quality in schools.

A pattern of introducing new ideas to the way people benefit from ICT can be traced, most ideas forming a convergent pattern towards introducing ICT to education for pedagogical use. Progressively, ICT developed its roots into the school curriculum, however adopting it requires measures putting in place for checks and balances, expressed through national systems or policies. It is important that the policies also state how ICT should be used.

3.4 General use of ICT in Education

This section summarises the general use of ICT in education, with a model of innovative uses of ICT presented and adapted to suit this study. This information is useful in classifying science teachers in an effort to investigate how ICT is being implemented.

It is argued in Section 3.3 that ICT offers much potential to enhance teaching and learning. Ainley, Enger, Searle (2008) note that there is currently little understanding of the way in which ICT is used in schools and classrooms around the world. Statistics that were collected for the SITES 2006 regarding the use of ICT in education internationally have shown that albeit this is increasing, for the majority of teachers it is still a tool used only in the margins of the educational process (Plomp, Pelgrum & Law, 2008). It is important for the national policy to state what ICT should be used for in schools and at classroom level. Further, Ainley et al. (2008) state that in the national policy document, the use of ICT should be made clear to the stakeholders so that money and effort can be spent appropriately. In addition, Kozma (2008) argues that the decisions involving ICT use should be informed by a strategic educational ICT policy framework, and that without a strategic rationale to guide the national use of ICT the effort of educational stakeholders may diverge.

Kozma and McGhee (2003, 2006) offer a model of classification of uses of ICT:

Table 3. 2: An adapted model of patterns of uses of ICT

Patterns	**Characteristics**
Tool use	Teachers use email, produce documents, information search, word processing and multi-media
Information management	Teachers use ICT to organise, manage and use information for teaching and learning, and to present information
Teacher collaboration	Teachers design instructional material or activities
Product creation	Teachers design and create digital products using software packages
Tutorial projects	Teachers use tutorials or drill-and-practice software to allow students to work independently

Source: Adapted from Kozma and McGhee (2003, 2006)

The teachers' use is outlined in Table 3.2 (above) to present the different uses for ICT in general. These patterns emerged from findings of the SITES Module 2

(SITES M2) study comprising 174 case studies in 28 countries (Kozma, 2003), modified to answer research question 2 of this study. In the Namibian ICT policy, intended ICT uses were described in Chapter 2 of this study, but since is not guaranteed that these are being implemented as intended, it is necessary to evaluate and measure the use of ICT by science teachers in rural Namibia against the adapted Model of patterns of innovative use.

Particularly, in the science classrooms teachers use ICT for exploring simulations of scientific phenomena, modelling scientific process, capturing and analysing data automatically and being able to access and communicate scientific information (Webb, 2008). Hennessy, Wishart, Whitelock et al. (2006) realised that teachers require opportunities to discuss, reason, interpret and reflect on scientific concepts they might have introduced in their lessons. In order to achieve these, teachers need a wide range of skills, in such fields as ICT, communication, problem-solving, information-handling, teamwork and collaboration, meta-cognition and positive attitude generation (Kozma, 2008).

The information about the general use of ICT is key to this thesis, as what teachers do with it at classroom level is not known in Namibia. The researcher agrees with Anderson and Plomp (2009) that decisions to implement ICT should be based on research outcomes, geared towards achieving the Namibian educational goals. In this light, the research question 2 evaluates how far away Namibia is in terms of achieving ICT educational goals as stated in the national ICT policy. The ICT uses identified by Kozma and McGhee (2003) are applicable globally, including in Namibia, though that does not necessary imply that they are applicable to Namibia. Rather, they serve as a form of reference for Namibia to reflect on possible adoption.

In conclusion to this section, the introduction of ICT in education is based on perceptions and the need to advocate an agenda like that of social development, to serve vocational and/or pedagogical needs. All ideas co-exist and in the end drive an educational agenda, leading to ICT spreading its roots into education. In

Namibia, the curriculum changes were made to accommodate this need, and required teachers' skills to be upgraded in order for them to keep up with the technological demands. Various ICT uses have been identified for tool use and for pedagogy. It is important to present evidence from different countries on effective ways of using ICT in schools. The experiences from schools in other countries describe innovative pedagogical practices using ICT and identify contextual factors that impact on educational practices and consequently on national policies and implementation strategies. The experiences of countries in the developed world are discussed in the next section.

3.5 ICT implementation in the developed world

Several authors have advocated greater implementation and spread of ICT in education within the developed world (Cecchini & Scott, 2003; Fullan, 1993, 2001; Kozma, 2005, 2008; Pelgrum, 2001; Polikanov & Abramova, 2003, Valentine & Holloway, 2001). The majority of research and evaluation studies conducted to date indicate that IT tools can be used successfully to extend educational opportunities widely available (Kozma, 2008). However, the dream of enhancing the quality or effectiveness for all with these same IT tools remains elusive in many cases (Reeves, 2008). This concern has developed in continuous research arenas over the past few years.

In response to the concern above, the International Association for the Evaluation of Educational Achievement (IEA) Science Study conducted a number of studies on ICT implementation in the developed world. An independent, international cooperative of national research institutions and governmental research agencies, it aims through its comparative research and assessment projects (1999) to:

- Provide international benchmarks that may assist policymakers in identifying the comparative strength and weaknesses of their educational systems

- Provide high-quality data that will increase policymakers' understanding of key school- and non-school-based factors that influence teaching and learning
- Provide high-quality data which will serve as a resource for identifying areas of concern and action, and for preparing and evaluating educational reforms
- Develop and improve educational systems' capacity to engage in national strategies for educational monitoring and improvement
- Contribute to development of the world-wide community of researchers in educational evaluation

Amongst the studies conducted widely across nations are the Second Information Technology in Education (SITES) studies. These were conducted in phases over a number of years, addressing different needs at a time. The SITES are useful for this study for a number of reasons. This study shares the same objectives as SITES, that is, to find the extent to which ICT is being used in education and which objectives education systems had implemented and considered important in the knowledge-based economy. This study has an interest in qualitative research, particularly on innovative pedagogical practices that use ICT, and the study sought to determine how these practices were sustained and the outcomes they produced. This study has its major focus on investigating the extent of ICT implementation and integration in science teaching, and also to identify factors that contribute most to the effective implementation or integration of ICT. In addition, other studies are cited as relevant to this study at national level as well as at school level. Literature about the national systems level is presented in the next section.

3.5.1 National systems level

This section presents literature on ICT implementation in education at the national systems level in the developed world. Firstly, the ICT implementation at national systems is presented with examples drawn from the SITES studies, Finland and Lithuania. These two countries have been chosen as examples based on the fact that Finland is said to be a success story that has evoked considerable interest in the Finnish school system in general and its pedagogical practices. Lithuania, on the other hand, started its second strategy in 2004, about the same time Namibia also started to roll out its TechNa Programme (see Chapter two). It was therefore significant to compare the success story of Finland and what was happening in Lithuania, also a developed country. Secondly, ICT implementation at school level is presented drawing findings from SITESM2, The European e-learning forum for education (ELFE) project, involving Finland and Lithuania, for purposes of obtaining a broad overview internationally.

SITES Module 1: Indicators Module (1999)

The SITES Module 1 (SITES M1) was an international comparative study designed to help countries estimate their current positions with regard to using ICT in education in comparison to other countries. The study established baselines against which developments could be judged in subsequent years. Moreover, the comparative data were intended to assist national policymakers reflect upon improvements that may be considered for the near future. The study was composed of a survey for principals and technology coordinators from a representative sample of schools in a total of 26 countries in Europe, North America and Asia. The data collection for the study took place between November 1998 and February 1999 (Pelgrum & Anderson, 1999).

Despite the general increase in the availability of computers and their connection to the Internet, the problem most often mentioned by respondents was the insufficient number of computers, peripherals, copies of software, and computers that could simultaneously access the Worldwide Web. However, the second most-often mentioned problem was teachers' insufficient knowledge and skills regarding ICT. While the majority of schools reported having a policy goal of training *all* teachers in the use of ICT, in most countries having participated in SITES-M1 this goal was achieved only in a minority of schools. For the technology coordinators, that is, those persons who answered the technical questionnaire, the majority across countries responded that they were adequately prepared with regard to *general* applications (such as word processing, data base and spreadsheet software), while a much lower percentage indicated that they were adequately prepared in the *pedagogical* aspects of ICT (for instance, didactical integration and application of subject specific software). A follow UP study, M2 and subsequently SITES 2006 was conducted.

SITES 2006

According to Law, Pelgrum and Plomp (2008), the major aims of SITES 2006 are to provide international benchmarks of (i) how in the information society pedagogical practices are changing, (ii) the extent to which ICT is used in education, and (iii) how the use of ICT is associated with (changing) pedagogical practices. In addition, the study aimed at building upon the large number of case studies of innovative pedagogical practices supported by ICT, to investigate the factors associated with the use of ICT and the nature of pedagogical practices found in schools and among teachers. SITES 2006 surveyed school principals and technology coordinators, as well as mathematics and science teachers at the lower secondary education level, and it had its focus on pedagogical practices and how these are supported by ICT. Findings from SITES 2006 were as follows:

- Almost all participating countries had computers and Internet access for pedagogical use. However, ICT adoption by teachers differed, varying from 20% to just over 80%.
- Teachers' understanding of the 21st century skills requirements varied and was making a major difference in how teachers were utilising ICT in their classrooms.

- ICT use in teaching and learning had brought about changes in pedagogy in mathematics and science classrooms. Teachers' practices involved use of ICT, showing signs of strengthening 21st century orientation.
- The most serious obstacle to ICT use in the classrooms were school-related factors. Specifically, pedagogical support was lacking.
- The extent of ICT use did not depend only on school factors but also on national curriculum policies, as evidenced by the huge differences in the extent of ICT adoption by mathematics and science teachers within the same country (Anderson & Plomp, 2009).

These findings inform this study in comparative ways and also in terms of identifying new and interesting results, if any, from this study. In doing so, the outcomes will assist national policymakers to make informed judgments about developments in their national education system as compared to other countries (Law, Pelgrum & Plomp, 2008).

Anderson & Plomp (2009) revealed gaps in countries that took part in the SITES 2006 study, most of the education systems that took part indicating that they did not have specific policies on ICT requirements for teacher specifications. About 50% of the education systems had no formal requirements for key types of teacher development, nor a system-wide programme geared towards stimulating new pedagogies. For purposes of comparison results from other developed countries are presented.

Finland

Kankaanranta (2009) summarises the success story of Finland. A rapid rise in educational attainment was observed as a result of the principle underlying Finland's education system, notably equal education opportunities on a lifelong basis. Access to education has been strengthened in terms of breadth and applicability for all population groups and regions, irrespective of their age, place of residence, economic status and language. According to the findings of SITES 2006, Finland has 100% access to computers and networks for all lower secondary schools. Students at this level of schooling had at least five years of computer experience and a computer at home. About 96% of science and 95% of mathematics teachers were reported to have a computer at home, with the majority using them for pedagogical related activities. The teachers used computers to teach at least once a week due to lack of time, too few digital learning devices at school, lack of ICT resources for students outside school and teachers not having the pedagogical skills necessary for using ICT when teaching. These experiences have posed challenges to the Finnish government to revise its ICT strategy to one that emphasises national values, has a deeper understanding of the foundations of innovations of education, and strongly emphasises enhancement of social skills, especially communication, necessary for a contemporary network economy. The strategies intend all teachers to have outstanding information society skills, and for ICT to be part of the multiform teaching at all levels of education.

Lithuania

Another case of interest to this study is that of Lithuania, summarised by Markauskaite (2009). ICT implementation into the general education system has undergone many reforms and dates as far back as 1980. In 2003, the Lithuanian government announced a new strategy to implement ICT in education that focused on developing an accessible system that would guarantee lifelong learning and social justice, and ensure high quality education that would allow technological skills acquisition directed to socio-economic advances. The challenge, however, lay in developing the ICT-related competencies of subject teachers. Currently, teachers' ICT skills are shallow and perhaps insufficient to teach students integrated lessons.

At school level, most schools have their own ICT strategies, and purchase their own tools based on the school's needs. Student: Computer ratio had dropped from 33:1 in 2002 to 13:1 by 2006, with dedicated computer rooms and only 18% to be found in regular classrooms and 12% in libraries. About 50% of these computers were connected to the Internet and access at home for students and teachers was about 33%, less in the rural areas.

Conclusion

The objectives of SITES 2006 studies match those of this study by way of evaluating provision of ICT, its use and how it influences pedagogical changes. Given this information, SITES benchmarks are useful for comparative reasons. Two countries, Finland and Lithuania, have been singled out to illustrate that countries in the developed world can be successful and yet also experience challenges, despite the high level of accessibility in Finland. On the one hand, Lithuania started with its ICT programme at the same time as Namibia and has almost similar challenges of accessing ICT in urban as well as rural areas, Internet connectivity and needs for professional development in order to realise the stated educational goals. Both countries could learn from the Danish professional development programme, which started with a pedagogical IT driver's licence in 1994 and gradually integrated ICT in the mainstream programme of an in-service teacher training programme. Subject-specific courses were developed as follow-ups for ICT licensed teachers (Larson, 2009).

In conclusion of this section, ICT implementation varies from country to country. The SITES study developed the benchmark against which countries could measure the level of ICT implementation. Two examples were cited as examples to illustrate the disparity that exists within the developed world.

3.5.2 ICT implementation at school level

This section presents the school-level policy developments as identified in the developed world. Findings from a large scale study, SITES Module 2 (SITES M2) cases and the The European e-Learning Forum for Education (ELFE) Project are presented, followed by the examples for Finland and Lithuania for purposes of consistency in tracing how the national systems are operationalised at school level.

SITES Module 2 (SITES M2)

Like the other two SITES study in section, SITES M2 is an international study of innovative pedagogical practices that use information and communication technology (ICT). A total of 28 countries participated in the SITES M2 study. National panels used common selection criteria, modified by national context, to identify 174 innovative classrooms. A common set of case study methods was used to collect data on the pedagogical practices of teachers and learners, the role that ICT played in these practices, and the contextual factors that supported and influenced them (Kozma, 2003).

The results of this study provide schools and teachers around the world with outstanding examples of how technology can change pedagogical practices and provide policymakers with guidelines they can use to increase the technological impact on educational systems (Kozma, 2003). Amongst others, conclusions drawn from the M2 case studies were:

- The technology-supported innovations had a limited impact on the curriculum. Only 18% of the 174 cases reported a change in curriculum goals or content being supported by technology.
- While 75% of the innovations had been used for at least a year, only 41% provided evidence that the innovation had been disseminated to other classrooms or schools. In the schools where ICT had been both continued and disseminated, continuation depended on the energy and commitment of teachers, student support, the perceived value for the innovation, the availability of teacher professional development opportunities, and administrator support.
- Innovations were more likely to continue if there was support from others in the school and from external sources, innovation champions, funding, and supportive policies and plans. Of particular importance was the connection

with national technology plans that provided resources that often enabled the innovation to succeed.

- ICT Policies, both local and national, were important to the success of many of the 174 innovations (Kozma, 2003).

These findings provide insight into what other countries have experienced in terms of innovative ICT use. Also, a number of relevant factors that affect ICT implementation could be identified from the SITES M2 findings, such as commitment of teachers, the perceived value of innovation, the availability of teachers' professional development, and administrative support. These contribute to the development of the conceptual framework of this study.

The European e-Learning Forum for Education (ELFE) Project

The ELFE project was initiated by the European Trade Union Committee on Education (ETUCE), with the main aim being to understand 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). This project was conducted between January 2004 and December 2005, it investigated the difference ICT made in schools, especially when used intensively for instructional or pedagogical purposes; how students are influenced by the different ways of teaching compared to the traditional classroom education, both individually and collectively; and factors that influence the intensive use of ICT. The study identified two areas where the use of ICT seemed to have made a difference, namely increased efficiency of school administrations and effectiveness of school management. In addition, a positive atmosphere and more collaboration between teachers, particularly of different subjects, were reported.

Finland

The 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). It is evidenced that ICT use as a tool for pedagogical development is not a focus, and the impact of ICT on knowledge sharing, communication, and home-school cooperation is only moderate. Thus, Finnish schools do not utilise the full potential of ICT and more so, its use for pedagogical purpose is not a focus (Kankaanranta, 2009). These findings raise questions on how to support and encourage schools to become competent members of the Finnish knowledge society.

Lithuania

In Lithuania, school boards and principals can decide how to spend school funds, and they are able to make decisions about most everyday aspects of ICT management and use at the schools. Teacher training covers technical, information-related, social, pedagogical, and management competencies. The standard for teacher training is based on the modules of the European Computer Driving License (ECDL), plus additional modules specifically related to the use of ICT in schools. ECDL (called outside ICDL, i.e. Europe International Computer Driving License,), is an international standard in end-user computer skills. The ECDL/ICDL Syllabus consists of 7 modules which define the skills and competencies necessary to be a proficient user of a computer and common computer applications (EDCL Foundation, 2007). By 2007, only 24% of educators were ICT literate (Markauskaite, 2009).

Conclusion

This section presented the review of literature on ICT implementation in the developed world. A number of cases of ICT implementation in the developed world have been presented. Findings on these cases serve as evidence of what other researchers found in their countries. This information is relevant for this study in that the findings provide insight into what already exists about how ICT has been implemented in classrooms elsewhere, as well as identifying factors that affect ICT implementation, necessary for developing a conceptual framework for this study. In Namibia, this information is not available as no study has been made to evaluate ICT implementation in schools, especially in rural schools. More cases about the developing world are presented in the next section.

3.6 ICT implementation in the developing world

This section presents an overview of ICT developments made in the developing world. The developments are focused on national systems as they strive towards achieving educational goals in Chile, South Africa, Mozambique and Namibia. These countries have been chosen as examples of the developing world, based on the fact that Chile is described as a successful case and that Enlaces, the Chilean government's ICT initiative, was fully taken over by the Ministry of Education by 2005, in the same year that the Namibian ICT Policy for Education was adopted. South Africa started its second phase of ICT in education policy in 2007. South Africa and Mozambique are from the same economic block of countries aiming to achieve the African Union goals set for ICT. In addition, Trinidad and Tobago in the Caribbean region has been cited as a good example for ICT implementation in rural schools. The developments are measured against the time ICT implementation began and what and how the goals have been achieved.

3.6.1 ICT implementation at national level

The core of this study is stated in research question 2, on how ICT is being implemented in rural areas. Very little has been written about ICT use in the developing world. Many of the articles that exist focus on ICT provision in line with issues of equity and access (Ali, 2009; Cossa & Cronje, 2006; Ibrahim, 2009; Matengu, 2006; Kozma, 2006; Unwin, 2004); and professional development in the Colleges of Education (Iipinge, 2010). These issues are important, but considering that many developing countries have introduced ICT (African Union, 2008, Gaible, 2008), it is worth investigating what it is used for. It is noted that a few publications concentrate on ICT use (Hinostroza, Hepp & Cox, 2009; Hinostraza, Labbe & Claro, 2005; Howie, in press; Lopez, & Iost, 2008). It is important to note that Chile and South Africa participated in the SITES (discussed in Section 3.4), amongst other countries representing the developing world. Much can be learnt from the South African findings, being the only African country participating in the SITES. The reason for non-participation of other African countries in these large scale studies is not known, but given that many developing countries are poor and struggle to meet the basic needs of their people, it could be challenging to extend the limited resources to ICT. Nevertheless, literature in this area continues to grow, albeit on a very small scale.

The little literature that exists at national level is presented below. The information presented has been collected through participation in the SITES 2006 study. At national systems level, the case of Chile was discussed, as well as that of South Africa.

Chile

Access to ICT in Chilean schools is relatively good. ICT implementation started in 1993 and by 2005 more than 90% of the student population had potential access to ICT in their schools, with more than 80% of the teachers having received training in its administrative and pedagogical uses. These were achieved through the *Enlaces* programme, a government initiative (Hinostroza, Hepp & Cox, 2009). The majority of computers in primary and secondary schools are located in the computer laboratories, as prescribed by the ICT in Education policy in Chile. Some Chilean secondary schools have a few computers in classrooms due to their own effort. A relatively high number of secondary schools are connected to the Internet, enabling ICT-related activities and use of Internet resources. The computer laboratories are used partly because about 60% of the total schools have ICT policies promoting ICT use at schools. The government has also provided all schools with software and is now in a process of trying to develop a strategy to involve schools in maintaining and renovating software.

Teachers used the computer laboratories for only half as much time as students did. In order to enhance effective ICT use, *Enlaces* developed a variety of initiatives to evaluate and monitor the ongoing activities of the project, such as e-learning products and possible impacts. With regard to its monitoring initiatives, *Enlaces* developed web-based systems that enabled schools and service providers to directly register the provision, reception, installation, and configuration of computer networks, and to annotate technical-support visits and training activities developed in the schools. To evaluate the quality of the services provided to schools, *Enlaces* conducted periodic surveys, which were answered by teachers and principals of the schools, giving their perceptions of the quality of the technical support, training, and equipment provided to the schools. However, the challenges still lay in developing local teaching materials. The government has produced a platform on an intranet, where school with locally produced materials could deposit them (Hinostroza et al., 2009). In addition, much investment goes into professional development to train teachers in ICT use (Sánchez & Salinas, 2008)**.** The Ministry of Education has partnered 24 universities to provide technical and pedagogical support to each school in Chile **(**Hinostroza, Hepp, Laval, 2000).

The study by Hinostroza et al. (2009) has its focus on achieving the national goals by addressing issues of equity in remote areas where the majority of the schools are located. As a result, particular attention was given to ICT access to rural schools, improved teacher quality and provision of better resources. Chile has managed a very successful ICT implementation programme in schools and universities. Universities and other institutions are working to develop models for ICT integration into specific curriculum subject matters, such as science and mathematics. The models include technology, teaching methodology, learning objectives, teaching resources and tools for student learning assessment (Sánchez & Salinas, 2008). Howie (2010) reports that the design of the implementation plan in Chile has been fast and apparently effective (p.26), by adopting a combined top-down and bottom-up approach that are results-oriented. In other words, schools that wanted ICT had to submit a detailed proposal as to what and why they needed the ICT.

South Africa

The national goals of South Africa are summarised by Blignaut and Howie (2009). The government of South Africa implemented Phase 1 of its roll-out plan in 2004-2007. The programme aimed at establishing an education and training system that would support ICT integration in teaching and learning and training teachers to gain confidence in using ICT, establish a framework that would enable educators to integrate ICT in the curriculum, to ascertain the availability of ICT, use quality education content, and connect schools to the Internet. Phase 2 of the programme (2007-2010) encourages educators and managers to integrate ICT into the curriculum and management. In Phase 3 (2010-2013) it is expected that all provincial departments of education will use ICT in their planning, management, communication, monitoring, and evaluation, and all institutions use the educational portal for teaching and learning, given that educators and students are capable of using ICT. The schools were supplied with ICT irrespective of whether they needed it or not.

In 2007, a baseline survey was conducted to determine the availability of resources for the Department of Education (DoE) to make informed decisions in terms of resource allocation. Like other developing countries, South Africa relies on donor funding for provision of computer laboratories, a less demanding target than getting more educators qualified to integrate ICT into teaching and learning. Curriculum and content development is the responsibility of the government. In order to ensure accessibility, equitable and quality education, the Thutong Portal (Setswana word meaning ‘a place for learning’) was developed to support needs of students, teachers, parents, administrators, managers and researchers in search of educational information. Specifically, this portal was supplied with quality educational information reviewed by a panel of educational specialists. As of 2007, about 23,635 had subscribed to it, of whom 11,565 were educators.

In South Africa, the universities have not been given any role in professional development in ICT training for teachers. Farrel and Isaacs (2008) report that universities in South Africa are developing their own internal ICT policies on the manner in which ICT is expected to be integrated into the teaching and learning process. Some universities have their policies on the management of ICT functions. The University of Stellenbosch has an "e-campus" strategy encompassing all related activities, and the University of Pretoria has a Telematics Learning and Education Innovation plan. This observation is further supported by Howie (2006) who stated that the South African strategy of ICT development in schools has not involved universities at all in the professional development. Every university in South Africa provide ICT training in the way they see it fit. The role of the university is not coordinated through the government. Rather, the researcher agrees with Howie (2010) that a lot can be learnt from the Chilean strategy where universities are given a specific role by the government to train teachers in ICT. Contrary to the South African system, the Trinidad and Tobago University offers Professional ICT programme for in-service training which is link to an incentive of salary increment with a combination of free tuition offered to all Government personnel via the Government Assistance for Tuition expenses (GATE) programme (Gaible, 2008). Currently in Namibia, provision of ICT training is similar to what is happening in South Africa. The role of the University of Namibia with regard to ICT professional development is not clearly defined. The national policy stipulates the guide line for ICT professional development in Namibia but this objective is not emphasised. Namibia can also learn from Chile.

Conclusion

Two cases have been presented on ICT implementation at systems level in developing countries. Chile has developed *Enlaces*, a national programme with a variety of initiatives to evaluate and monitor the ongoing activities of the project such as e-learning products and (possible) impacts. *Enlaces* developed web-based systems that enabled schools and service providers to directly register the provision, reception, installation, and configuration of computer networks, and to annotate technical-support visits and training activities developed in the schools. South Africa has developed a Thutong Portal to support needs of students, teachers, parents, administrators, managers and researchers in search of educational information. The portal was supplied with quality educational information reviewed by a panel of educational specialists and a number of educators have subscribed to it. It is noted that unlike South Africa, Chile invested many resources in its implementation programme and schools have to submit to government a detailed proposal explaining why they needed ICT. The South African schools are supplied with ICT, irrespective of whether the school needed it or not. As a result, ICT use in school is either limited or not at all. In the Trinidad and Tobago, the government has made computers accessible to all teachers through a government subsidy to enhance computer practice at home and with the hope that the teachers will use them for pedagogical purposes (Gaible, 2008). These factors become important to consider for Namibia as the Tech-na project has not been evaluated, nor is the ICT implementation process monitored to feedback the relevant offices for improvement of service provision to rural schools.

3.6.2 ICT implementation at school level

This section summarises cases of ICT implementation at school level in developing countries. Examples of ICT use in a number of African countries were drawn in order to present the African rural context, namely Ghana, Mozambique, South Africa, and Namibia. The reason for including these countries in the literature review has been presented in the introduction of this section, with the exception of Ghana, which was included on the basis that it is an African country and shares economic problems similar to those of Namibia, especially for rural areas. The cases of Ghana, Mozambique, South Africa are discussed and Namibia are presented respectively.

Ghana

A PhD study by Boateng (2007) focused on the use of computers in Ghanaian schools, and how computers and related technology were used in a rural-based school. It addressed issues of use and non-use of computers and related technology within the critical social theory framework in order to determine the underlying social, economic, and political factors that affected the use of the technology at school. Particularly, Boateng's study examined how a rural school, Twifo Praso Secondary School, used computers and related technologies in its curriculum in compliance with national policy on ICT in Ghana, and in view of increasing the use of ICT in the pre-tertiary school curriculum.

Boateng (2007) found that although computers were available at the school, teachers were not using them. Instead, computer lessons were taught as stand-alone subjects without any relevance to the curriculum. This is attributed to inadequate training of teachers in the effective use and integration of computer technology in the school curriculum and lack of support from the local communities. With these findings, Boateng calls for future research on how national educational policies aimed at integrating computers and related technologies can be effectively implemented in schools, especially in rural areas, and models on how to integrate technology in school curricula.

Mozambique

Cossa and Cronje (2004) conducted a study on "Computers for Africa: lessons learnt from introducing computers into schools in Mozambique" between the period 1997-2001, from the perspective of the project leader. The aims of the research were to extend the understanding of the global phenomenon of using ICT and Internet-based learning in secondary schools; to provide knowledge about the use of ICT-based learning activities in Mozambique; and to contribute to the formal use of ICT and Internet-based learning in secondary schools through descriptions of aspects that challenge educators in ICT implementation in developing countries. Particularly, the study followed a case study approach on the Acacia project, designed to work with rural and disadvantaged communities that were isolated from the ICT networks to which their urban counterparts increasingly had access. By the year 2000, only 2% of the 80,000 telephone lines served the rural areas. The project managed to network 13 schools with access to e-mail and Internet, and subsequently the programme was transformed into a national programme now run by the Ministry of Education. Teachers and learners were trained in how to use computers for teaching and learning, WorLD (World

Links for Development) and web page design. Principals of schools were also trained to allow them to understand and support the project activities. The project succeeded because of government's political and financial support, the refurbishment of classrooms where the computers were installed, and the acquisition of new computer equipment for all teacher training colleges.

South Africa

Several authors allude to the introduction of ICT into South African schools (Brandt, Terzoli & Hodgkinson-Williams, 2008; Howie & Blignaut, 2009; Langmia, 2006; Mentz & Mentz, 2003), all acknowledging deployment of computers into schools to a certain extent, but reporting on various challenges experienced in different parts of rural South Africa.

According to Brandt et al. (2008), there are many previously disadvantaged schools from the apartheid dispensation still lacking basic infrastructure, such as electricity, telephone lines and libraries, where information could be sought. In response to these challenges, a number of projects were initiated across the country: the Ulwazi project was introduced to five schools of which four are situated in the township of Mamelodi and one in Lynwood Glen suburb, Pretoria. The project was established as a result of need for schools to share in each others' learning experiences and knowledge, interactively and in real situations. In Grahamstown, 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 continuous programmes that educate and train teachers to make effective use of technology for teaching and administrative purposes. Schools in Grahamstown have at least one telephone line but cannot afford to have a second installed for either dial-up network and/or other telecommunication devices. These projects were necessitated by the result of a need for the schools to share in each others' learning and cultural experiences.

Accessibility to ICT is very low in South Africa. For example, Mentz and Mentz (2003) found that, in the Potchefstroom district, only 46% of schools had computers for administrative purposes, while 19% had computers for teaching. In the majority of schools where computers were used for teaching, principals were of the opinion that they were used effectively and that the educators responsible for computer training were well-trained. The study also observed that the majority of the schools had no access to computers, but 88% of the principals viewed access to computers by learners as very important (5 on a scale of 1-5 being the highest). The importance of computers to students remain elusive, as is does not guarantee that the schools will be provided with more computers.

In addition to the challenges, Brandt et al. (2008) report on a recent survey undertaken by the Education Policy Unit of the University of the Western Cape and the International Development Research Centre, which found that South Africa has an alarmingly low teledensity in some rural areas, sometimes less than 5% in certain rural areas. This makes it difficult to connect those schools that do have computers to the Internet, even in the simple form of a dial-up link. It would be beneficial for the affected rural schools to have Internet connection in terms of interactivity, immediacy, accessibility, targeting, reach and versatility. Effective use of the Internet for pedagogical purposes requires teachers not only to be connected but also to have the skills necessary to find the relevant information.

Langmia (2006) states that training of teachers took place between 1999 and 2002, after which technology was introduced in public schools as compulsory school subjects taught in grades 4-6 and 5-9. Mentz and Mentz (2003) emphasise that, in addition to teacher training, there is a need to identify existing strategies followed by school principals in under-resourced schools, in order to cope with increasing demands on the integration of technology into curricula. Mentz and Mentz (2003) concluded that when comparing efforts of developed countries to deal with the increasing demand for integrating technology into curricula and schools, it is clear that there was still conceptual as well as managerial confusion around the role of technology in schools.

Howie and Blignaut (2009), reporting on the SITES 2006 South African results, found that the ICT policy in education was in place and on the list of priorities. However, there were a number of ICT-related obstacles to realise pedagogical goals, such as the location of ICT, staffing, the channels for teachers to acquire skills and knowledge, and integration of ICT in mathematics and science classes. The analysis of the data revealed that some essential conditions were not yet in place in most of the schools. Where the hardware and software was in place, significant attention was needed regarding the location of ICT, provision of staffing and the acquisition of skills and knowledge. The data also reveal that only a small number of science teachers had integrated ICT into their classes and that achieving digital equity had not yet been met on such issues as access to technology, educator development strategies, pedagogical and technical support, digital content, and escalating telecommunication charges.

Namibia

In Namibia, the use of ICT in schools has not been researched. In a PhD study on 'Adoption of ICT at schools in core and peripheral settings of Namibia: Exploring innovation, technology policy and development issues', Matengu (2006) evaluated, critiqued and developed an understanding of factors involved in the adoption of ICT in schools in Namibia, particularly in Windhoek and Katima Mulilo. Matengu (2006) noted that schools were provided with computers on the basis that they did not have them, and therefore cautioned against the assumption that schools with ICT would necessarily use them. Matengu (2006) therefore called for a critical review of ICT Policy goals and the implementation process. The study also found that the availability of technology infrastructure at schools did not guarantee their usage by learners and teachers.

In addition, Katulo (2010) researched on the role of school principals in promoting and managing computer usage in selected schools in the Caprivi region. The study found that principals were often the initiators of the acquisition of computers. some schools were resourced than others and the maintenance of equipment depended on the kind of school and the way the computers were acquired rather than on the role of the principal. School principals that demonstrated the qualities of transformational leadership promoted the usage of computers by taking part in training offered to teachers. The principals also encouraged teachers on different platforms to make use of computers. The study also found that schools with principals actively supporting and promoting the use of computers were successful in computer usage than schools whose principals left the operations of the computer laboratory to an individual teacher. The factors that hampered usage were internet connectivity, qualified personnel to cascade training and minimum infrastructure.

Another study in Namibia was on the integration of ICT in the preparation of teachers at the Colleges of Education (Iipinge 2010), which revealed that while teacher educators expressed interest and willingness to integrate ICT in the teaching situations, there was a lack of infrastructure and digital learning material. ICT was used more in the Integrated Methods of Technology Education (IMTE) as a subject and to a lesser extent in Mathematics and Natural Sciences. Most of the integration activities encouraged drill and practise and used the common *Microsoft* Office (MS Office) programme.

Very few studies have been carried out on ICT policy implementation in the developing world, especially in Africa. More work needs to be done on evaluation of policy documents, especially on the impact they make at school level Like Mozambique, Ghana and South Africa, schools in Namibia are equipped with ICT but whether it is being used is a matter of concern to all countries. Also, none of the schools in Africa seem to have put strategies in place to motivate teachers to use ICT. School leadership is also not reported on extensively although it has a big influence on how ICT is being used in schools. The researcher concurs with Tiene (2002), who claimed that trying to bring technology into the schools systems in developing countries was unsuccessful due to the lack of planning and support to secure the support of key participants.

Conclusion

It is important to monitor new developments made in schools, and how the ICTs are used. Cases to demonstrate ICT use in schools were drawn from Ghana, Mozambique, South Africa and Namibia. These schools share common characteristics in that ICT provision is still very low, with low connectivity to the Internet. Teachers seem to be unready to fully utilise ICT. Despite the challenges, the developing countries still see ICT as a 'powerful catalyst for change' to help them leapfrog in the industrialised world (Tiene, 2002, p.216). Challenges remain and the factors causing these need to be identified.

3.7 Factors affecting ICT implementation at school and teacher level

The aim of this chapter is to review the literature on the issues and topic of ICT implementation and integration. Based on the findings and the analysis of the Namibian context, this will be combined to formulate a conceptual framework for this study. This section presents the factors that affect ICT implementation at school and teacher level, with a focus on rural areas, infrastructural development at national level, professional development, vision, leadership, support, digital learning materials, ICT infrastructure at school level, expertise, and pedagogical use of ICT.

Characteristics of rural areas

Kozma (2006) argues that ICT is important to rural villages in Africa for the improvement of education and other basic living conditions. To put this study into context, Zhao, Yan and Lei (2008) state that evaluation begins with context in which the technology programme is to be implemented. Contextual factors include the basic characteristics of the school, such as size and location, current technology conditions (infrastructure, hardware, software, uses), learner characteristics (technology proficiency, access to technology, academic performance), teachers characteristics (years of teaching, technology proficiency and uses, academic background), and institutional support or expectation for technology uses (policy related to technology, professional development efforts, and resources for teachers). These factors will likely influence the effect of the programme and can be used to interpret future changes (Zhao et al., 2008).

This information is needed for this study in order to give descriptive information about the rural context in which ICT is being implemented. Since, it has been argued that the information obtained from the Namibian government documents was inconsistent (see Chapter two), it became necessary to repeat this exercise for purposes of accurate reporting for the three educational regions of interest.

Infrastructural development

ICT infrastructure is limited and not provided to all educational institutions with the depth needed to allow optimal usage of education systems (Cecchini & Scott, 2003; Cossa & Cronje, Hinostroza, Hepp & Cox, 2009; Hinostroza, Labbe & Claro, 2005; Tearle, 2003; Ward, 2003; Wagner, 2004; Reeves, 2008). In particular, rural areas are more affected by the lack of electricity and there are cases of low density of Internet connectivity which pose many challenges to rural areas (Howie, 2010; Brandt et al., 2008). Other challenges include the cost of ICT provision, which can be high in comparison to the costs of other equipment. In under-resourced schools the cost can even be higher due to the need for installation of electricity and landline connectivity. Provision of infrastructure competes with the provision of other basic needs, such as textbooks, furniture, teacher training, and nutritional supplements (Cawthera, 2002). Balanskat, Blamire & Kefala (2006) argue that schools with good ICT resources achieve better results than those that are poorly equipped. However, other factors may also contribute towards ICT implementation such as professional development.

Professional development

It is argued that professional development is necessary for ICT integration in schools. Both teachers and the school management need to be trained in skills that will enable them to perform their duties effectively in the advancement of teaching and learning. Teachers must understand the place of ICT in schools and its educational role. However, a number of researchers (Howie, 2010; Kozma, 2008; Matengu, 2006) have argued that policies are well articulated but often teachers are not aware of the specifics of these policies or their goals. ICT policy implementation is best assured when teachers' professional development includes specific skills and tasks that include ICT in their everyday classroom practices and explicitly connects these practices to ICT and broader education policies (Kozma, 2008).

Garet (2001, in Strudler & Hearington, 2008) identified six factors associated with succesful ICT implementation. The first three are structural features that set the context, whilst the next three are core features that charaterise the processes that occur:

a) The form of the professional development activities refers to the reform type of activities. For example, developing teacher network or study group which include:
b) The duration of the activity including time per session and number of sessions. The longer the activity the better.
c) Collective participation of groups of teachers from the same school, department, or grade was found to be more effective than individual participation.
d) Active learning opportunities were associated with effective professional development.
e) Content focuses teaching strategies were found to be better than generic teaching strategies not tied to particular content areas.
f) Coherence, which refers to the degree to which the activity is tied to school goals, policies, and standards: the greater the coherence for teachers, the more effective the professional development.

Comprehensive plans for professional development should include wider opportunities for teachers to learn through a number of platforms (Strudler & Hearington, 2008). It is assumed in the Garet professional development framework that groups of teachers, depending on various possible combination of groups (e.g. teaching related subjects), should be offered prolonged multiple learning opportunities that promote active learning. More importantly, the learning goals should be linked to the school goals and policies both at national and school level. However, Ward (2003) warns that time for teachers to learn how to use computers is limited, but for the sake of continuity of learning up-to-date skills that will enable the teachers to keep up with the technological and pedagogical demand, it becomes necessary that the teachers create time for professional development activities.

This information is relevant to this study, in order to inform the professional development activities aimed at teacher training in ICT in Namibia. This is one of the main activities to be implemented in accord with the National ICT Policy Implementation Plan. A study recently conducted in Namibia found that the professional development is ineffective as lecturers at the Teacher Training Colleges have not been trained themselves in ICT and therefore are not in a position to train the teacher trainees. These findings were obtained from a study conducted in the Teachers Colleges (Iipinge, 2010). It is necessary that the view of schools on professional development with regard ICT be sought, especially in the rural areas.

Vision

Policy vision for ICT in education is a critical component of the policy (Law, 2009). The World Bank (2003) reports that ICT should aim to deliver resources to the poor, take markets within reach of rural communities, improve government services and transfer knowledge needed to meet the challenges of the MDGs. In this light, ICT can increase access to education through distance learning, enable a knowledge network for students, develop teacher training, and broaden opportunities for accessing quality educational materials.

UNESCO (2008a) presented a policy framework on ICT competency standards for teachers in which three different policy foci were explained: *technological literacy*, which puts emphasis on computer or information literacy as a subject; *knowledge deepening*, which emphasises improving effectiveness of learning in different subjects by using ICT, and *knowledge creation*, which emphasises ICT as an agent of curriculum and pedagogical change to foster students' development of 21st century skills. These policy foci call for different curriculum goals for the use of ICT in teaching and learning, a framework useful for this study in determining the focus of the Namibian ICT Policy for education. It is important that the vision of the policy is clear and that the science curriculum is aligned to the vision of the National ICT Policy for Education (2006), which is currently aligned to a vision that sees Namibia becoming an ICT literate nation by the year 2030. An ICT implementation plan has been drafted to guide the operations of the implementation process.

Leadership

Several authors express the challenges of leadership with regard to ICT policy implementation at national level (Cecchini & Scott, 2003; Kozma, 2008). In particular, these authors raised concerns about strategic policies to provide specific goals on how technology can advance economic, social, and educational development. It is argued that operational policies should describe how these visions and resources will impact the education system with measurable outcomes.

Yee (2000: 291) has characterised ICT leadership in eight categories, namely leadership as:

Equiptable provision of ICT: principals provide ICT hardware, software, and complementary resources.
Learning focused envisioning: principals as leaders transmit a vision or sense of mission and create enthusiasm in teachers.
Adventurous learning: principals express the desire to be an ICT learner along with staff members.
Patient teaching principals possess ICT skills and are willing to teach students and staff. They also attempt to create many flexible learning opportunities.
Protective enabling principals often create shared leadership activities for teachers and students.
Constant monitoring principals ensure that teachers and learners use ICT according to the vision of the school.
Entrepreneurial networking principals who are very skilful as 'partnership builders' in an effort to source the necessary ICT resources for the school.
Careful challenging in an ICT enriched school, innovative teachers are on the edge of knowledge with regard to ICT.

The eight characteristics were deduced from a study conducted in Canada by Yee (2000), based on the assumptions that government views ICT as instrumental to creating a high skilled workforce capable of coping with the technological demands of the 21st century. Emphasis is placed on ICT to ensure that students develop the abilities to make informed choices about ICT, to use it skilfully, and to become technological innovators. Thus, the use of ICT in schools had become both a pedagogical and a political issue. The second assumption is that ICT can be used in a number of ways in education, bearing in mind that not all ICT used in school is meaningful, pedagogically sound, fiscally responsible, or ethical. The leadership approaches are useful to determine the kinds of ICT leadership styles that are present in Namibian rural schools and how it can be improved.

Support

ICT support is essential for the sustainability of ICT projects, many of which in African countries were discontinued because neither the government nor the schools made plans to sustain them (Cossa & Cronje, 2004; Clecherty & Tjivikua, 2005; Kozma, 2006; Thomas, 2006). Support in the model adopted from the Kennisnet (2008) is divided into two: pedagogical support; and technical support.

Technical support refers to support towards basic trouble shooting in and out of the classroom.

Pedagogical support refers to support related to teaching and learning of science. Both will be briefly discussed.

Pedagogical support

In order to develop capabilities of teachers, principals should foster intellectual stimulation amongst them, provide well-designed professional development, and facilitate focused activities such as integrating ICT to meet the learning needs of a learner (Dexter, 2008b). Thus, support needs to come from the principals, HoDs and the experienced teachers.

Sutherland and Sutch (2009) offer a model demonstrating how pedagogical support can be offered to novice or less experienced teachers. Within the *InterActive* project, Sutherland and Sutch (2009:30) developed a way of working that enabled teachers to work together with teacher educators and researchers in order to start the process of using ICT in the classroom. Each teacher developed a subject design initiative (SDI) and the process involved:

Deciding on a focused areas of the curriculum that students normally find difficult to learn and choosing ICTs that could potentially enhance learning in this area.

Out-of-the-class design as a thought experiment. This involves thinking about the area to be taught, considering relevant research, developing activities and experimenting with the chosen ICT, while at the same time imagining how learners would engage with these activities from the perspective of the intended learning. Also, the background knowledge and experience of the learners is considered.

Into-the-classroom contingent teaching draws on all the prepared activities while at the same time opportunistically using what learners bring to the lesson to extend their learning.

Out-of-class reflection on and analysis of the design initiative using video data collected from the classroom experimentation.

Although this model is used by teacher educators and researchers, it may still be useful in providing guidance towards increased use of ICT through this pedagogical support model.

Technical support

McGhee and Kozma (2000) offer a benchmark for infrastructure in the World Evaluation Conceptual Model (p.6), particularly, the technical support requirements, namely hardware installation; software provision; network installed; and technical assistance available. This information is useful to determine the availability of technical support.

Collaboration

The Delphi project (2004) offers an insight on the indicators for uses of ICT in learning. Amongst the identified indicator is teachers' collaboration. In the Delphi project, teachers' collaboration skills have been identified as crucial for teachers to participate in formal and informal networks of teachers. Increased collaboration and rich interpersonal relations among the teachers minimise power-related tensions that may arise among them. Collaboration has a positive impact on the effectiveness of the introduction of ICT in curriculum-based activities. Teacher online forums offer online facilities, new modules and ideas for enhancing teaching. In addition, teachers online forum are necessary for creating quality materials and that staff could work with colleagues located in other geographic areas.

Digital learning materials

A number of authors pointed to a need to develop local digital content (Kozma, 2008; Kohn, Maier & Thalman, 2009), however the costs of development of digital learning materials are high and effective demand is not likely to be large, while those with purchasing power are already served by good conventional schools (Dede, 2000; MacFarlane & Sakellariou, 2002; Wagner, 2004). In order to ensure access to all schools, many governments have taken it upon themselves to take on the task of e-content distribution, either through a portal or any Learning Management Systems. The development of this material and the quality of these is also a concern (Cawthera, 2002; Cecchini & Scott, 2003). Kennisnet (2008) offers three broad approaches on schools' expenditure on digital learning materials:

1. *Pragmatic approach* - where digital learning materials is being used occasionally and with a weak link to between the school's overall educational approach and its use of such material. This is a low level of risk for the school as the school opts for low cost materials, but so are the low benefits.
2. *Project-based approach* - where a limited number of teachers use digital learning material for small-scale projects, combined in a number of ways with their current teaching. The idea of teaching using ICT is being

appreciated. Capital investment in digital learning material is increasing but it can be compensated for by efficient management.

3. *Conceptual approach* promotes the design and organisation of teaching and learning being the basis and use digital learning materials to support those educational principles. It is assumed in this approach that as the digital learning materials become more important, the price of books will fall. Without effective leadership on the part of school managers, expenditure on digital learning material may increase.

Information about the different approaches towards acquiring digital learning materials is useful to determine the approach currently being pursued by the Namibian government and in an effort to improve the current situation, make the necessary changes that suit the country's education system.

Infrastructure

Hinostroza, Labbe, Lopez and Iost (2008) claim that there is not enough evidence available to produce responsible recommendations for technology choices for a given pedagogical approach and instructional instance that has to be implemented in a particular context. However, much outdated ICT infrastructure has been noticed in rural schools, and the high cost of telephonic connections is a concern to many rural schools and those from a disadvantaged background which have their telephone lines cut for not paying bills (Cecchini & Scott, 2003; Cossa & Cronje, 2004; Polikanov & Abramova, 2003).

Table 3. 3: Classification of different ICT applications & their educational ICT

Type of application	**Examples**	**Educational use**
General tools	Word processing, presentation, spreadsheet, multimedia etc	Becoming more important requires innovative use and creative thinking. The tools are not dependent on particular content
Teacher tools	On-line lesson outlines; computer projector systems, interactive whiteboard	Lesson preparation; whole class teaching with shared view of screen; interaction managed by teacher
Communications	E-mail, e-learning, video conference, Internet browser	Review a view of education as reaching beyond school, for which they offer huge potential; familiar in the out-of-school context.
Resources	Web-based	Used according to availability, in whatever way wished; for resource-based, skills-oriented learning.
Computer-assisted instruction (CAI)	Drill-and-practice, related to a certain kind of content and relatively unsophisticated	Offers individual learning opportunities without expensive development, appears to fit well with transmission models of teaching and learning.
Integrated learning systems (ILS)	Individual task assignment, assessment and progression, including CAI, with recording and reporting of achievement	These appear to sit outside teacher-led instruction and learning, but are only truly effective as an integral part of the learning process, which may have to be re-thought.

Type of application	**Examples**	**Educational use**
Computer-based assessment tools	Examination boards are developing computer-based examinations, which attempt to mimic paper-based tests.	Components give advantage to the computer literate; teachers will need to incorporate some elements of similar tasks in their teaching, to prepare students adequately.
Management tools	Classroom procedures School administration Publication of results communication	Students progress, deficiency analysis etc. Financial, personnel and educational resources Parents, governors, inspectorate, general public e.g school to home and vice versa

Source: OECD (2001, pp. 38-39)

The matrix of the different ICT application shows the complex nature of ICT application in schools. This information is necessary in identifying different pedagogical approaches that require different tools, and teachers should have a fair knowledge of the ICT in order to choose the appropriate tool for the intended purpose.

Expertise

Anderson (2008) offers a taxonomy of knowledge related skills and knowledge-related task processes with or without ICT. These knowledge-based skills are implicit in the level of teacher technology competency (Baylor & Ritchie, 2002), which is in line with the development of the knowledge society and guides the design of the curriculum, learning and assessment activities more in cases where learners can access ICT. The required teacher expertise for the knowledge-based society is summarised in the figure below:

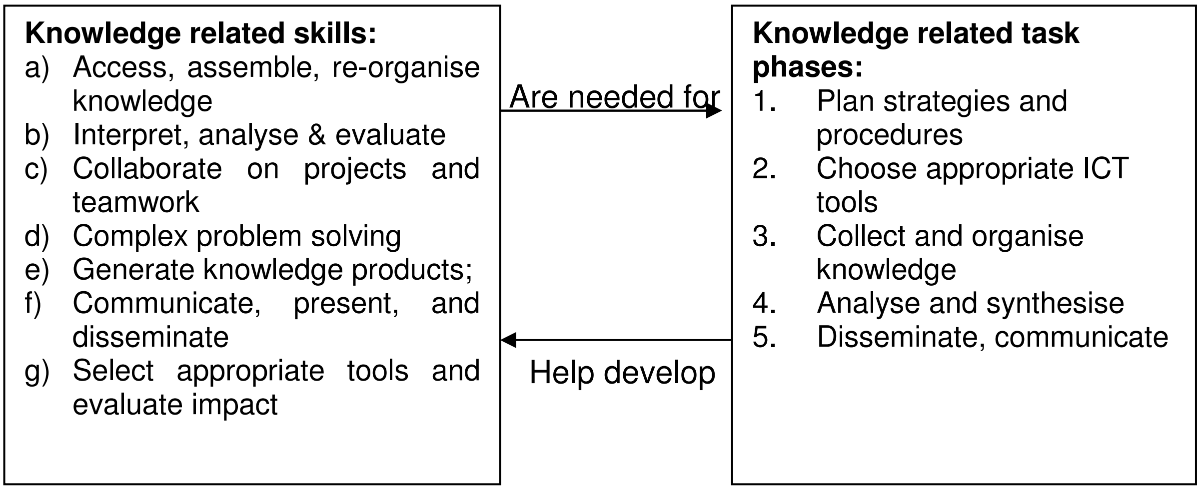


Figure 3. 1: An adopted conceptual framework illustrating the relationship between knowledge-related skills and knowledge-related task progresses, with or without ICT

(Anderson, 2008: 12)

Each skill category pertains to a set of tasks and should be analysed with respect to the type of knowledge predominating in these tasks. Each skill category may pertain to multiple types or levels of knowledge: facts, principles, procedures, metacognition, and subjective states, however, some require predominantly one type.

Access, assemble, and reorganise knowledge refers to the ability to effectively and quickly find and assemble information of all types using Internet and database search.

Critically interpret, analyse, and evaluate evidence refers to make critical evaluation of the quality and relevance of knowledge to make appropriate conclusions.

Collaborate on projects and teamwork refers to sharing knowledge in a team and the ability to consult with experts and others at all levels of the hierarchy using emails, conferencing, and instant messages.

Solve complex problems refers to the ability to demonstrate planning strategies and higher-level thinking skills central to the school and the workplace and relevant to everyday living.

Generate knowledge products refers to the use of relevant software tools such as word processor, spreadsheets, databases, and concepts mapping.
Communicate, present, and disseminate refers to the ability to present knowledge to the audience using multimedia tools or by reports.
Select appropriate tools and evaluate their impact refers to the ability to prepare learners to deal with ICT both technically and responsibly.

The information obtained from Figure 3.1 (above) is useful in detecting the skills that Namibian science teachers possess against what they need to have if they are to integrate ICT effectively.

Pedagogical use of ICT

Mioduser, Nachmias, Tubin and Forkosh-Baruch (2003) developed an analysis schema for the systematic study of transformational processes in schools using ICT, based on Itzkan (1994). From their schema, the levels of pedagogical use of ICT in rural schools are taken. They distinguish a progressive continuum of three levels of innovation: assimilation, transition, and transformational.

Assimilation is the first level of innovation that refers to the situation in which ICT is first introduced into the school. ICT is integrated as a useful tool in common learning activities and in specific projects. At this level, specific pedagogical situations change qualitatively but the school curriculum (content and goals), the instructional means (textbooks), the learning environment (class, laboratories), and the learning organisation (timetable) remain the same.

Transition is the second level where support for ICT integration in school's everyday function of new contents, didactic solutions, and organisational solutions side-by-side with the traditional ones. At this stage, the school keeps its identity and basic course of operation while changing the character of particular activities.

Transformation is the third level, where substantive changes take place in the schools. Traditional processes still exist, but the school's identity is mainly defined by the rationale and goals of the new lines of operation. Teachers' roles are enriched with new dimensions, new contents are introduced to the curriculum, new teaching methods are developed and implemented, and for particular activities, the traditional time and space configuration is completely transformed.

This schema is useful in determining the level of pedagogical use of ICT in the rural school. This information is added to the conceptual framework to describe the pedagogical use of ICT as an outcome of the ICT implementation process.

Science teachers' attitudes

Cavas, Cavas, Karaoglan and Kisla (2009) claim that as in many developing countries, ICT tools are provided to teachers without considering their attitudes towards ICT. Cavas et.al. (2009) conducted a study in Turkish primary schools to test the science teachers' attitudes towards ICT in education and then explore the relationship between teachers' attitudes and factors which are related to teachers' personal characteristics. The Turkish teachers indicated attended in-service training related to ICT use in classroom. The findings of this study revealed that the science teachers, irrespective of their gender had the same perception about ICT use in education. Another study conducted in Syria, exploring attitudes of English as Foreign Language high school teachers revealed the same findings that teachers had the positive attitude towards ICT in education Alibrini (2006). The attitudes were explored through a number of independent variables such as computer attributes, cultural perceptions, and computer competence. This information is necessary for this study in collecting information on this construct.

Conclusion

In summary of this section, a number of factors that affect ICT implementation have been presented, useful to this study for a number of reasons. They provide information on variables that need to be considered in the description of how ICT in being implemented in a rural context. In addition, the information on the efforts spent of infrastructural development for rural areas is vital as this study is focusing on the rural setting. Information on professional development provides guidance on ICT skills requirements and expertise for science teachers, and has provided insight into the formulation of the conceptual framework of this study.

3.8 Conceptual framework

This section presents the conceptual framework of this study. The Four-in-Balance-Model (2009) is presented in Section 3.8.1. This model is focusing on ICT implementation at school and at classroom/teacher level. The Howie Model (2002), providing the frame for the structure of the conceptual framework of this study is presented in Section 3.8.2. Finally, the conceptual framework for this study, known as the 'Factors that affect ICT implementation in rural schools' is presented in Section 3.8.3.

3.8.1 The Four-in-Balance-Model

The Four-in-Balance-Model (2009) was developed to structure key factors that influence ICT use at school level. This model has been chosen to structure the presentation of the findings from the literature. The model itself will be discussed in the next section. The Four-in-Balance-Model is a research based approach used to introduce ICT in education (Kennisnet, 2008, 2009), first presented in 2001 by the ICT at School Foundation and updated in 2004 as Four-in-Balance Plus (ICT op School, 2004). From this point on, the model has been referred to as Four in Balance, and suggests successful implementation of ICT at school and teacher/classroom level requires a balanced approach towards deploying the four basic elements: vision, expertise, digital learning materials and ICT infrastructure (Kennisnet, 2009).

Vision refers to the schools' view of what constitutes a good teaching approach and how the school aims to achieve its objectives, considering the role of the teachers and learners, the teaching, and the materials being used to teach. The vision of the principals and teachers determine the policy of the school and the design and organisation of its teaching.

Expertise implies that teachers and learners need to have sufficient knowledge and skills in order to utilise ICT to achieve educational objectives. This requires skills beyond basic ICT skills to operate a computer. Pedagogical ICT skills are also necessary to help structure and organise learning processes.

Digital learning materials refer to all digital learning educational content whether formal or informal. This includes educational computer programmes.

ICT infrastructure refers to the availability and quality of computers, networks, and Internet connections. ICT constitutes infrastructure facilities. In addition, electronic learning environments and the management and maintenance of the school's ICT facilities are also considered as ICT infrastructure.

Collaboration and support refers to collaboration between teachers in the same school sharing knowledge in a team and the ability to consult teachers from other schools.

Support refers to supporting teachers with the use of ICT, i.e, pedagogical support and/or supporting teachers technically.

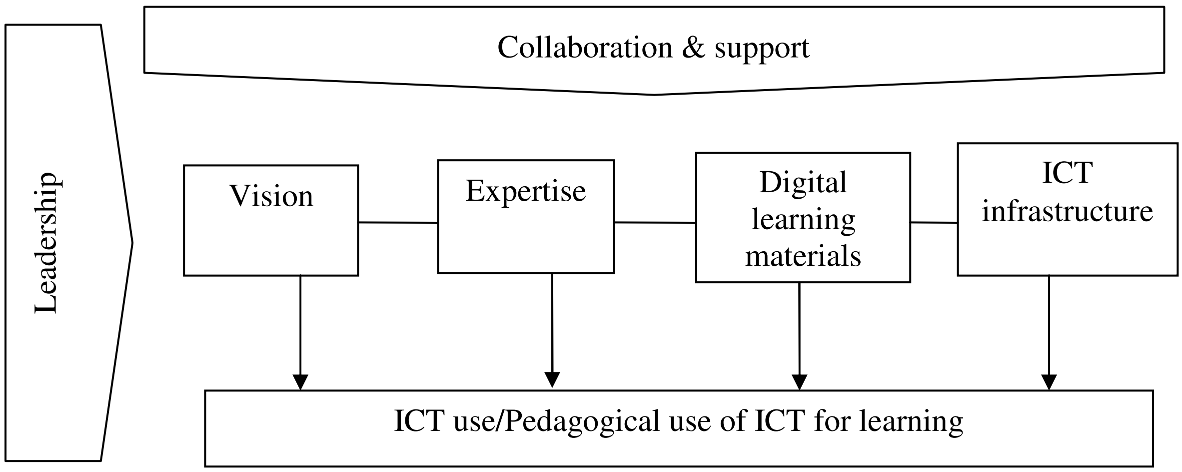


Figure 3. 2: An adopted basic elements of the Four-in-Balance model (2009)

This model has been adopted in this study to provide the theoretical and conceptual basis for the description of how ICT is being implemented in rural schools. The concepts in the model have been found suitable to serve as a guide for generating items of variables to be considered in the generation of instruments for data collection for the main study. In addition, this model summarised the factors that affect ICT implementation in line with the research question three of the study. Based on these reasons, the Four-in-Balance Model (2009) was adopted for use in this study. However, it has also been argued in Chapters 1 and 2 of this study that some factors may have more influence on ICT implementation process and therefore not all factors have the same level of impact. In order to distinguish between factors that were considered at national level as well as school level, the Howie Model (2002) was adapted.

3.8.2 The Howie Model

The Howie model was used to conceptualise, categorise and to organise the variables to be used in an exploratory manner to identify relationships between factors related to mathematics achievement of secondary school pupils in South Africa. It should be noted that the Howie model (2002) was not developed for the area of ICT in education. The model is widely accepted to show the various system levels in education: 'national/regional system-school-individual'. The Howie model (adapted from the Shavelson, McDonnell & Oakes, 1987) presented the education system in terms of inputs, processes and outputs. Figure 3.3 (below) illustrates the Howie model (2002):

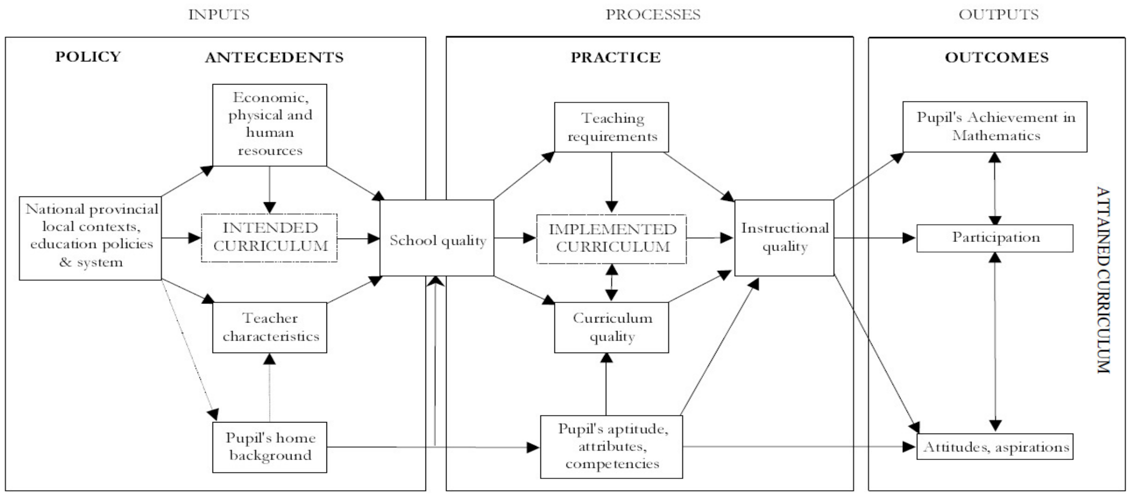


Figure 5.3
Factors related to mathematics achievement

Figure 3. 3: The Howie model (2002)

In the Howie Model (2002) the *inputs* are policy-related contexts at a national, provincial and/or local level. At this level, the intended curriculum is designed and developed. The inputs reflect the antecedents at national level such as: the economic, physical and human resources supplied to different levels of the system; the characteristics of the teachers and the background of the students.

The inputs affect the *processes* within the schools, the education system units at regional and local level. At the level of processes, the implementation of the curriculum depends on the context in which teachers work. The *outputs* reflect the outcome in terms of students' achievement (in terms of teachers' success in teaching in science subjects) and participation in class and school activities and also teachers' attitudes towards subjects and schooling and the future aspirations. It is assumed in this model that indirect benefits such as improved teaching may result from improved curriculum quality at national level and subsequently at school level.

The Howie Model (2002) has been adapted for this study to provide the structure within which the Four-in-Balance Model will be placed for purposes of distinguishing the systems level from the school level. Some parts of the Howie Model (2002) have been changed to suit the conceptual framework of this study.

All the three levels have been adopted from how they appear in the Howie Model (2002) (see Figure 3.3, above). These are input, process and output. The levels are described as have been adopted or adapted for this study. The new meaning of concepts is also explained and what has been retained is highlighted.

Input level

Input is policy-related context at a national level, where two issues are important: the National Policy and the description of the context. The National ICT Policy for Education spells out the intended ICT goals and objectives with regard to ICT implementation. The inputs reflect the investments into *national vision, ICT infrastructual development, and the professional development,* with regard to ICT implementation.

The description of the context refers to the rural areas. A number of variables are considered such as the *socio economic conditions, learners ICT skills, efforts put into developing rural schools, the population of the villages, school attendance.* The national policy and the rural area's variables are said to have an impact on the *school quality*. This factor has been adopted from the Howie Model (2002).

Process level

The inputs affect the *processes* within the schools, the education system units at regional and local level (Howie, 2002). At the level of processes, ICT is implemented at school level. This is the area where the Four-in-Balance is inserted in the frame to illustrate that ICT is being implemented in the school that may have been affected by the quality depending on the input. Also, the argument to placing the Four-in-Balance Model is to evaluate whether what is stated in the National ICT Policy is what is being implemented in rural schools.

In the Four-in-Balance Model appear a number of constructs of which *leadership* and *collaboration and support* are considered to take place at school level whilst the *vision, Expertise, Digital Learning Materials* and *ICT infrastructure* were considered at classroom level. The definitions of these concepts have been adapted in Section 3.8.1.

Output

The *outputs* reflect the outcome in terms of *ICT use* and *pedagogical use of ICT* by science teachers. These outcomes may influence *science teachers' attitudes towards ICT use* and their schooling and future aspirations. It is assumed in this conceptual framework that increase support and motivation may result in increase ICT use and pedagogical use of ICT by science teachers. The definition of output has changed from that in the Howie Model (2002) as this study focus on different output, but the attitudes of teachers has been retained.

The Howie model (2002) has been adapted as follows:

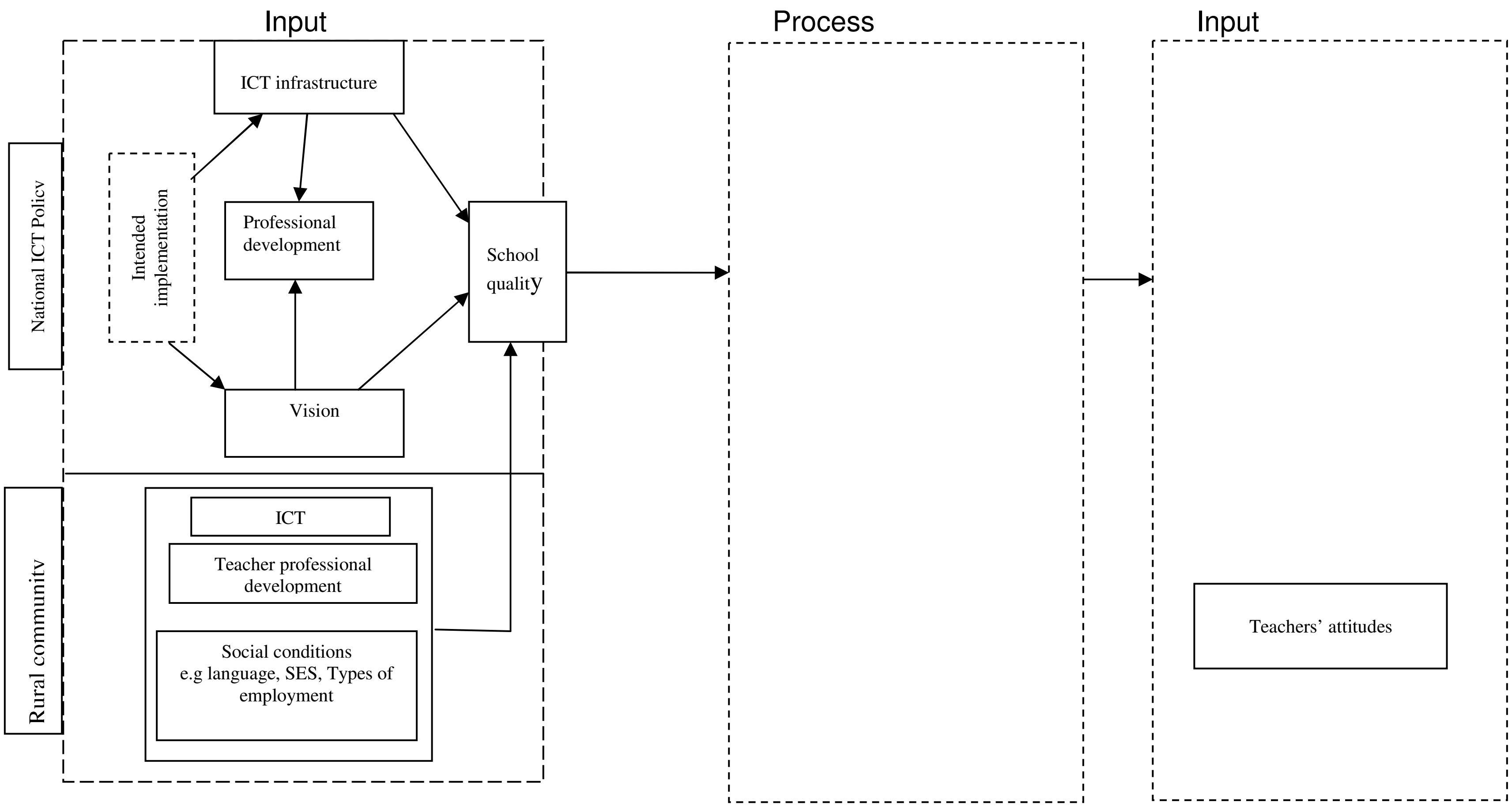


Figure 3. 4: The adapted Howie model (2002)

The Howie model has been adapted to include critical components of the National ICT policy, such as ICT infrastructure as provided by the Government of Namibia, professional development and the vision of the education system in Namibia as intended. These factors are said to influence the quality of the rural schools at regional level. Depending on how ICT is being implemented at school level, it may impact on ICT use and pedagogical use of ICT, and consequently influence the attitude of the science teachers. These changes are reflected in the conceptual model of this study, known as the 'Factors affecting ICT implementation in rural schools'.

3.8.3 Conceptual framework for this study

The conceptual framework for this study employs the Four-in-Balance model (2009) and the Howie model (2002). The two adapted models were merged in Figure 3.6 (below). For purposes of operations, constructs that appear in the conceptual framework of this study are adapted as described in the Four-in-Balance Model. In addition, the concepts that appear in the input level of the conceptual framework of this study are explained below.

ICT provision refers to providing ICT to rural schools. The infrastructure is measured in terms of type of ICT available, e.g. PCs, laptops, Internet connection at national level.

Professional development refers to a teacher training programme with regard to ICT skills and ICT integration in the science subjects.

Vision refers to the focus of ICT implementation in the education system, particularly with ICT use in enhancing science education.

School quality refers to how well the ICT provision, professional development and the vision has been successful in terms of provision, training of teachers and the translation of vision into curriculum goals.

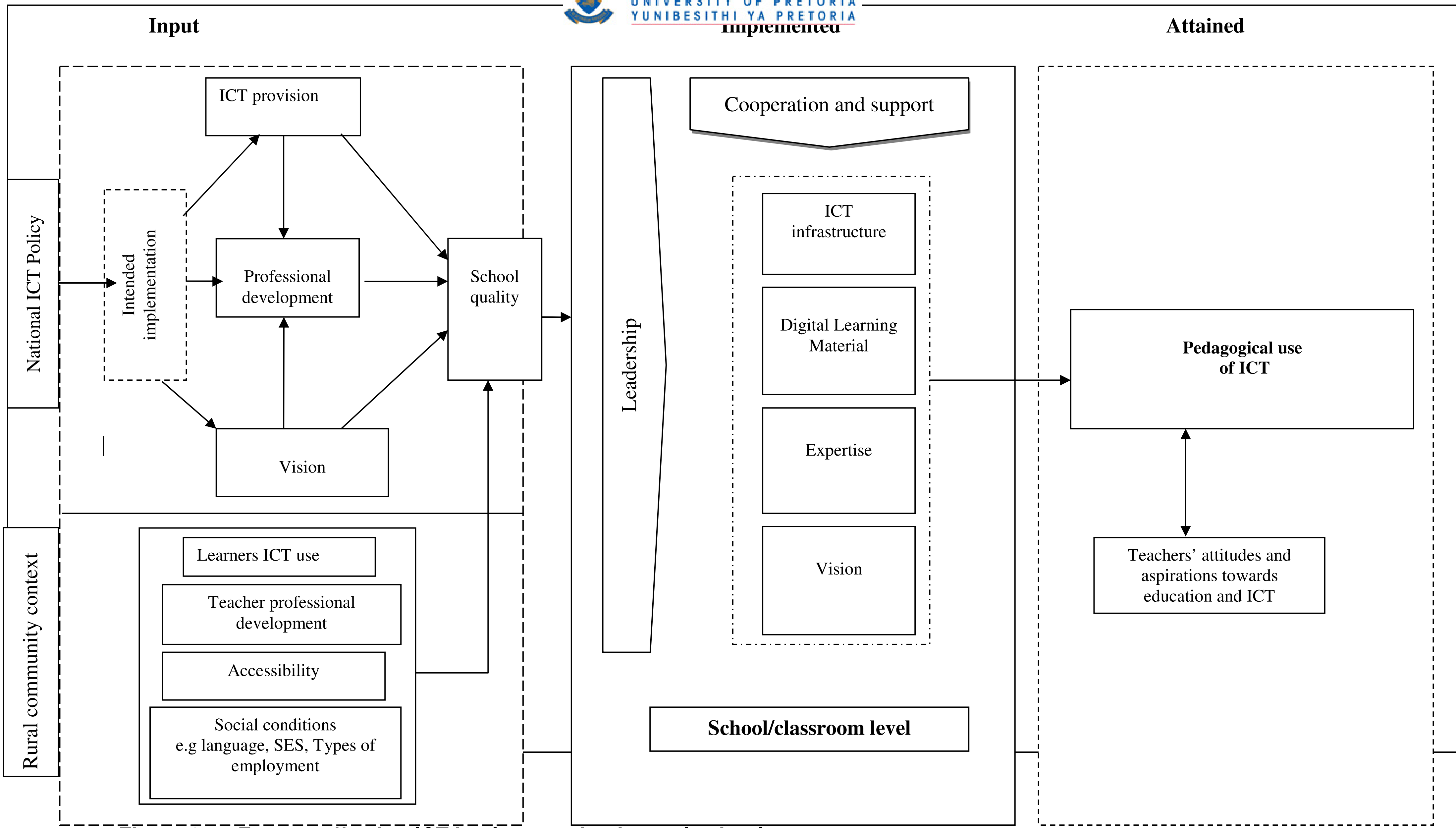


Figure 3. 5: Factors affecting ICT implementation in rural schools

Conclusion

In conclusion of this section, the constructs found in the Four-in-Balance Model are explained in line with what was found in the literature. The Four-in-Balance Model is described and the rationale for its adoption in this study is discussed. The constructs of the Four-in-Balance Model are explained in their original meaning and how they have been adapted for use in this study. In addition, the Howie Model (2002) has been adopted for use in this study. This model was useful in providing the frame within which the Four-in-Balance Model could be placed to illustrate the level of operation of all constructs. Changes that have been made to the Howie model have been highlighted accordingly. Finally, the conceptual framework of this study is presented as a combination of the adapted Four-in-Balance Model (2009) and the adapted Howie Model (2002).

Summary of conclusions

Chapter three begins with the introduction followed by the definition of key concepts of the study. The literature reviewed presents the rationale for ICT adoption and general uses of ICT in education in developed and developing countries respectively. Special reference has been drawn to the SITES study which covered a number of developed countries over three phases (1998 to 2006) with a focus on school (Module 1 and SITES 2006) as well as classroom level (Module 2). The studies reported in this thesis have similar objectives as SITES, which therefore served as a source of inspiration for this study. A number of other studies have also been referenced for a broad overview. A number of cases of ICT implementation in the developed world have been presented. The case of Finland has been identified as successful but not without challenges. Lithuania has the same experiences as some developed countries. The developing countries examples draw reference to Chile and South Africa. These countries have both policies on ICT in education and developed portals through which support for teachers is offered. However, in the case of Chile, the schools had to develop proposals as to why they needed ICT. A number of developing countries share common problems of insufficient ICT provision by the state and low connectivity of the Internet hampering teachers to use ICT in their everyday teaching. Factors affecting ICT use in education were also identified from the literature. These are costs of ICT, training of teachers, lack of strategies to align the curriculum goals to ICT. These factors are all summarised in the Four-in-Balance model adopted as the conceptual framework for ICT use at school level and this way to pave the way for research methods and analysis. The Four-in-Balance model was placed with the Howie model in order to relate with other systems levels.

CHAPTER 4

RESEARCH DESIGN AND METHODS

This chapter presents philosophical assumptions, research design, general procedures followed in the strategy of inquiry, and detailed procedures of data collection and analysis. The chapter is divided into four main sections: Section 4.1 which gives an overview of the chapter followed by the research paradigm in Section 4.2. An overview of the research design is presented in Section 4.3. A detailed research design of the baseline survey, the case studies and the legitimation of the findings which forms the three identified phases of the research design of each research question are spelt out in Section 4.4. The issues of validity and reliability are presented in Section 4.5, and ethical issues and conclusion of the chapter in Sections 4.6 and 4.7 respectively.

4.1 Introduction

This chapter focuses on the research designs and methods employed in this study. The research paradigm is discussed to indicate the theoretical assumptions underpinning the operations of this study. The research design employs a mixed method approach, comprising the baseline survey, the case studies (interview and classroom observation schedules) and the ICT use conference. In an attempt to obtain valid and reliable responses, the research designs further discussed population and sample, instrument development, data processing and analysis, and research procedures.

4.2 Research paradigm

This section presents the theoretical assumptions underpinning this research. A pragmatic approach has been adopted as a framework guiding the general philosophical ideas of the researcher. The research question influenced the research design. Generally, knowledge paradigm claims arise from actions, situations and consequences. The actions involve the identification of the problem, and then develop strategies and approaches to understand and address it. In this study a pluralistic approach was used to generate knowledge about the 'what' and 'how' (Creswell, 2003) of the identified problem, and according to Creswell (2003, 2009) pragmatism is not committed to one specific method to address the problem. This notion was further supported by Johnson and Onwuegbuzie (2004:15), who suggest that 'taking a non-puristic or compatiblistic approach allows a researcher to mix and match the research design components offering the best chance to answer their research questions'. In this same vain, Teddlie and Tashakorrie (2003:27) offer two decision rules to combine the two methods as follows: a) deciding on the priority of either the quantitative or qualitative methods depending on the weight, and b) deciding on the sequence of two by identifying the order of conducting the complementary methods, which is either a preliminary or a follow up phase sequence in which the two methods have to follow each other sequentially. A sequential mixed method approach is one in which the researcher seeks to elaborate on or expand the findings of one method with another method.

This study decided to choose the "Mixed Methods" due to the following reasons:

1. It ensures balancing of biases that may arise from using a single research method. Information obtained using a single method is triangulated and leads to convergence between quantitative and qualitative methods.
2. It allows for simultaneous exploratory explanatory and confirmatory questions in the same study.
3. The adoption of the sequential mixed method approach allows for movement from description of the context to an in-depth understanding of

cases studied. Thus, results from the quantitative method were used to select cases for the qualitative component to explore whether the factors that influenced ICT implementation could be confirmed.

4. Deliberation in curriculum conference is *praxeological,* i.e. an open system that allows new research results and rational argumentations that are for and against proposals are integrated to resolve a practical problem (Mulder, 1994).
5. The mix methods allow for flexibility of *integrating fi*ndings from both the quantitative and qualitative methods to seek convergence of the results (Creswell, 2003; 2009).

In summary, this study adopted a pragmatic research approach to guide the research design and the selection of the research methods used to collect and analyse the data obtained. A sequential mixed method approach was used to collect data for this study using the following: conducting a baseline survey through the development and administration of questionnaires, compile and analyse results using appropriate statistical tools, and through the use of modern ICT techniques, a conference of invited guests was organized within the case study area, i.e. rural situation for the purpose of openness, certification of data, and to seek for further comments on key issues of the research. The research design is elaborated in the next section.

4.3 Research design

It is generally believed in Namibia and other parts of the world that rural teachers receive inadequate support to implement ICT at classroom level, hence making it difficult for learners to meet to modern academic challenges. This forms the basis of this research, with the aim of evaluating the ICT Policy implementation in Namibian rural junior secondary schools and formulating strategies on how the implementation process can be improved.

This section presents an overview of the research design in Section 4.3.1. The survey method used is presented in Section 4.3.2. The case studies methods are presented in Section 4.3.3 and the ICT use conference method is presented in Section 4.3.4.

4.3.1 Overview of research design

This section presents the research methods used in this study: the survey, the case studies and the legitimation of the findings. The research design for each phase is presented accordingly. The population and samples of the survey, case studies as well as for the ICT use conference are described, followed by data collection strategy and the description of the instruments for each phase.

Based on problems highlighted in Chapter two, three out of four rural based educational regions were selected to obtain rich descriptive information necessary to answer this main research question:

"*How and to what extent is the intended ICT Policy implemented in the rural junior secondary schools in Namibia"*

As stated in Chapter one, the main research question can be further divided into the following sub-questions:

1. *What is the national context with regard to implementation of the ICT Policy for Education in rural junior secondary schools?*
2. *How has the national ICT policy been implemented in science classrooms?*
3. *What factors influence the ICT Policy implementation in rural schools?*

In answering research question one, this study followed two approaches: 1. a document analysis and 2. an interview with the National ICT Policy Coordinator in Namibia. The findings of these two approaches are presented in chapter two.

On research question two, the approach of conducting a baseline survey, the development and administration of questionnaires was followed. As explained in Chapter two, several existing national documents give inconsistent and conflicting information on the real situation in such schools at different times. With the approach taken by the research, accurate and reliable results and information about the availability of ICT can be obtained and appropriate advice and implementation strategies can be formulated to ensure effective and sustainable use of ICT in schools in both rural and urban areas.

As a means of addressing research question three and to identify factors that affect ICT implementation, two research approaches were employed, viz a survey and a case study approach. Some answers to questions raised in the questionnaires of the baseline survey sought to answer the research question, especially identifying factors that influence ICT Policy implementation. Part of the data for research question three was obtained through case studies. The case study methodology includes classroom observations, interviews and filling in structured questionnaires by a heterogeneous group of science teachers, principals, ICT technicians and a National ICT Coordinator.

To legitimise the findings of research questions two and three, the approach of organizing an 'ICT use conference' was taken. This approach was adopted from the 'curriculum conference' method as presented by Mulder, 1994), (see also Brinkerhoff, 1983). The ICT use conference is an approach for deliberations about ICT use that will generate recommendations about ICT use and its implementation. A number of stakeholders, different from the case study participants were brought together as a consultation group to discuss pertinent issues in the ICT use domain (Mulder, 1994:157). Because of its obvious advantages, this method has been adapted for 'ICT use' in this study. The findings developed after the conference are a true reflection of situations in the study area, and any results and conclusions that will emanate from such a study will be used as template or guide on how ICT can be improved in these regions and the country at large.

In terms of research design, both quantitative and qualitative methods were used and therefore the study applied sequential mixed methods. This is diagrammatically presented below:

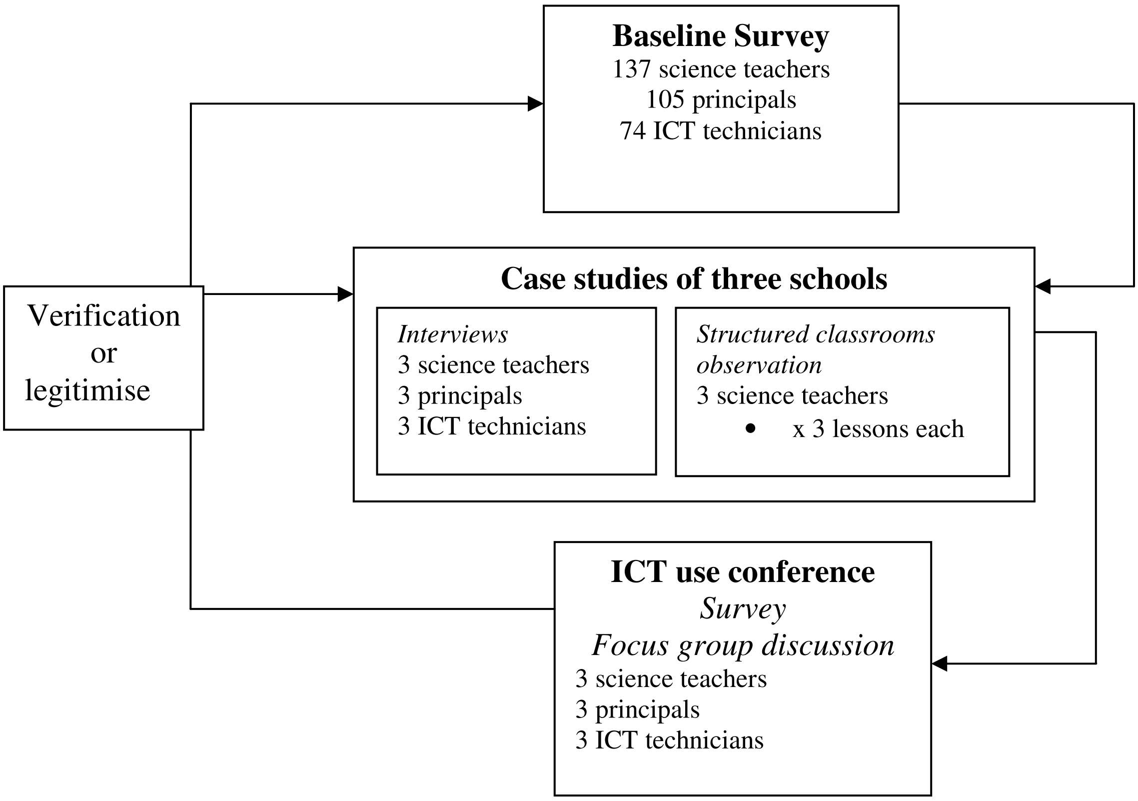


Figure 4. 1: Research design

Figure 4.1 (above) refers to the research methods employed in this study. According to the figure, the methods start with the survey, followed by case studies that used two methods: interviews and structured classroom observations. Data from both the survey and the case studies was analysed so as to give to the participants accurate results and information during the ICT conference, for possible comments and pave the way for improvement in their existing strategies.

Data sources for this study were identified for quantitative as well as qualitative methods. Data sources were identified for various constructs proposed in the conceptual framework of Chapter three of this study. For better understanding, various concepts necessary for addressing the research questions are defined and plotted in the Table 4.1 (below) with an indication of the data sources for particular pieces of information.

Table 4.1: Data collection matrix

		Data sources									
		Survey (Questionnaires)			Case studies						
					Obser-vation	Interviews			ICT use Conference		
Constructs	**Construct description**	**P**	**T**	**ST**	**ST**	**P**	**ST**	**T**	**P**	**ST**	**T**
Background information	Characteristics of the respondents				✓	✓	✓	✓	✓	✓	✓
Leadership	Developing an overall view of how to use ICT, channelling school development and inspiring goals.	✓		✓		✓	✓	✓	✓	✓	✓
Vision	Overall school's view of ICT programme	✓		✓		✓	✓	✓	✓	✓	✓
Expertise	Knowledge and skills regarding ICT application,	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Professional development	Acquisition of knowledge and skills on the use of ICT	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Constructs	**Construct description**	**P**	**T**	**ST**	**ST**	**P**	**ST**	**T**	**P**	**ST**	**T**
Collaboration	Collaboration between teachers in the same school sharing knowledge in a team	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pedagogical support	Support given to teachers regarding curriculum related challenges – see comments on 'curriculum' made in interview schedule			✓	✓	✓	✓		✓	✓	
Technical support	Support given to teachers regarding trouble shooting related problems	✓	✓			✓	✓	✓	✓	✓	✓
Digital Learning Materials	E-content supplied to or available in schools		✓	✓	✓	✓	✓	✓	✓	✓	✓
ICT infrastructure	Availability of ICT at the schools	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Use of ICT	The types and frequency of ICT use	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Appropriatenes s of ICT		✓	✓	✓	✓	✓	✓	✓	✓	✓

P=Principal, T=ICT technician, ST=Science teacher

The constructs used in Table 4.1 (above) are taken from the literature reviewed in detail in Chapter three, and described as follows:

Demographics: biographical information about the respondent and the school.

Leadership: Developing an overall view of how to use ICT, channelling school development and inspiring goals.

Vision: the school's view of good teaching and the way to achieve it.

Expertise: knowledge about ICT, skills to use ICT and attitude that motivates teachers and the school management to do their work efficiently.

Professional development: Acquisition of knowledge and skills on the use of ICT.

Collaboration: Collaboration between teachers in the same school sharing knowledge in a team. Given the rural situation, collaboration is an important factor between the school and the community within which the school is located.

Pedagogical use of ICT: Use of ICT for purposes of teaching science.

Technical support: Support given to teachers regarding trouble shooting related problems.

Digital learning materials: computer programmes that the school uses, as well as formal and informal digital education content (Kennisnet, 2008:18).

ICT infrastructure: ICT is any electronic device used in teaching. It ranges from computers, printers, cell phones, PDAs etc.

ICT use: the types of ICT and frequency of use. Also, the appropriateness of ICT to be used is very important.

As stated above, many of the constructs used in the matrix above are taken from the literature. These also appeared in the SITES2006 questionnaires for principals, science teachers, and technicians adopted for use in this study. The SITES2006 questionnaires addressed similar concepts to this study by seeking information on how teachers organized their teaching and learning, the ICT available at school, how they use ICT for teaching and learning, and the obstacles or difficulties they experience in relation to ICT. The researcher believes that information sought with these questionnaires will dig deep into the current state of pedagogical approaches and on how technologies support them. The ultimate aim of the survey is to allow educational practitioners and policymakers to gain a better understanding of areas in the implementation of ICT in education in rural areas that need interventions and additional support.

A major difference in contents of the SITES2006 and this study lies in the context of the study. On that basis, the SITES2006 questionnaires were adapted to suit the Namibian conditions, and especially the rural situation. Some aspects of the questionnaire considered highly technical to a developing nation were taken out. The language used in the SITES2006 questionnaires was also adapted to contain familiar words used in the Namibian context. The case study utilised classroom observations and interview methods. The principle of triangulation was applied to verify the information gathered through the two methods. The case study approach would also help in filling the gap of missing information from the survey. In addition to quality issues of this study, the ICT use conference design is adopted to allow stakeholders to bring forth the argumentations for a better perceived educational philosophy, goals, values and standards before conclusions are drawn and suggestion are made for consideration in the science classrooms.

To summarise, the study adopted a mixed method approach to tackle the research questions 2 and 3. Constructs crucial to these research questions are explained for better understanding of the context. For the survey part of the study, the SITES2006 questionnaires were adopted and adapted for use in the Namibian context. The case studies as well as the curriculum conference designs are explained to complement the results from the quantitative methods. The methods adopted in this study are further elaborated on in the next Section 4.3.

4.3.2 Survey

This subsection presents the research design used in the survey. After a summary of the purpose of the survey, the research design is outlined according to the components population and sampling, instrument development and pilot study, data collection, data analyses, and research procedures.

The aim of the survey is expressed in two operational research questions (viz 2 and 3), formulated in line with the objective of this study. It is imperative to obtain a good understanding of the use of ICT in schools and particularly by science teachers in terms of pedagogical practices, support provided to science teachers (see Chapter one) and availability of appropriate infrastructure. These three elements constitute the perspectives from which the characteristics of the teachers' use of ICT are viewed during the survey. The characteristics identified for teachers' use of ICT was informed by literature and later by the pilot of the data collection instruments. In order to determine the quality of the questionnaires, the validity and reliability of the adapted SITES2006 questionnaire was checked.

Population and sampling

The population of this study comprises rural schools. This study has identified three categories of respondents: principals, science teachers and ICT technicians in order to provide school level data. They also provide data about their specific contexts as principal or science teacher or ICT technician. The study has therefore three sub-populations with their responsibilities described below:

School principals - have the responsibility of implementing the government policies on education, including the national ICT policy for education. They are also responsible for creating a conducive environment for the implementation of ICT.

Science teachers - are active subjects to be studied in terms of whether they implement the ICT policy at classroom level.

The ICT technicians - are active subjects who are either appointed formally or informally in the position of an ICT technician. Formal appointment of a technician refers to a person who is occupying a designated position of a technician at the school. Informal appointment of a technician refers to a teacher who acts in this position voluntarily by virtue of his or her knowledge of ICT.

The survey draws participants from the three educational regions: Ohangwena, Oshana and Oshikoto, to represent the rural context. As referred to in Chapter 2, the country is divided into thirteen regions clustered into north, west, south and east. The three educational regions of interest are located in the far north of the country and are known as the North Central Regions (NCR). The three educational regions shared the same history of education before the Namibian independence in 1990 and beyond. The two regions, Ohangwena and Oshana were heavily militarized by the South African army during the liberation struggle. The Oshikoto region was partly militarized but the region was extended to include the nearest town Tsumeb after 1999. The schools in the Tsumeb area were excluded from the sample for this reason.

There is no difference between the three regions in terms of socio-economic development, language, and budgetary allocations by the Revenue Office, Ministry of Finance. People in these regions speak the same language of Oshiwambo, although in at least eight different dialects. The difference between the regions lies in the remoteness of the areas and the infrastructure to access the schools. The Ohangwena region has far more schools than the other two regions and is highly populated if far more remote and isolated than the other two regions. Most of the circuit offices and schools were only accessible using a 4X4 vehicle.

The population of the survey comprises 247 schools, which include combined schools (CS), Junior Secondary School (JSS) and Senior Secondary Schools (SSS), befitting the description of schools with secondary grades. The decision to include all schools with secondary grades in the population was made after reviewing several government reports.

The samples of schools per region were purposely selected to include those with electricity and functioning ICT. A total of 163 schools befitting the criteria of electricity and functioning ICT were identified from the EMIS database (MoE, 2010). In search of answers to research question 2 and part of research question 3 of this study, the questionnaires were sent to the identified schools with electricity and functioning ICT (n=163). Thus, three questionnaires were sent to each school (for the principal, the science teacher and the ICT technician).

Table 4. 2: Population and samples of schools per educational region

Region	Population	Planned sample	Achieved sample	% Achieved
Ohangwena	116	63	43	68
Oshana	67	62	62	100
Oshikoto	64	38	32	84
Total	247	163	137	84

The table above shows that 84% of the planned sample was achieved. This figure is good enough to make general statements about rural schools in northern Namibia.

Instruments development for surveys

The study used three questionnaires adapted from the SITES 2006 study. The SITES instruments have proven to be valid and reliable in the SITES study, and address topics and issues also relevant for this study. These questionnaires have been developed to address how ICT is being implemented in schools and the fact that the questionnaires have been used in a number of countries makes them very reliable. The questionnaires were adaptable for changes to suit the Namibian situation. The development process of the questionnaires was informed by the literature review on what and how ICT is influencing policy or vice versa and how it is being used in classrooms. A number of authors refer to factors influencing ICT use and have identified constructs (Howie, 2009; Kennisnet, 2009; ten Brummelhuis, 1995; Anderson & Plomp, 2009).

In this study, many constructs were identified and were found to be well operationalised in the SITES2006 questionnaires for principals, science teachers and the ICT technicians. The depth of coverage was considered adequate at national as well as at school level, where it was also important to categorise the identified factors and how they possibly related to each other. Questions were clustered according to variables they addressed and in line with the aims and objectives described in Chapter 1. Several drafts of the adapted questionnaires were produced and reviewed by experts for purposes of content validity (Cohen, Manion & Morrison, 2000; 2007), to ensure that the questionnaires targeted the intended respondents and that the results would obtain face validity by testing whether the questionnaires actually tested what they were designed for (Cohen, et al., 2000; 2007).

The questionnaire for <u>School principals</u>

The SITES2006 questionnaire for school principals *(Appendix E)* has been modified to suit the Namibian context. The components on history of innovation and educational systems structure and responsibility have been deleted as it is assumed to have high level content about which rural teachers may not have knowledge. Also, the component on budgetary issues has been deleted because Namibian schools are fully funded by the government and do very little to raises funds to purchase their own equipment. The adopted questionnaire consisted of 10 main sections that also appear in the conceptual framework (Section 3. 7), as follows:

Table 4. 3: Contents of the principals' questionnaire

Part	Construct	Information being sought
A	Demographics	Information about the school and personal information
B	Vision of your school	Principal's vision
C	Leadership and ICT	The leadership style used at a school to encourage ICT use
D	Cooperation	Type of cooperation from either outside or within the school and support given to teachers
E	Support	Pedagogical support and technical support
F	ICT infrastructure	The type of ICT available at schools
G	Use of ICT	The types of ICT use at the school
H	Expertise	Principal's knowledge about ICT versus teacher's attitude and skills
I	Pedagogical support for teachers	The pedagogical uses of ICT
J	Obstacles	Obstacles experienced by the principals

It was noted that some questions refer to the entire school, while others refer to Grades 8 to 10 only. Also, some questions ask for educational policies and activities in general in the school, while other questions explicitly focus on the use of ICT. The questions contained multiple choice items with Likert scale or nominal scale and open-ended questions. Although the majority of the questions were closed, they provided the principals with the opportunity to express their views and opinions by exploring the 'other specify___' type of items. Also, the principals were asked to comment on any other issues that were not addressed in the questionnaire.

The questionnaire for science teachers

The questionnaire *(see Appendix F)* contents are listed in Table 4.4 (below). Particularly, this questionnaire asks for information from teachers about science education and policy matters in the school related to pedagogical practices and ICT. When a question is about ICT and/or ICT use, this was explicitly stated. Most questions were answered by marking the most appropriate answer. A few questions (16, 17 and 18) required responses to (a): whether certain activities were taking place without ICT and (b): whether the same activities as in (a) were taking place using ICT. Teachers were asked to mark one most appropriate answer for each of the two parts in each row. Also, guidelines to identifying the "target class" were provided *(Appendix F)*. Teachers were also provided with the opportunity to express their views and opinions by exploring the 'other specify___' type of items, and also to comment on any other issues that were not addressed in the questionnaire. Some of the items on 'Impact of ICT Use' have been deleted from the original questionnaire as they do not apply to the Namibian situation in which ICT was recently introduced to schools and so would not yet warrant an impact study.

Specifically, the questionnaire was composed of the following parts:

Table 4. 4: Contents of the science teachers' questionnaire

Part	Construct	Information being sought
A	Demographics	Biographical information about the school and the teacher
B	Curriculum Goals	The importance to achieve educational goals
C	Leadership and vision	The extent to which leadership goals are applied in decision making and teacher collaboration and support
D	Digital Learning Material	The different methods of ICT use
E	Expertise	The frequency of ICT use for different purposes
F	ICT infrastructure	ICT infrastructure availability and accessibility at and after school
G	Use of ICT	The confidence teachers have in using ICT
H	Specific Pedagogical Practice that Uses ICT	The times allocated to ICT use and the different types of use

The questionnaire for <u>ICT technicians</u>

The components of questionnaire for technicians *(Appendix G)* are shown in Table 4.5 (below). Most of the questionnaire comprised a number of closed questions related to the parts listed. For the part that asked for infrastructure, the type of information needed was nominal, providing space for writing the exact numbers of the available infrastructure. Specifically, this questionnaire asked about the current state of pedagogical approaches and the technological support provided to teachers and principals.

Table 4. 5: Content of the ICT technicians; questionnaire

Part	Construct	Information being sought
A	ICT in your school	Biographical information and the general use of ICT
B	Digital Learning Material	The availability of ICT and need for ICT
C	ICT infrastructure	availability and accessibility of ICT
D	Professional Development	Ways to acquire skills on ICT
E	Support facilities for ICT	Responsibilities of a technician
F	Obstacles to realize pedagogical goals	Reasons for not using ICT

All three questionnaires described above were designed to collect information about vision and leadership, ICT provision, teacher professional development and e-content development in a rural school. The information gathered through the survey is triangulated using case studies and data collection strategies.

For purposes of validity and reliability the three questionnaires (principal, science teacher and ICT technician) were sent for piloting to 20 schools, randomly selected within a short distance from the researcher's duty station, Oshakati. Fifteen out of 20 schools returned the questionnaires. The pilot was conducted towards the end of the year when all schools were busy with examinations and had little time for other activities. Given that situation, the number of returned questionnaire seemed sufficient. However, three more schools made efforts to return the questionnaires, resulting in a total of 18 questionnaires returned. These were later administered in the main data collection of this study.

The main objective of the pilot was to increase validity of the instrument to be used for the main study. Also, the pilot was used to ensure that the respondents would understand the questions being asked in the same manner. In ten cases the researcher had meetings with schools principals, science teachers and ICT technicians to explain the purpose of the survey and also observed them as they completed the questionnaire to ensure content and construct validity. It is important that the respondents understand the way the questionnaire is constructed, especially the response categories. The participants were given a chance to raise queries on the questionnaire in writing, or by expressing them during the interview with the researcher. Also, the time it took them to complete the questionnaire was timed in order to check whether the respondents answered the questionnaires within the given time. The reliability of the instruments was checked to see if the respondents answered in a similar kind of way, and also for pattern identification in the responses. During the piloting, no major problems were detected with any of the questionnaires. However, the principals raised concerns about the length of the questionnaire, although they managed to complete it within the given time (30 minutes). It was observed that most schools did not have an ICT technician, however it was explained to the school that whoever was responsible for ICT was considered to be the ICT technician in this study, and therefore qualified to fill in the questionnaire for technicians. Some schools relied on the service by *SchoolNet* technicians, but since its funding was exhausted this service had been terminated. The instruments were finalised and sent to Ohangwena first, then to Oshana and Oshikoto educational regions. Ohangwena has the highest number of schools and most remote of the three regions.

Data collection

The researcher attended an informal meeting with school inspectors through the Ministry of Education, where she had a short briefing meeting with individual inspectors to explain the purpose of the survey and distributed the questionnaires per circuit. She also asked the inspectors to collect the questionnaires from schools through their respective offices. This was done to establish a good relationship with the participants with an aim to get them to participate and minimise rejection.

The vastness of the country was considered and school inspector's offices or circuit offices were used as distribution points for questionnaires. It is a practice that school principals visit the circuit office on average twice a week. The principals collected envelops within which three questionnaires (one for the Principal, one for the Science teacher and one for the ICT technician) were enclosed. The respondents were given one month to respond to the questionnaire, after which they were expected to return to the principal's office for return to the circuit office. After a month of non-response, follow-ups were done through telephone calls and by sending short text messages with a cell phone to the school inspectors, reminding them of the due date.

Three methods were used to collect the questionnaires from the circuit office: 1) the circuit office was advised telephonically to send the questionnaires to the Ohangwena Examination Officer, who was personally known to the researcher and would send them to the researcher; 2) the researcher collected the questionnaires herself from the circuit office; and 3) the researcher collected the questionnaire from non-responding schools as a last resort to get a response.

Data was entered in the SPSS statistical package (version 17.0). It was also audited and verified before analysis. A database to record the returned questionnaire was developed to ensure proper data storage. Returned questionnaires were checked for completeness before data was entered into the statistical package. This data was analysed to give descriptive and inferential statistical information, after which it was interpreted (Fink, 1995) in order to determine the actual situation.

Data analyses

Data was captured and analyzed using the Statistical Package for the Social Science (SPSS – version 17.0). The analysis of the data is descriptive and frequency counts standard errors as well as maximum and minimum values were calculated, to measure the extent to which ICT is being implemented. Further, the outcome resulted in explanatory analysis of constructs, aimed at identifying the different factors that affect ICT implementation and how these factors correlate with each other.

The exploratory factor analysis was used to reduce the data set from a group of interrelated variables into a smaller set of uncorrelated factors and achieve parsimony by explaining the maximum amount of common variance in a correlation matrix using the smallest number of explanatory concepts (Field, 2000). The amount of common variance was calculated by estimating the communality values for each variable by extracting the underlying factors. The communality is a measure of the proportion of variance explained by the extracted factor. The correlation matrix was computed to determine the variates. The number of variates calculated will always equal the number of variates measured (*p*). The variates are described by the eigen vectors which are the weights of each variable. The eigen vectors are associated with the correlation matrix. These values are the factor loadings. Factors with relatively large values are retained. Further, Field (2000) recommended $r > 0.7$ as the cut-off point, and only when the determinant was less than 0.001. The correlation matrix aimed to eliminate one or more variables that correlated highly (Field, 2000).

In addition, the Kaiser-Meyer-Olkin (KMO) method was used to determine whether the correlations for the data were adequate for factor analysis. According to Hutchinson and Sofroniou (1999, in Field, 2000), values below 0.5 are poor, values above 0.5 and 0.7 are mediocre, values between 0.7 and 0.8 are good, values between 0.8 and 0.9 are great and values above 0.9 are superb. Thus the reliability of the constructs was developed (see Appendix, O). Similarly, Bartlett's test of Spherecity was applied to tests whether the off-diagonal components were not zero. The Bartlett's test of Spherecity value should be always significant ($p<.05$) for sufficient correlation between the variables, so as to proceed with the analysis (Field, 2000).

The minimum criterion for the Cronbach's alpha of the scale was determined to be 0.70 (Pearson, 2010), for the items to be combined into a single scale. Brigss and Cheek (1986) in Pearson (2010) suggest that the average inter-item correlations of 0.2 to 0.4 justifies the combination of items into a scale of fewer than 10 items. For this study, correlations of 0.70 were considered as adequate to continue with the development of the factors.

This study met the above conditions and the constructs were extracted using the Kaiser-Guttman retention criterion of eigen values greater than 1.0. A scree plot was generated to provide a visual presentation of the best solution of the data. Cattell in Field (2000) argues that the cut-off point should be at the point of inflexion of the curve. The 0.40 cut-off point was used in this study for factor loadings, which represent substantive values (Field, 2000). This value has been used frequently by factor analysts as a means of making preliminary examination of the factor matrix. Factors that weighed more than 0.50 were identified and named to suit the items underlying the set of items on a scale.

In order to determine the level of ICT implementation in rural schools, the responses were converted in indices to develop levels of implementation. The descriptive analysis used measures of central tendency (percentages) and variation (standard error) to describe the biographical information. The scores from the questionnaires were converted into indices in order to calculate the maximum and minimum value of ICT Policy Implementation. The development of indices in this study borrows from the concept of Gender Status Indices (GSI) (2004). The GSI focuses on the quantitative aspects of gender relations. In this study, the GSI model is adapted to create levels of pedagogical use of ICT. An index was compiled and comprised three levels: low, medium and high levels of pedagogical use of ICT. This index is used by governments to evaluate good practices in neighbouring countries and learn from them. In this study, the indices were used to determine the level of ICT use in rural schools.

Calculating the indices entailed providing the indicators the same weight in each scale. Thus, each construct has the same weight in each scale and each scale has the same weight of indices. The weight of a constituting item depends on the number of items in a constituting scale (Economic Commission for Africa, 2004). In order to determine the validity of the constructs used in the conceptual framework of this study, a regression analysis was employed. The constructs were considered in the regression analysis used to predict the value of one variable on the basis of other variables. The technique involves a mathematical equation that describes the relationship between the variable to be forecast, called the 'dependent variable', and the variables that the statistics practitioner believes are related to the dependent variables, called the 'independent variables'.

In order to analyse data for research question 2, relating to how ICT is being implemented, sub-total scores were calculated for each item per construct. The subtotals were converted to percentages to indicate the level of ICT implementation per individual. The percentage was divided by three to determine the range that represented each level: low (0, 33.3%), medium (33.3, 66.6%) and high (66.6, 100 %). The response rate for individual items was noted for all the constructs (see Appendix O). In line with Table 4.2 (above) the response rate for the questionnaires was 83%, but the response rate for individual items may vary.

In order to analyse survey data generated for research question 3, frequencies were calculated and analysed per construct. The same method used to analyse research question two was adopted. Thus, the exploratory factor analysis, the indices and the regression analyses were applied to determine the factors that affect ICT policy implementation in rural areas. The responses from the principals and the science teachers were combined to form one data set, representing the school level. The responses from the principals were matched to those of the science teachers and a reduction in data should be noted. Data from ICT technicians was left out as it did not cover all the constructs noted in the conceptual framework of this study (see Chapter 3). Data from principals and science teachers was considered sufficient to represent their respective schools. Responses from schools that had two science teachers were averaged to indicate a response at school level. A Pearson's correlation was run to determine the strength of the relationship between the respective construct. In addition, linear regression analyses were also run to strengthen and direct relationships between variables and to be able to assess the "statistical significance" of the estimated relationships, namely, the degree of confidence that the true relationship was close to the estimated relationship (Zikmund & Babin, 2007; Aaker, Kumar & Day, 2004). The quantitative findings were discussed in relation to the case studies findings to find one common finding per construct.

4.3.3 Case studies

This subsection presents the purpose for the case study design, strategy for data collection and structure. The population and sample size and methods are also presented, followed by the instrument development and data processing and analysis. Finally, the research procedures are presented.

The case studies method of this study was inspired by the Success Case Method (SCM) (Brinkerhoff, 2005). According to Brinkerhoff (2005), the SCM is simple and can be implemented in a short timeframe. In general, SCM is aimed at producing concrete evidence of the effect of – in Brinkerhoff's case - training (or the lack of it), in ways that educational stakeholders find highly believable and compelling, relating verifiable incidents which can be convincingly shown to lead to worthwhile results. SCM is used in this study to get better understanding of what is going on in the science classroom in terms of ICT use and pedagogical use of ICT.

Population and sampling

The population for case study comprises a total of all schools (N=137) captured in the survey. Through the survey, extrapolating results were obtained to get an estimate of quantitative estimates of the proportion of teachers who have used ICT, and particularly how they have used it. Table 4.6 (below) shows the population considered for the case studies selection, as well as that three success cases have been selected per educational region.

Table 4. 6: Population and samples for case studies per educational region

Region	Schools (N)	No of success case studies
Ohangwena	43	3
Oshana	62	3
Oshikoto	32	3
Total	**137**	**9**

To select the 'success cases', this study adopted the *expert judges* purposive sampling method, which sampled respondents with high scores in the survey. The schools considered for sampling were those that had ICT and use it more than others. Based on the survey data, per region three success cases were selected, from which one per region was selected for the case study based on the recommendation of principals. A jury of five principals was identified, based on the information from the survey, to recommend at least one or more schools in their regions that they knew were practicing ICT. The decision to ask for recommendation from at least five principals was based on the fact that schools are divided into circuits and principals know which schools use ICT most of the time. In addition, the issue of accessibility to schools was also considered due to a flood that occurred in the regions during the time of data collection. The sample for the case study comprised one school per region, and from each school the principal, one science teacher, and the ICT technician.

Instruments development and piloting

The instruments used in the case studies were interview schedules and classroom structured observational schedule. The development processes are explained below.

Interviews schedules

The interview guides were developed in light of filling the gaps that were detected in the survey. The interview questions were structured and aimed to seek the best practices or recent advances (Brinkerhoff et al., 1983). The interview guide has been developed such that it followed a pattern of categories similar to that of the science teacher questionnaire (Section 4.4.1).

Interview guide development

The interview guides were developed to elicit the best possible understanding of ICT and the use thereof. Questions for principals (*Appendix H*) focused more on the vision, leadership of the school, and collaboration and support from the school leadership to the science teachers. Questions for the science teachers (*Appendix I*) focused on ICT infrastructure, expertise, vision and digital learning materials. Questions for the ICT technicians (*Appendix J*) were the same as those of the science teachers. The pilot study of the interviews was conducted with one science teacher who taught at a local secondary school in Windhoek prior to entering the field. The teacher was practicing and sometimes acted as a principal in the absence of the principal of her school. In addition, she was computer-literate. The purpose of the pilot was to determine the suitability of the research questions and clarify interview questions.

Classroom structured observational schedule

The classroom observation schedule was adapted from the Model of patterns of innovative uses developed by Kozma and McGhee (2003; 2006) (see Chapter 3, Table 3.1). The observation schedule is structured and focused on seeking evidence for various ways of ICT use, such as tool use, information management, teacher collaboration, production creation and tutorial projects were closely monitored for noting in the observational schedule (Cohen, Manion & Morrison, 2000) *(Appendix K).*

Classroom structured observational schedule development

The observation schedule was developed based on the constructs that appear in the science teachers' questionnaires. Each construct had a number of variables that the researcher would look for during the observation. The researcher ticked off these events off as they happened and wrote notes in a separate column. Upon arrival at one of the selected schools, the observation schedule was piloted. The events the researcher planned were listed on the observation schedule. In addition, the researcher took notes. No changes were made on the observation schedule.

Data collection procedures

In this study however, the concept of Success Case Method (SCM) of Brinkerhoff (2005) was adapted to identify the success stories amongst rural schools with regard to ICT implementation. Firstly, the researcher identified the potential and likely success stories (Brinkerhoff, 2005) based on the survey results. Success stories are stories of teachers who have been successful in using ICT in their science classroom. These individual teachers have been identified through the survey and also by asking their principals. Secondly, interviews and observation methods were used to codify success stories and documented.

Before any data is collected, the researcher explained to the participant that his/her participation in the research is voluntary and he/she could withdraw anytime of the research process when not feeling comfortable. Confidentiality was also assured.

Upon the consent of the participant, interviews were conducted and recorded using the MP3 device. The interviewee was questioned in order to probe the answers and also to repeatedly check the reliability of the answers and also verify the interviewee's interpretations (Kvale & Brinkmann, 2009).

During the interview process, the screening of the candidate was done in order to determine whether the person being interviewed can be considered a representative of a true and verifiable success story. Upon meeting the earlier requirements, the candidate was probed during the interview, and the success story was documented. The interview outputs were stories of ICT use and the findings supported by evidence that would "stand up in court" (Brinkerhoff, 2005: 91).

The interview took approximately 45 minutes for the science teachers and 30 minutes for each of the principals and technicians. The interview was recorded using an MP3, a modern recording device, and notes were also taken during the interview as a method of contingency. The recorded conversation was transcribed, distinguishing clearly the interviewer from the interviewee through the transcription process. Transcriber reliability is noted by replaying the inaudible section of the recording over a number of times before transcribing. The verbatim descriptions such as pauses, repetition, and tone of voice were also noted for purposes of validity. Text data were produced.

In addition, a structured observation schedule was conducted. The focus of the observation was the teacher to events. The length of the observations was three lessons at the frequency of 45 minutes per selected schools. Notes were also taken as part of the text data.

Data analysis

Data collected through the interviews with the principals, science teachers and the technicians was analysed manually. The text data were analyzed using a coding schemes system which categorized it into constructs to allow for simple statistical analysis (Nachmias & Frankfort-Nachmias, 1996). A computer programme, *MSWord* was used to categorize and group the data into constructs. In this study, an inductive coding scheme was used for data analysis. In this scheme, data was transcribed from the recorded tables used to record participants' responses. This raw data from the transcripts, including the response from each of the interviews, was then organized into constructs. These were then grouped together in order of the responses by schools to determine the finding for each construct. Data from the questionnaire and observation worksheets was analyzed using basic descriptive statistics. In order to summarise the findings, the cases were cross-analysed per construct and by position of the respondents at school level. The meaning was condensed and categorized for interpretation of meaning (Kvale & Brinkmann, 2009).

4.3.4 The ICT use conference

This subsection presents the research design of the ICT use conference, based on the curriculum conference approach of Mulder (1991, 1994). The purpose for this approach, the curriculum conference method, the conceptual framework for analysing curriculum deliberation and the use thereof in this study are presented. In addition, the population and sample, the instrument development, the data collection procedures and the analysis are presented.

The phase of the study was inspired by Mulder (1991, 1994), who describes the curriculum conference as the process aimed at addressing questions of quality of curriculum deliberation involving broader communities. Mulder used the curriculum conference approach in a number of curriculum development projects to deliberate, validate, and legitimise findings of a those projects. The curriculum conference method has to be adapted to specific application situations and could be used to determine the consequences of new technologies for programmes, to validate these consequences and to justify curriculum content for the curriculum in the respective domains, and to make decisions about investing on a large scale in certain expensive equipment.

This approach has been adapted in this study to verify and legitimize preliminary findings of the research with a heterogeneous group of stakeholders who have an interest in the implementation of ICT in rural schools in Namibia. The approach is to make an inventory of the differences and agreements in opinions between ICT Project Manager, and representatives of the school principals, the technicians and the science teachers about the findings on ICT implementation in rural schools and to explore the nature of these differences and agreements. Also, this approach is useful for exploring the existence of a typology of decision-making profiles in ICT deliberations and the retention of the emerging convergence (Mulder & Thijsen, 1990). The thrust of this exercise is to verify and legitimise the description of the constructs and the factors that may possibly have an effect on ICT policy implementation in Namibian rural schools. In the following sections, the population and sampling, instrument development, data collection procedures and analysis are described.

Population and sampling

This phase of the study adopts the *key informants* purposive sampling method (Brinkerhoff, Brethower, Hluchy & Nowakowski, 1983). This method used purposive sampling criteria and sampled respondents who have participated in the baseline survey of this study, but not in the case studies. In addition, the respondents have an interest, knowledge, and experience in the general use of ICT. Some respondents have particular experience in ICT use in the science classrooms. These participants have not acted in the interest of their own schools but in the interest of all rural schools. In addition, these participants were willing to participate in the ICT use conference. It was believed that by purposively sampling respondents from three schools, which are different from the schools that participated in the case study, in the three educational regions of interest, plus the National ICT Project Coordinator, a good verification and legitimation of the findings could be obtained. The composition of the conference included: one ICT Project Coordinator, three principals (one per school), three science teacher (one per school), and three technician (one per school).

Table 4. 7: Population and samples for ICT use conference per educational region

Region	Schools (N)	No of participants (1 school per region)
Ohangwena	42	3
Oshana	62	3
Oshikoto	32	3
Sub total	**136**	**9**
National ICT Coordinator	**-**	1
Total respondents		**10**

Table 4.7 (above) shows a heterogeneous group of respondents selected from schools in the three educational regions plus the National ICT Project Coordinator. As described above, these participants possess the characteristics that enable them to represent rural schools. Thus, whatever arguments and opinions expressed by them in the ICT use conference, these represented the schools. However, these participants have equally scored high in the baseline survey and on that basis they qualified to part take in the ICT use conference.

Instrument development and piloting

Mulder (1991, 1994) warns that the basis of the curriculum conference is the necessity to share information. This information can be provided by the conference organizers in a form of a document that is forwarded to participants four weeks before the conference takes place. The document can contain various types of information, to be gathered using different strategies and different modes of inquiry. The document prepared for the ICT use conference, comprised a *PowerPoint* presentation (*Appendix M*) which contained information about the introduction to the study, aims, the research questions, research design and the preliminary findings of this study.

The materials for ICT use conference composed of a questionnaire and a *PowerPoint* presentation. The multi-perspectival preliminary studies (survey and case studies) were combined, commonalities and discrepancies were described. Tentative conclusions were formulated about the outcomes of the study and presented on *PowerPoint*. The instruments for the conference were designed based on the outcomes of the survey and case studies.

The questionnaire had two exercises (*Appendix N*). A set of instructions to fill in the questionnaire was provided in order for the participants to understand what was required of them. Exercise 1 was aimed at verifying and legitimising findings for research question 2 of this study. Exercise 1 consisted of a set of statements derived from the findings of the baseline survey. A set of statements were composed per construct in order to allow for verification of findings from the baseline survey. The statements had a four point scale response, ranging from ‘strongly disagree’ to ‘strongly agree’ and ‘very sufficient’ to ‘not sufficient at all’, for some of the constructs. Each construct had its own scale, befitting the statements.

Exercise 2 was aimed at verifying and legitimising findings for research question 3 of this study. Exercise 2 comprised a matrix of constructs and a response scale of four points, ranging from ‘very important’ to ‘not important at all’ to allow for variance in the response. Also, instructions on how to complete this exercise were provided. Additional space was provided in case the respondents had comments to make about the ICT use conference.

In order to test for validity and reliability, several drafts of the conference instrument were developed. The drafts were presented to an expert for review in terms of content and structure. In addition, the instrument was piloted with three schools in the three educational regions of interest to test if the participants could understand the sequence of event and structure of the questionnaire, and also to test if the participants would understand the contents as intended.

The participants of the pilot study did suggest some changes to the instrument but rather emphasised that the researcher needed to develop the programme to be followed during the ICT use conference so that the activities are easy to follow. Also, the expert suggested that the instrument should include clear instructions for undertaking the activities. The programme for the conference (*Appendix L*) was designed based on suggestions from Mulder &Thijsen (1990). The *PowerPoint* presentation was sent to the participants a week before the conference for perusal and also for the participants to familiarize themselves with the content before the ICT use conference. The programme for the conference was also attached.

Data collection procedures and analysis

As described earlier, Mulder (1991, 1994) suggests adaptation of the method which uses a deliberation approach to collect data from the participants. This is useful for establishing agreement on practical curriculum matters. Mulder (1994) argues that the usefulness of deliberation is that the curriculum work is interwoven with the constellation of its context, and that the processes are predominantly situation specific, as context tend to vary significantly on certain variables. Decisions may also be influenced by intuition and praxis. In order to establish an agreement on the desired curriculum, deliberative decision making combines 'epic' description of and issues in the field, on the one hand, and 'emic' perceptions and preferences of the decision makers on the other hand (Mulder, 1994:172).

Further, Mulder describes four possibilities of curriculum deliberation. These are possibilities that could happen during the curriculum conference:

1. If the preferences are homogenous, the group of decision makers probably does not need much deliberation, as there exists perfect preconcensus. Conclusions can easily be drawn. If the preferences are heterogenous, several things can happen.
2. The participants can jump to conclusions and take decisions without further discussion of differences of opinion. This approach is called *quasi deliberation*.

3. Participants may go a step further in analyzing the heterogenous preferences, and discuss the issues of the problem. Proposals may be formulated, conclusions drawn, and decisions taken. This approach is called *restricted deliberation*.
4. Ideally, from a deliberation point of view, participants with different preferences specify the issues within the problem, exchange their opinions, and base these on arguments; these arguments are weighed and conclusions are drawn, and decisions taken. This approach is called *full deliberation*, or simply *curriculum deliberation*.

In line with what Mulder (1994) prescribes, this research opted for a full deliberation approach so that the point of view of the ICT use conference are exchanged, bases for these arguments are presented and that the arguments are weighed before the conclusions are drawn. This approach was applied in this study as follows:

In order to validate and legitimise the findings for research question 2, the National ICT Coordinator collected the data through questionnaire on preliminary findings asking the participants to tick the most appropriate answer first, individually and then collectively discuss their scores in groups of three (3) as per the rank they occupy at their schools. The participants also expressed their opinion in terms of issues they had problems with. The conversations were recorded throughout the conference.

In order to validate and legitimise the findings for research question 3, the National ICT Coordinator collected the questionnaires, added the scores of each construct and determined the highest score. The participants decided to group themselves in two groups A and B. Each group drew one picture (see Chapter 8). The participants deliberated on the relationships that exist between the factors. These findings on the relationships between the factors were presented by one of the group members to the rest of the audience and other members could interrupt or add onto the presentation for purposes of clarification.

Data analysis

Data analysis used simple statistics such as frequency counts. Data was analysed using frequency count per construct. The scores were presented immediately to probe further deliberation and test the stance of the participants. Further, the results were negotiated before conclusions were drawn. Particularly for Exercise 2, the pictures were collected as evidence of what the participants presented as influence on factors that affect ICT implementation in rural schools. These pictures are analysed in comparison with the correlation analysis presented in Chapter 6 (see Chapter 8).

4.4 Methodological norms

This section presents issues of validity and reliability that were considered in the development of the instruments. It is highly unlikely that research would be done without possible threats that would interfere with the interpretation of the results, if not controlled throughout the research process. The following validity variables were considered for quantitative data as well as for qualitative data:

The issues of quantitative data considered important are the content validity reliability of the questionnaires and the transferability as discussed below:

Content validity - The researcher ensured content validity in both the survey and case studies by ensuring that the instruments (questionnaire, interview schedule, classroom observation and conference material) tested what they were supposed to test. This has been done by reviewing the content of the questionnaires and piloting them. The content of the instruments for both the survey and case studies was presented to a number of experts in the field for their comments. The comments were included in the questionnaires before they were piloted with principals, science teachers and technicians through the pilot study.

Reliability of the data

The reliability of the data was assessed through Cronbach's alpha analyses, which showed that the instruments and the scales have internal consistency and reliability. Cronbach's alpha reliability coefficient normally ranges between 0 and 1 with no lower limit to the coefficient. The more the Cronbach's alpha coefficient is close to 1.0, the greater the internal consistency of the items in the scale. Based upon the formula = rk / [1 + (k -1) r] where k is the number of items considered and r is the mean of the inter-item correlations. The size of alpha is determined by both the number of items in the scale and the mean inter-item correlations (Zikmund & Babin, 2007). The results of the reliability analysis are depicted below in Table 4.8. One may conclude that the reliability of all instruments is sufficient till good (Cohen, 1969)

Table 4. 8: Reliability analysis of questionnaire data per instrument

Reliability Statistics	Cronbach's Alpha (+)
Technician questionnaire	0.754
Principals' questionnaire	0.943
Science teachers' questionnaire	0.890

Transferability- various data collection instruments were used to enable judgment to be made about the transferability of this research findings to another setting of similar nature. Thus, the methodological procedures may be generalized to the broader theory of evaluation studies. The findings of this study may be applied in at least all rural junior secondary schools since they share the same characteristics.

This study discusses issues of qualitative data such as credibility and trustworthiness as it pertain to this study:

Credibility : refers to the truthfulness of the data. Credibility is enhanced when strategies are put in place to check on the inequity process of data and to allow for direct testing of findings and interpretations by the human sources from which they have come (Lincoln and Guba 1985). In addition, credibility was enhanced by using various methods such as survey, case studies, ICT use conference, thereby triangulating the research methods suggested by Cohen et al. (2007).

Trustworthiness: refers to the trustworthiness of the interview instruments. There are many criteria to insure the trust (Denzin & Lincoln, 2003). These criteria are concerned with determining the criteria to judge confidence in the outcome of the study and the extent to believe what the researcher has reported (Maykut & Morehouse, 1994). In this study, in order to know that the data of the interview is trustworthy, the researcher considered the credibility and transferability of the instrument.

Triangulation: refers to the use of multiple sources of data and using it to build a coherent justification for variables (Creswell, 2009). the study used results from survey to inform the case studies. The results from both methods were compared, combined and verified and legitimised in the ICT use conference.

4.5 Ethical issues

This section presents the ethical issues that the researcher was confronted with in the research process of this study. It is important to note that the requirement for conducting research at the University of Pretoria was met. Permission to conduct research was sought from the Faculty of Education after which it was granted by the University of Pretoria ethical clearance committee. The committee approved the procedures suggested for consideration during the research process.

Debriefing and the right to non-participation: Prior to undertaking any research activities, all participants were informed about the nature of the research, its objectives and that their participation is voluntary. Also, it was explicitly stated to the participants that they could withdraw at any time of the research if they felt uncomfortable (Denzin & Lincoln, 2003).

Confidentiality and privacy - The researcher knows who has provided the information or is able to identify participants from the information given, the participants identity remains un-announced to the public. Therefore it was explicitly stated at the beginning of the questionnaire that the information provided by them would remain confidential and should they be required to part take in the recorded interviews and classroom observations, their permission would be sought. The researcher also guaranteed privacy whereby the participants have the right not to take part in the research, not to answer questions, not to be interviewed and or to be observed (Cohen et al. 2007).

Equality - All participants for the curriculum conference were treated equal without intimidation by the supervisors.

Respect and autonomy - Arguments and deliberations from all participants were treated with autonomy at each typology (Cohen, et. al., 2007). All participants were entitled to reasonable opinions and suggestions for improvement.

Public perspicuity -This study considered openness to the public (Cohen et al., 2007). Any member of the public can question the evaluative procedures, their intentions and their results.

4.6 Conclusion

This chapter presented the research design of this study, which consists of three parts: the survey, case studies and the ICT use conference. The survey aimed at describing ICT infrastructure, expertise, cooperation and support, leadership, digital learning materials, and vision of ICT as implemented. In addition, the case studies approach adopted for this study was also presented. The case studies aimed to explore ICT use events and understand how ICT is being implemented in rural schools. The case studies entail interviews with principals, science teachers and ICT technicians. The classroom observation is conducted with a few selected science teachers. The findings obtained through these methods were summarised and presented at the ICT use conference where the participants were expected to verify and legitimised them. The involvement of experts in the field has added value to the development of the instruments and also the research design of the study. These efforts have laid the foundation for Chapters 5 in which the survey results are presented as well as for case studies results presented in Chapter 6.

CHAPTER 5

ICT IMPLEMENTATION IN SCIENCE CLASSROOMS

This chapter presents the research findings for research question two of this study and also serves as a basis for presenting the quantitative part in Chapter 6 of this study. The introduction is presented in Section 5.1. The background information of the science teachers is discussed in Section 5.2. The description of findings with regard to ICT use in science classrooms is presented in Section 5.3. The case study findings per school are presented in Section 5.4 and the case cross analysis in Section 5.5. Finally, the conclusions are drawn in Section 5.6.

5.1 Introduction

This section presents the introduction to the chapter that aims to present findings for research question two, *how is ICT being implemented in science classrooms?* For a better understanding it is important to present the background of respondents. This information will provide the context within which ICT is being implemented, followed by a description of ICT integration and implementation in science classrooms located in rural areas. For the purpose of this chapter only descriptive data for the constructs is provided.

As explained in Chapter 3, the findings of all constructs are presented at classroom level, containing only the science teachers' data on variables that appear in the middle component of the conceptual framework (see Chapter 3), marked 'implemented' as well as those in the last component of the conceptual framework marked as 'output'. The variables are leadership, collaboration, vision, support, expertise, digital learning materials, and ICT infrastructure and pedagogical use of ICT, and these in turn may have an influence on the science teachers' attitudes and aspirations towards education and ICT.

The analyses of the data covered the indices scores of the science teachers. In order to have a substantive meaning of the constructs, an index table is provided showing the computation of the indices per construct (*Appendix H*). The findings are presented at classroom level because the scores on the constructs provide insight into the science classrooms for the aspects represented in the constructs. In some schools, however, more than one science teacher responded to the questionnaire, but since the findings are reported at classroom level this has no effect on the findings.

The data was collected from science teachers and therefore it became necessary to present the background information (Section 5.2). Description of ICT use is presented in Section 5.3 and the Conclusion in Section 5.4.

5.2 Biographical information of the science teachers

This section presents the background information of science teachers with regard to period of teaching experience, age groups, gender and ICT use.

Teaching experience

The science teachers were asked to indicate their number of years of teaching experience, with responses as follows:

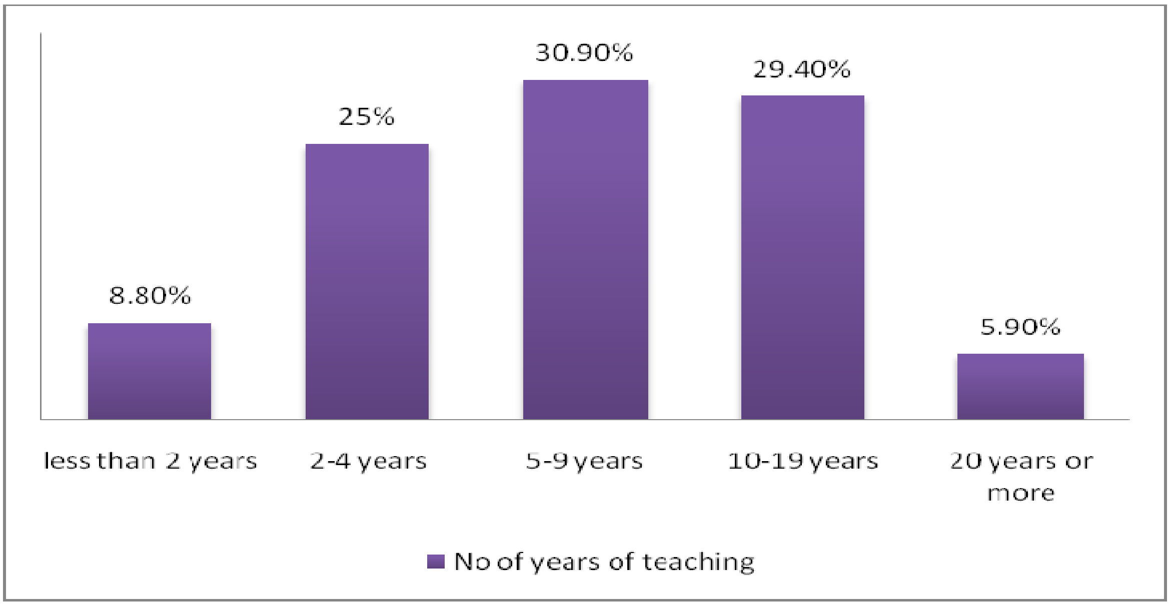


Figure 5. 1: Years of teaching experience of science teachers (N=137)

Figure 5.1 (above) shows that more than half (31%+29%) of the science teachers had between 5 and 19 years of teaching experience. This does not imply that they have been teaching science since the beginning of their teaching career. It should be noted that there was a shortage of science teachers and it is probable that these teachers upgraded themselves through courses such as MASTEP, one that most teachers at junior secondary school level followed in order for them to become science teachers (Clegg, 2004).

Qualifications of science teachers

The science teachers were asked to indicate what qualifications they held, and the responses showed their qualifications ranged from secondary school leaving certificate to a Bachelor's degree, as in figure 5.2:

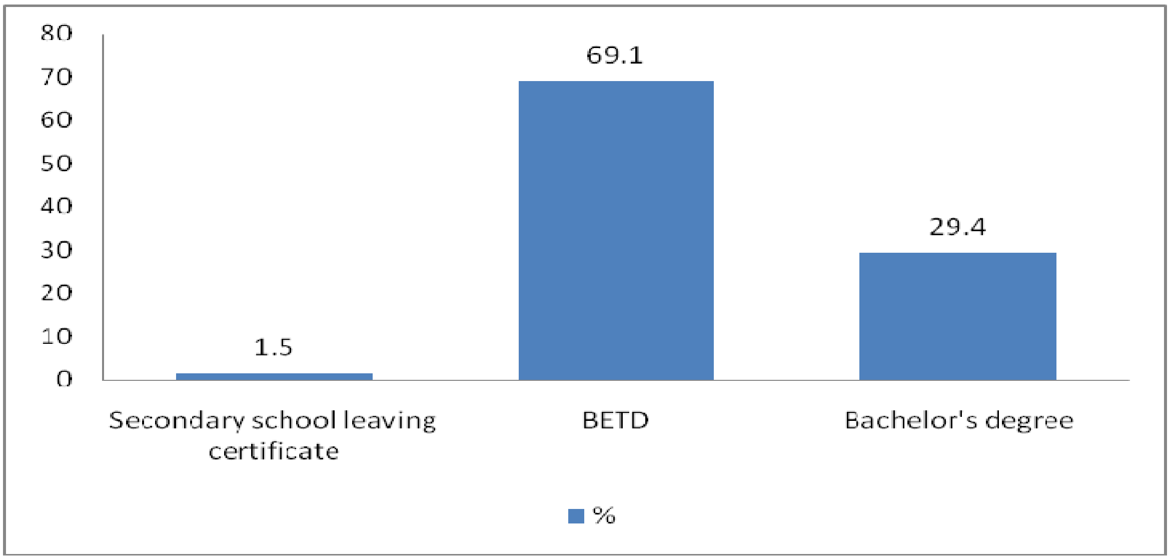


Figure 5. 2: Science teacher's qualifications (N=137)

Figure 5.2 (above) shows that most science teachers (69.1%) have a Basic Education Teaching Diploma (BETD), and only 29% have a Bachelor's degree. Very few (2%) of the responding science teachers were unqualified.

Age of science teachers

The science teachers were asked to indicate their age category, and the age distribution is presented below:

Table 5. 1: Age distribution of science teachers (N=137)

Age group	Percentages (%)
below 25	7 (2.2)
25-29	33 (4.0)
30-39	38 (4.2)
40-49	16 (3.2)
50-59	5 (1.9)
Total	**100**

The highest age group distribution was between 30-39 years of age (38%) followed by 25-29 (33%) of the total number of science teachers. Most science teachers (38% + 33% + 7%) were about the category '39 years of age or below', a finding that suggests that there is a new generation of science teachers in rural schools. This could be because following Namibia's independence in 1990, emphasis was placed on science education of which these science teachers were likely to be products (Clegg, 2004).

Gender of science teachers

The science teachers were asked to indicate their gender, with response as follows:

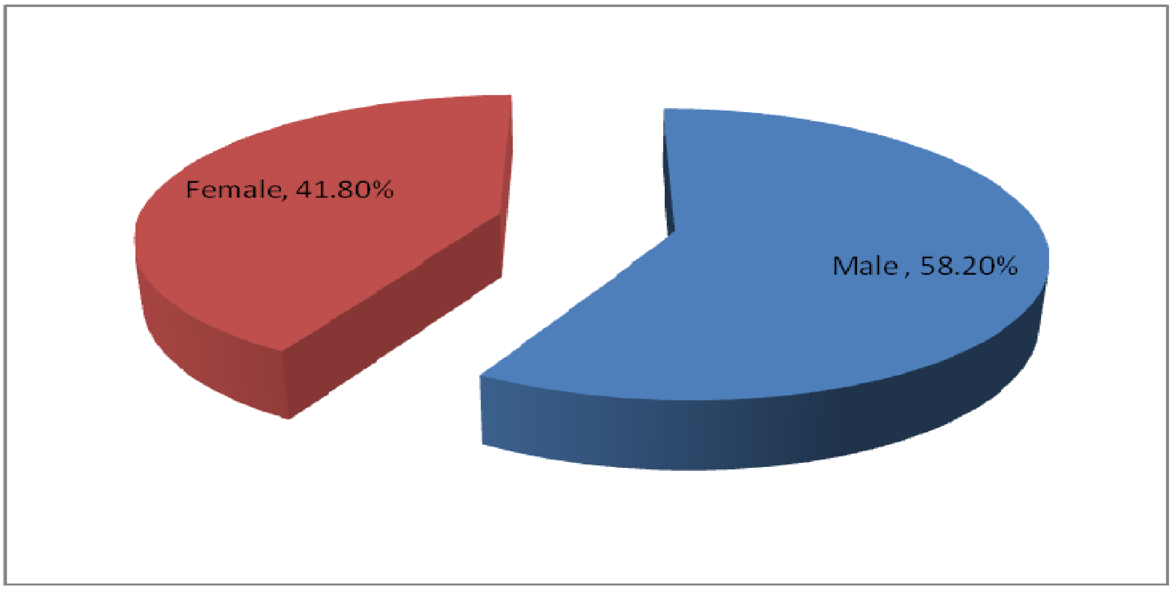


Figure 5. 3: Gender of science teachers (N=134)

The pie chart (Figure 5.3, above) shows that more than half (58%) of the science teachers were male, not surprisingly since for many years this profession has been occupied by men. Gradually, with the advocacy of female children in science and other projects supporting women in science, in an attempt to get girls to study science at secondary schools level, this profession is becoming slightly less male-dominated.

Access to computers at home

Asked whether they had a computer at home, the responses of the science teachers were as follows:

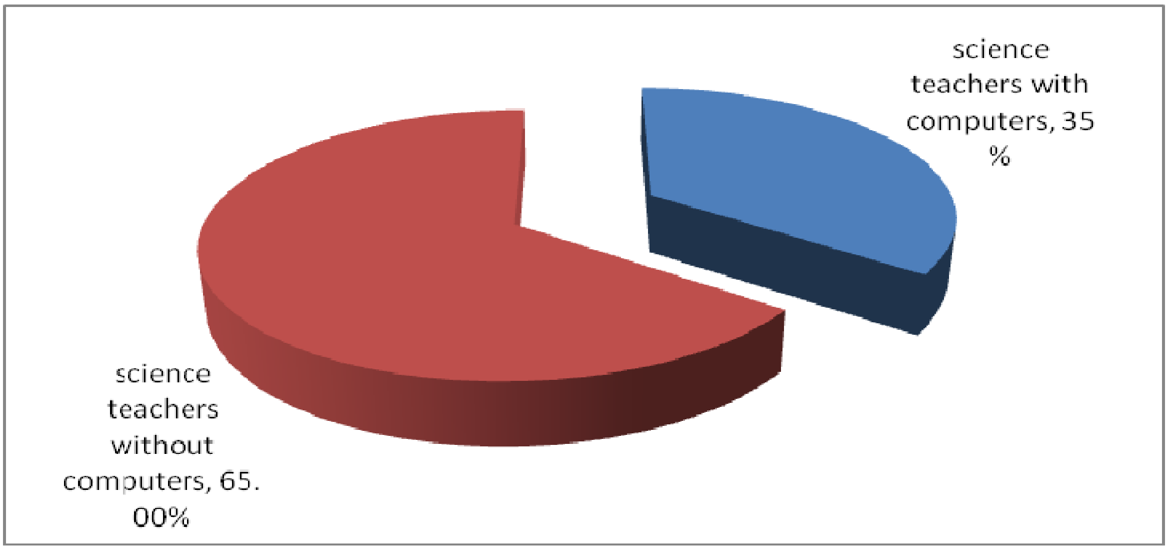


Figure 5. 4: Access to computers at home (N=137)

Figure 5.4 (above) shows that a third of the science teachers owned computers and used them for school related activities, an indication that some did posses computers and used them after hours for school-related activities.

Connection to internet

The science teachers were asked to indicate if their computers at home were connected to the internet, eliciting responses as follows:

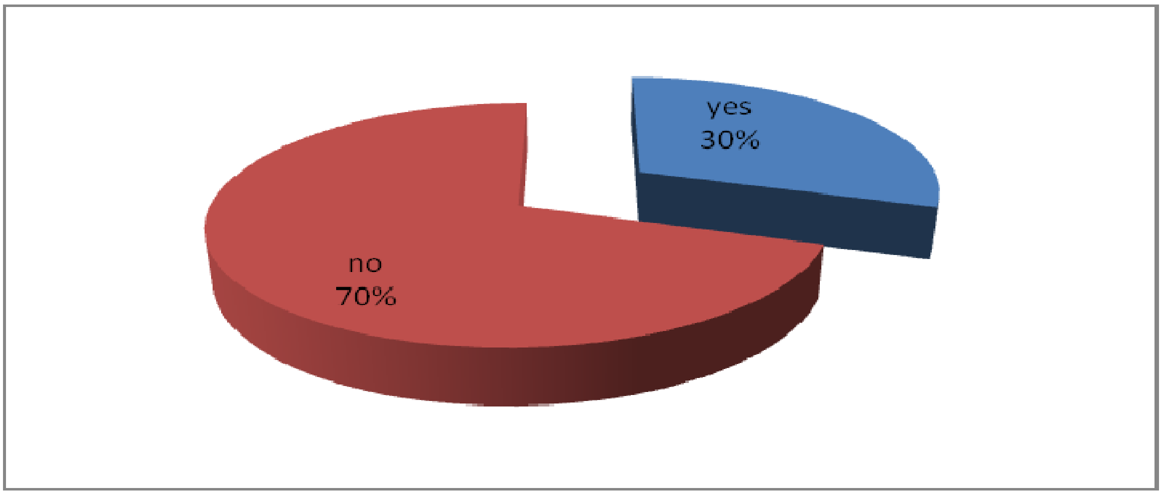


Figure 5. 5: Computers' connectivity to internet (N=137)

Figure 5.5 (above) shows that about a third of the science teachers' computers were connected to the Internet. This does not imply that science teachers who indicated that they did own computers were necessarily the same who indicated that their computers were connected to the Internet. It was probable that some science teachers did have access to the Internet through other devices, as indicated by Figure 5.4.

Learners' ICT skills operations

The science teachers were asked to indicate the level of ICT skills for learners, with the response rate as follows:

Table 5. 2: Learners' ICT skills operations (N=137)

Operation software		nearly none		some students		majority of students		nearly all students		don't know	
	N	n	%	n	%	n	%	n	%	n	%
Word processing	129	72	56	20	16	10	8	3	2	24	19
Database software	130	89	69	11	9	3	2	1	1	26	20
Spreadsheet	126	86	68	12	10	2	2	0	0	26	20
Presentation software	127	86	68	11	9	2	2	0	0	28	22
Application of multimedia	127	77	61	18	14	3	2	0	0	29	22
Email	126	77	61	15	12	8	6	0	0	26	21
Internet	127	77	61	17	13	9	7	0	0	24	19
Graphic calculator	127	77	61	19	15	10	8	2	2	19	15
Data-logging tools	127	93	73	5	4	2	2	1	1	26	21

Table 5.2 (above) shows that the majority (between 93% and 72%) of the science teachers indicated that almost none of the learners knew about the operation software. However, some science teachers indicated that a few learners did

possess ICT skills to operate some software. The non-response rate was high as many teachers did not integrate ICT in their science lessons.

Classroom information

Science teachers were asked to indicate the time they allocated to ICT use per week, with the response as follows:

Table 5. 3: Average ICT class time allocation per week (N=137)

Time	% /SD
less than 2 hours	17 (3.2)
2-4 hours	47 (4.3)
5-6 hours	14 (3)
7-8 hours	13 (2.9)
more than 8 hours	10 (2.5)
Total	**100**

Table 5.3 (above) shows that about half (47%) of the science teachers had allocated between 2 and 4 hours a week to ICT use. A few schools (22.6%) allocated 7 hours or more per week to ICT, a finding that suggests ICT use is higher than the number of hours spent by the Finnish teachers (Section 3.5). This could be attributed to a number of factors that are presented in the next sections.

5.3 Description of ICT use in science classrooms

This sub-section presents findings on the ICT use in Namibian rural science classrooms. For better understanding the definitions are presented before the findings.

Definitions of variables:

Vision refers to the schools' view of what constitutes a good teaching approach and how the school aims to achieve its objectives considering the role of the teachers and learners, the teaching, and the materials being used to teach. The vision of the principals and teachers determine the policy of the school and the design and organisation of its teaching.

Expertise refers to teachers and learners need to have sufficient knowledge and skills in order to utilise ICT to achieve educational objectives. This requires skills beyond basic ICT skills to operate a computer. Pedagogical ICT skills are also necessary to help structure and organise learning processes.

Digital learning materials refer to all digital learning educational content, whether formal or informal. This includes educational computer programmes.

ICT infrastructure refers to the availability and quality of computers, networks, and Internet connections. ICT constitutes infrastructure facilities. In addition, electronic learning environments and the management and maintenance of the school's ICT facilities are also considered as ICT infrastructure.

Collaboration: the encouragement by the school leadership to use ICT and the initiatives to create partnership within the school and between schools in the same region or outside region.

ICT use: refers to the general use of ICT.

Pedagogical use: refers to the use of ICT for purposes of teaching science.

Having presented the definition for better understanding, a brief discussion on the computation of the indices and the descriptive findings on ICT use are presented respectively.

This section presents findings on ICT implementation in science classrooms. The original responses by the science teachers were converted to indices to allow for computation of the constructs into scales. The scales comprise three categories of low, medium and high. For further explanation on how the scales were computed, see Chapter 4. The findings show the outcome of indices calculated in maximum and minimum scores as well as the mean scores (see Table 5.4 below):

Table 5. 4: Description of findings on the use of ICT in the science classroom

Construct	***Data source***	***N***	***Mean***	***Minimum***	***Maximum***	***SD***
Pedagogical use of ICT	Science teachers	137	24.99	.00	91.00	17.11
Leadership	Science teachers	137	80.17	0.00	100.00	19.96
Vision	Science teachers	137	66.18	0.00	100.00	39.60
Science curriculum goals on ICT	Science teachers	137	53.94	0.00	71.79	12.01
Collaboration	Science teachers	137	55.20	0.00	75.00	15.87
Technical support	Science teachers	137	24.57	0.00	100.00	25.17
Professional development	Science teachers	137	52.14	0.00	92.86	12.26
Digital learning materials	Science teachers	137	62.91	0.00	100.00	27.72
Expertise (ICT related)	Science teachers	137	41.95	0.00	76.56	13.85
Confidence in ICT use[i]	Science teachers	137	12.14	0.00	53.00	15.08
Confidence in Pedagogical use of ICT	Science teachers	137	14.94	6.00	59.00	14.57
ICT infrastructure	Science teachers	137	17.35	0.00	66.67	16.73
Obstacle	Science teachers	137	48.72	0.00	100.00	30.06

Pedagogical use of ICT by science teachers

The science teachers were asked to comment on statements on the pedagogical use of ICT and also to indicate the impact thereof. The responses range from 00.00 % to 91.00%, with a mean score of 43.76% (SD=17.11). This finding suggests that the mean score is medium. However, some school have scored high on the scale, suggesting that those schools that scored highly make more use of ICT for pedagogical purposes than for others.

Leadership

The respondent science teachers were asked if the statements about leadership applied to them in their respective schools. Table 5.4 (above) shows that the science teachers responses on questions about leadership ranged between 0.00% and 100.00% (SD=19.96, and a mean of 80.17 %). The indices scores show a mean score at a high level. It can be interpreted from this that the school leadership was performing its duties in relation to the vision of the National ICT policy. Some schools as per the views of the science teachers suggest that the leadership is more emphasized than in other schools.

Vision

The respondent science teachers were asked if the statements about vision applied to them in their respective schools. Table 5.4 (above) shows that the science teachers' responses range between 0.00% and 100.00, with a mean score of 66.18 (SD= 39.60), suggesting that the vision of the science teachers lie in the high category of ICT implementation.

Science curriculum goals

The responding science teachers were asked to indicate within this school year (2010) how important it was for them to achieve the curriculum goals. The response ranged from 0.00% and 71.79% with a mean score of 53.94% (SD=12.01). The mean score was medium (53.94%) and it could mean that the science curriculum goals with regard to ICT were implemented halfway in line with the goals of the National ICT Policy for Education.

Collaboration

The science teachers were asked to state whether they agreed or disagreed that the school leaderships encouraged teachers to engage in cooperation that allowed them to work in groups, sharing knowledge and solving problems; and also on whether the leadership encouraged teachers to use different assessments. The science teachers showed a response range between 00.00 and

75.00%, with a mean score of 55.20% (SD=15.75). The findings could mean that some schools were not at all supportive of ICT related activities. This should also be noted that the principals scored themselves high on this construct, implying that they performed their duties very well, and therefore the high means score.

Technical support

Asked to comment on the technical support offered to them, the science teachers' mean score was slightly above the low range (Mean = 24.57%, SD= 25.17). However, some schools have high level (Max=100.00%) of technical support while other schools have no technical support at all (0.00%). From this it can be interpreted that the level of support offered to science teachers was low.

Professional Development

Commenting on statements that pertain to professional development, in particular whether they had participated in any professional development course and if not, whether they would liked to attend any, the science teachers' responses ranged from 0.00 % to 92.86%, with a mean score of 52.14% (SD=12.26). This finding suggests that they were being trained, although from the minimum and maximum values it can be stated that some schools were offering training of science teachers more (max=92.86%) than others (min 0.00%). The likelihood exist that some schools created opportunities to train more of their science teachers.

Digital Learning materials

The science teachers were asked to state how often the target class performs certain activities and also to state whether ICT was being used for such activities. The table shows that the mean score on digital learning materials was low (Mean=18.47%, SD=18.47), reflecting a lack of them in science classrooms.

Expertise

The science teachers were asked to state how often they conducted the ICT-related activities and also to state if they did use ICT to conduct the activities. The table shows that the knowledge skills and attitude of the science teachers was the medium range (Mean=41.95%). However some schools did not conduct ICT-related activities at all (Minimum value=0%) and some conducted ICT related activities using ICT (Maximum value=76.56%). It is likely that the schools that conducted ICT related activities in the science classrooms were also those that were being encouraged to do so by the school leaderships.

ICT infrastructure

Asked to indicate the frequency of use of ICT software the table shows that the frequency of ICT use by science teachers was low (Mean=17.35%, SD=16.72). It can be said that the ICT infrastructure in schools was insufficient in terms of acquisition and availability, and poor with regard to decision-making about acquisition and maintenance.

Attitude

In response to being asked to indicate whether they were confident in the general use of ICT and also in pedagogical use of ICT, the figures show that confidence in the general use of ICT ranged from 0.00% to 53.00% with a mean score of 12.14% (SD= 15.08), whilst in pedagogical use of ICT, the responses ranged from 6.00% to 59.00% with a mean score of 14.94 (SD= 14.57). These findings suggest that the attitude of the science teachers was very low hence the low level of ICT implementation explained above. The low category in this instance could be interpreted to mean that the attitude was negative.

Obstacles

Finally, the science teachers were asked to comment on the extent to which they were affected by a number of obstacles. The findings show a range of 0.00% and 100.00% with a mean value of 48.72% (SD=30.06), suggesting that the obstacles are medium, meaning that the teachers were not completely affected by the various obstacles.

Summary of ICT use in science classrooms

Findings on indices have been presented per construct that appear in the conceptual framework of this study. The origin of the categories of low, medium and high have been referred to in Chapter 4 and for more information is attached (Appendix, O). The findings showed that pedagogical use of ICT, technical support, attitude of science teachers and ICT infrastructure, fell in the low range. Science curriculum goals, collaboration, professional development, digital learning material, expertise and obstacles have mean scores that fall in the medium range. Leadership and vision had high mean scores, however, the use of ICT and pedagogical use of ICT was low. Interestingly, the obstacles had a mean score which was in the low range. This raises questions as to why the mean score for the obstacles was low, given that ICT use was also in the low range. In order to understand this apparent anomaly, qualitative findings are presented.

5.4 Case studies' findings on ICT use in science classrooms

This section presents findings of schools A, B, and C., presented per construct. The three case studies participating schools are all rural based, one in each of the three educational regions. As explained in Chapter 2, these educational regions were war zones before the years 1990. In terms of resources, none of the schools is said to be better equipped than the others. All the three schools depended on the Namibian Government to provide them with basic resources. Given the fact that the case studies participating schools are homogenous in nature, the findings are similar in many respects. It can be said in generally that the findings for all schools are in agreement with one another.

Table 5. 5: Characteristics of science teachers

Science teachers	School A	School B	School C
Age	25	32	32
Training	BETD	BEd	BEd
No of years as teachers	2	5	5

Table 5.5 (above) shows that the science teachers are both young between the ages of 25 and 32. Two of the three teachers have Bachelor's degrees with five years of teaching experience, and one has a BETD Diploma with two years of teaching experience. This background information is important as it might have influenced the responses of the science teachers. The responses are presented per school below:

School A

This section presents the views of the respondents at School A on factors that may affect their ICT implementation. The views are presented per construct then summarized.

ICT use

Computers are largely used for administrative duties. For example, Science teachers also stated that they use computers for preparing lesson plans and typing notes for use in class. This is evidenced by:

> *'I use computers to plan my lesson, type the notes for the learners and to make copies to give to my learners if there is a photocopier machine'* (Science teacher A, 13 April 2010).

The science teacher stated that ICT was used almost every day for lesson preparation. In addition, during observations, he was also observed teaching using ICT, which appeared to be the type he needed to deliver the lesson.

Pedagogical use of ICT

The theme being taught determines the ICT to be used. Science teachers use ICT such as an overhead projector, a screen, a radio or a video when teaching. The science teacher mentioned:

> *'… depending on the theme being taught determines the ICT to be use, sometimes I use an overhead projector, a screen, a radio or a video to project on the wall for all the learners to participate'* (Science teacher, A, 13 April, 2010).

Leadership

The school leadership is encouraging ICT use in the science classrooms and also gives advice. Some members of the school leadership lacked knowledge about ICT and therefore were not able to give informed advise on ICT-related matters. This is evidenced by:

> *'The school leadership monitors teachers especially when they are in the computer room. E.g. they come to give ideas though not all of them know how to use computers very well' (Science teacher, A, 13 April, 2010).*

Collaboration

The science teacher receives assistance from the ICT technician, indicating some collaboration between the two. During observation, a staff member from the circuit office was seen typing question papers for schools that did not have computers. A science teacher stated:

> *'I get assistance from our instructor here and our principal is not that good at ICT and if you go there and ask him question he will only refer you to the instructor and even the Head of Department for Science'* Science teacher, A, 13 April, 2010).

Pedagogical support

Pedagogical support towards science teachers is minimal as not many teachers use ICT in their class. For example:

> *'Support from other teachers is good but not all of them are ICT-orientated'* (Science teacher, A, 13 April, 2010).

Technical support

The ICT technician has developed rules to guide the teachers through the use of ICT and teach the school administrative assistant to take over some responsibilities. The science teacher stated:

> *'Technical support is not a problem, we have a teacher who is teaching ICT'* (Science teacher, A, 13 April, 2010).

Vision

The science teacher seemed to know what the vision of the school was towards ICT use:

> '...all our teaching should make use of ICT' (Science teacher, A, 13 April, 2010).

ICT infrastructure

The researcher observed that the Ministry of Education had provided this school with 20 computers, and though it did not have access to the Internet the principal knew that he would have to pay N$150.00 for Internet services once installed. The electricity supply was not continuous as power failures had been experienced whilst teaching. During observation, a number of obsolete computers were seen to be stowed away in one corner of the computer laboratory. There was a shortage of desks and chairs, with two learners sharing a chair and a computer:

> *...the negative impact can be also while you are in the motion of teaching the power failure occurs and teaching is disturbed.'* (Science teacher, A, 13 April, 2010).

Expertise

The science teacher has had training for a short period on basic ICT skills. The training happened when he was a student at the College of Education. The Ministry of Education provided a computer software package without necessary training to teachers:

> *'I have been trained but not in Encarta… I was trained by … Dr Ella for two weeks'* (Science teacher, A, 13 April, 2010).

Digital learning materials

Encarta software was pre-installed in the computers provided to schools. In addition, the school bought extra software, such as one for teaching mathematics. *Encarta* is seen as relevant to teaching science. The science teacher stated:

> *'The ministry came to install the computer, they also put in Encarta... it is relevant... it makes learners come to school. Encarta is mostly used... relevant but there are more software with more details'* (Science teacher, A, 13 April, 2010).

The science teacher uses ICT almost every day for lesson preparation, and was observed teaching using ICT. The teacher was well prepared and appeared to know the appropriate ICT to use for that particular lesson. The lesson plan was also made using computers, although in the interviews he mentioned that he used different types of ICT such as radio, television and computers. The science teacher had undergone a two-week training course in basic computers. The school leadership was supportive of ICT-related activities, although some members lacked knowledge about ICT. Collaborative activities between science teachers and other teachers were minimal due to many teachers not having been trained in ICT and therefore unable to offer the required support.

School B

This section presents the views of the respondents at School B on factors that may affect ICT implementation in their school. The views are presented per construct and summarised.

ICT use

The science teacher stated:

> *'With computers it's easy for me to prepare my lesson activities using a computer, printout, make copies and it is easy for learners to answer questions. Learners pay much attention when they do activities with computer in class rather than me coming without any activities* (Science teacher B, 13 April 2010).

Pedagogical use of ICT

The science teachers use ICT more to teach and search for information in preparation of the lesson. However, the challenge is that, when using ICT, the science teacher does not get to finish the syllabus:

> *'I use ICT to explain the content what is being taught, I project the information on the screen so that learners can see what is being taught... to produce handouts with some information, print and give to the learners. Also, I can search for information on the Internet. However, you don't complete the syllabus on time*

> *because you end up going slower. Sometime you have to tell every learner to stop using the computer and sometimes you have to go show them how'* (Science teacher B, 13 April 2010).

Leadership

The science teacher stated that the function of the school leadership was to acquire computers and to ensure that Internet was accessible. However, it was up to the teacher to choose the appropriate ICT for a particular lesson. The science teacher stated:

> '*The school leadership makes sure that computers are there and functioning also that the Internet is working'* (Science teacher B, 13 April 2010).

Collaboration

There is some evidence of collaboration between the ICT teachers as they assist each other. The type of collaboration is in a form of support and is not explicit. The community members are not allowed to use the schools' ICT facilities.
The science teacher stated:

> *'Teachers who have better skills in ICT always help whenever I am stuck '(*Science teacher B, 13 April 2010).

Pedagogical support

The science teacher claims that the support system is weak. A number of teachers have knowledge about ICT and therefore help in times of need. The more people are shown how to fix the problem, the better for the school in terms of increasing the number of people who will be able to attend to recurring problems.

Technical support

The science teacher claims that technical support offered to them is weak. A few teachers have skills in troubleshooting and they assist others:

> *'The support system is weak. There are those teachers that got special training in computer and when you are stuck with something on the computer they assist in fixing the problem'* (Science teacher B, 13 April 2010).

Vision

The science teachers related that a vision was not stated in any school document but concurred with the one expressed by the principal and the ICT technician. During classroom observation, the researcher noted that the school had a vision statement posted on the wall at the entrance of the school, but that it made no mention of ICT. The teacher said:

> *'I cannot tell that much because we don't have anything on paper, I haven't seen anything on paper. I'm the chairperson of the timetable committee I can see clearly that the school is aiming at having all learners at least acquire computer skills'* (Science teacher B, 13 April 2010).

ICT infrastructure

During classroom observation, the researcher observed that the school was provided with 20 computers by the Ministry of Education. In addition, it had purchased a few more computers out of the school development fund. The Internet connection fee was N$ 300.00 per month, accessed through a 3g device. About 7 computers were placed in the staffroom for teachers, one in the principal's office and two at the reception. The computers were protected against dust with the intention of increasing duration of functionality.

Expertise

The science teacher had undergone basic training in ICT during post-school training. The school had been supplied with pre-installed *Encarta* but no training had been provided to the users. Pre-knowledge acquired in the teacher training programme became necessary. Training in ICDL was about to start at the time of data collection. During classroom observation, the science teacher portrayed confidence in ICT integration. He was able to teach a class of 40 learners with 20 computers and still accomplished the objectives of the lessons:

> *'I was trained in using the timetable software by the service provider. When I was at UNAM we had a course called Communication Technology, I did a bit of that for a volunteer from America who came to train us'* (Science teacher B, 13 April 2010).

Digital learning materials

The school had been supplied with pre-installed *Encarta*. In addition, the school could buy the timetable and report card software. This software was said to be very relevant for pedagogical use, with *Microsoft Word* the mostly used and easy to operate:

> *'Timetable, report cards is mostly used. Operating these software is quite easy and relevant at our school'* (Science teacher B, 13 April 2010).

The science teacher B uses ICT to prepare lessons and give activities to learners. The ICT technician confirmed that the science teacher used computers at least twice a week. The science teacher was observed teaching using ICT. The teacher was well prepared and appeared to know the appropriate ICT to use for that particular lesson. The lesson plan was also drawn up using computers.

School C

This section presents the findings from the case study, School C. The findings are presented in a logical format of schools A and B respectively, before they are summarised.

ICT use

The science teacher stated that he used computers for administrative purposes and also for browsing the Internet:

> *'I use ICT to type documents and to search for information on the Internet'* (Science teacher C, 16 April 2010).

Pedagogical use of ICT

The science teacher used ICT for lesson preparation and for assessment. In addition, the science teachers used ICT for the Internet. The science teacher felt that the reason some teachers, including the science teachers, were not using ICT in their lessons was that it was not stated in the curriculum. Science teacher C stated:

> *'I use it for lesson preparation and for assessment. I would like the science curriculum to indicate when to use ICT like it is done in Mathematics. Some teachers do not make an effort to use ICT because it is not stated'* (Science teacher C, 16 April 2010).

During observation, the science teacher did not use the Internet to teach.

Leadership

The school leadership encourages science teachers to use ICT in lesson presentation, with examples from simulations. In addition, the school leadership ensures that teachers conduct lessons on ICT and also advises on what software to buy, based on the need. However, the decision about ICT-related matters are made by the school leadership and not by school board. Science teacher C:

> *'The management makes sure that each teacher is teaching ...and bring the learners to the lab so that we show them how to use computers'* (Science teacher C, 16 April 2010).

Collaboration

There is evidence of collaboration where more knowledgeable teachers in ICT support those who are less knowledgeable in teaching using ICT. During a lesson observation, the science teacher was being assisted by the ICT technician, showing learners where to click if they failed to follow instructions. Science teacher C stated:

> *'I get assistance from my fellow teachers who have knowledge in ICT'* (Science teacher C, 16 April 2010).

Pedagogical Support

Pedagogical support was lacking. Science teacher B seemed very well vested in ICT skills and showed other teachers how to prepare report cards using computers. For example:

> *'We are not very much supported in that. I help all of them regardless of whether they are science teachers or not. Like now, I just gave them a lesson on how to do the report cards' (*Science teacher C, 16 April 2010).

Technical support

Technical support is weak. The principals only made sure that they released the funds for computers to be repaired. In this case, the science teacher was also acting as an ICT technician and sometimes taught fellow teachers on how to use the report card development software. However, this support was only given during free time or when absolutely necessary, as it may have required the ICT technician to leave her class. For example:

> *'We the management only make sure that computers are repaired as soon as possible technical support is not good, sometimes you sit for the whole week or whole month with computers and you do not know what to do or who to contact'* (Science teacher C, 16 April 2010).

Vision

The vision for the school was for all teachers and learners to use ICT in preparation for the tertiary education. The vision of the school was written at the entrance of the school, but no words about ICT feature. Science teacher C stated:

> *'…the vision of the school is to produce learners who know how to use computers'* (Science teacher C, 16 April 2010).

ICT infrastructure

The school has been supplied with 20 computers by the Ministry of Education. In addition, the school bought about six computers:

> *'Since I started in 2007, the computers that I found here…were not compatible with the CD that I am using. But now with the acquisition of these new computers which we bought, it is possible to use ICT'* (Science teacher C, 16 April 2010).

Expertise

The principal had received training on ICT whilst in high school. The science teacher acquired ICT skills through an Engineering programme with UNAM. Science teacher C stated:

> *'Firstly, in my first year, I was doing Engineering and I could not continue due to financial problems. I did Computer Engineering at UNAM I know more of… data processing, GPS…'* (Science teacher C, 16 April 2010).

Digital learning materials

Computers given to the school had pre-installed *Encarta* software. In addition, some additional software for mathematics, timetabling and report card development software. The science teachers stated that *Encarta* was mostly used and that the software are relevant. Science teacher C stated:

> *'Encarta is mostly used... and relevant. We bought Equation 3.0, a timetabling software and report card making software'* (Science teacher C, 16 April 2010).

School C showed a low level of ICT implementation based on the fact that the principal uses computers for letter writing and record keeping. The Science teacher used ICT for lesson preparation, searching information on the Internet. However, very few teachers used ICT because of lack of expertise. The science teacher had acquired ICT skills informally through a course at UNAM, the principal also mentioned that he acquired ICT in high school. The principal encouraged teachers to use ICT and as a result the school had bought additional software to enhance their teaching and administrative tasks, such as report writing. During observation, the electricity went off three times within a period of 45 minutes. Inconsistent supply of electricity has an effect on pedagogical use of ICT in the science classrooms.

5.5 Cross case analysis

The findings of cross case studies with the three science teachers and classroom observations are presented. In order to understand how the cases have been crossed, see *Appendix I*. The findings from the interviews and classroom observations are presented to draw common findings per construct. Findings from other studies are elucidated to elicit what is already known about the topic.

ICT use

On the question relating to what ICT the science teachers used with confidence, their responses ranged from *Encarta* to *Microsoft Word*, *Spreadsheet*, *Word pad* and *PowerPoint*:

> *'I teach in class in prefer to use Encarta the most..In fact Microsoft I can use it when for example I prepare activity as class work or test for the learners...'* (Science teacher B, 13 April 2010).

Also, Science Teacher A used other software such as the

> *'... spreadsheet, mh… and also aahh… word pad and mmmm….. PowerPoint presentation' (Science teacher A, 13 April 2010).*

From the data, on average science teachers used *Encarta* more than all the other software on the computers in school. In addition, Science Teacher A listed many more skills than all the other teachers. It is not convincing that Science Teacher A was much more advanced in using the software as he listed numerous skills. From the observation notes, the science teachers used *MS Word* and *Encarta* in all of the observations. The science teachers stated reasons for the choice of *Encarta*, such as getting an additional definition to a concept and providing a picture which was well labelled. Science teacher A responded:

> *'... It [Encarta] contains everything that you are requesting and they can give additional definition to a certain term mhhh…. term terminology and again they can provide a photo there and everything is well labelled...'*

During observations, the teachers used *Encarta* in almost all the lessons observed. The learners did some activities in class, including the search for definition and read more in order to obtain more information about a concept being taught at the time. In addition, the science teachers demonstrated classroom management skills by going around the class to check if learners were actually doing the task or activity given to them during class time. The teacher continued walking around to check whether they understood the activity and be available for help.

Baylor and Ritchie (2002) argue that teachers' willingness to integrate technology into the classroom is closely tied to external factors such as professional development and a supportive climate. The supportive climate, in this study referred to as 'support', consists of technical support and pedagogical support. The extent to which teachers use ICT can be a measure of their interest and corresponding skills in using ICT (Baylor & Ritchie, 2002). At lower secondary level it is most satisfying to retrieve information and presentations in more specific domains of the curriculum, such as science (Howie et al., 2005). In addition, other authors place emphasis on the provision of schools with ICT to enable the teachers to practice and gain confidence in its use.

Curriculum goals

The science teachers commented on how they would implement ICT in the curriculum and also their role with regard to ICT implementation in their classroom.

The responses of two science teachers are alike in that they tried to match what was in the syllabus with the ICT to be used. Science teacher B responded as follows:

> *'... when I prepare I have to get what topics to teach and try to look for different ICT that I can get in the school or maybe which I can make myself I try to look for them and see which ICT is appropriate to use in a lesson... I can't tell much but like in Mathematics I remember there are topics that have to refer to*

> *ICT things e.g. the use of the calculator the curriculum stipulates that one should refer to the calculator'* (Science Teacher B, 13 April 2010).

Science teacher C referred to a CD that demonstrated how ICT was to be integrated into the curriculum:

> *'We have a CD that shows us the approach on how to teach and that is normally the one I refer to'* (Science teacher C, 16 April 2010).

From the data, it appears that the science teachers understood the link between the curriculum and ICT, and they had implemented it well in Mathematics for Science teacher B for example. It was not very clear whether Science teacher C understood the concept well since he did not elaborate on what the CD detailed.

With the regard to the teachers' roles, science teachers understood them to be very important as they had to prepare lessons that involved learners, make presentations about a topic in class and engage in classroom management. Science teacher B summarised his role as:

> *'Actually my role is a very important one because I have to apply ICT in my teaching when I prepare my lesson and I really have to make sure I include ICT because it is believed that ICT enhance the learning process. So, my role is to make sure that during the teaching learning process ICT is applied in the lesson just for the learners to catch up with the content'* (Science Teacher B, 13 April 2010).

In addition, Science teacher C was thinking about classroom management:

> *I keep on walking up and down. I go table by table... ensure that learners are busy with the task given to them* (Science teacher C, 16 April 2010).

From the data, the science teachers understood their roles well, however, they did not mention the aspect of monitoring students' progress using ICT. Howie et al. (2005) found that many schools do not use ICT to monitor students' progress. The fact that the science teachers did not mention it is not conclusive evidence that they do not use it. Meanwhile, in the literature, Fullan (1993, 2001) emphasizes the moral purpose of education to improve the livelihood of all learners, irrespective of their background in order to live and work productively in an increasingly dynamic complex society. Learners need to be prepared for the 21st century (Doornekamp, 2002; Valentine & Holloway, 2001). Specifically, Kapenda (2008) emphasises that the science curriculum in Namibian schools needs to encourage the use of ICT in the classroom. The more people are ICT literate the broader the spectrum of achieving the Millennium Development Goal (MDG) of becoming a knowledge-based economy.

Leadership

The science teachers expressed their views on the leadership and vision of their respective schools, in particular on the vision of their school and the level of involvement of the school leadership. When asked about the role of the school management with regard to ICT implementation, their responses listed monitoring, facilitation and administrative roles, increasing access and infrastructure:

> *'facilitation is done very well because they use to monitor, mhhh… they use to monitor teachers especially when they are in the computer room for example they use to be there too giving mhhh… ideas though not all of them know how use them [ICT] very well. But those of them that know and are at the top of the school [leadership] they are actually helping.'* (Science teacher A, 13 April 2010).

> *'I think they make sure that the instructor of computer studies is present and that computers are there and functioning. Sometimes the internet is working because I understand that it is paid for so they make sure they*

> *have these things... I think that their intention to have ICT working well in the school '* (Science teacher B, 13 April 2010).

> *'The leadership… I think they are doing well in that. This year in the timetable, there is a new programme allowing each student to have two ICT lessons per cycle. The management makes sure that the teacher teaching that class does teach'* (Science teacher C, 16 April 2010).

The science teachers indicated that they understood the scope within which the school leadership should operate in order to enhance the teaching and learning using ICT. It is very important that the school leadership shares its view with teachers in order to empower them. It was likely that the science teachers were implementing the ICT policy within the perceptive of how the management should facilitate ICT related activities. The functions of the school leadership appeared to be the same across all the schools.

When asked whether the school leadership prescribed to the science teachers what ICT to use, they responded that:

> *'It is upon the teacher to decide' (Science teacher A, 13 April 2010).*

This is an indication that the school leadership was not becoming involved in day-to-day issues of the teachers, but rather it was acting within the scope of ensuring that the teacher did his/her work, irrespective of whether ICT was used or not.

ICT infrastructure

The science teachers also stated that they had experienced some negative impact from the electricity failure and completion of the syllabus from time to time:

> *'... it can be also be while you are in the motion of teaching the power fails and everything is now disturbed and it can be that it is gone maybe for a day...'* (Science teacher A, 13 April 2010).

It was also observed that electricity had failed three times before the end of the day for School C. These problems, if perpetual, would be a de-motivation to teachers using ICT in their lessons, for fear that a power failure might occur at any time.

In terms of ICT availability, there were substantial differences noted in quality and functioning of ICT equipment between schools, as well as access to the Internet for instructional purposes. As a result, learners were observed rushing into class in order to access a computer hoping to share a chair with a learner of the same sex. From the literature, governments internationally are aware of potential unequal access to technologies (Howie et al., 2005).

Vision

The science teachers expressed their views on the vision of their respective schools, in particular on the vision of their school:

> *'The vision of my school, I cannot tell that much because we don't have anything on paper...I can see clearly that the school is aiming at having all learners at least [ahhh] acquiring computer skills.'* (Science Teacher B, 13 April 2010).

> *'…the vision of the school is to produce learners who know how to use computers and how to type, how to create a document and just the basics…'* (Science teacher C, 16 April 2010).

The findings indicate that the science teachers shared the values as expressed in the ICT policy. It can therefore be argued that the ICT policy did reflect to a larger extent what was happening in the classrooms.

Digital Learning Material

The science teachers were asked to indicate the different types of digital materials, if any, available at their school, and the relevance thereof. They responded in the affirmative, specifying *Encarta* and *MS* package, the timetable software and report card software. The *Encarta* and *MS* package was common to all participating schools. Teacher B and C mentioned additional software that the school had purchased, but one of the two science teachers could give the name of the two software packages for report cards and for the timetable. In addition, Science teacher C mentioned mathematical software called *Equations,* which he normally used in the Mathematics lessons.

When asked about the relevance of the available software, the science teachers agreed that the *Encarta* software was of great importance:

> *'... the good thing is all disciplines are there, the topic that I that I am teaching now they are also there'* (Science teacher A, 13 April 2010).

From the observation notes, science teachers at all participating schools in the interview made use of this software to teach different topics in science. Mostly, it contained definitions of concepts and simulations about them. The learners were observed searching for meanings of words and also definitions of concepts, no longer carrying dictionaries for the same purposes.
Teacher C had additional reasons for using ICT:

> *'I started with this timetable a long time ago when we were not having these software but it was very much hectic and I have to spend some days and some nights trying to come up with timetable but now is easy you just go to the computer with little bit of information and you just enter and then you generate data and the timetable is ready. So now is quite easy...'* (Science teacher B, 13 April 2010).

The National ICT Policy Implementation Plan (2006) stipulates that no complete, standardised digital content package is currently available. Materials are adopted in an *ad hoc* manner but the Namibia E-Learning Centre will coordinate the development of locally produced content. Where quality content is unavailable, content will be licensed or 'borrowed' from both proprietary and non-proprietary sources.

This is in line with findings by Howie et al. (2005), that at lower secondary school level the most satisfying experiences with technology appear to be information retrieval and presentation. However, Ten Brummelhuis, de Heer and Plomp (2008) argue that no accurate information concerning the educational software and its content actually used by teachers and students is presently available in the Netherlands. Teachers wish to have ready-to-use software for unknown reasons, but they speculate that it may be due to lack of awareness in schools of the programmes and content available, and inability to find software that meets the needs of the schools, and/or a mismatch between supply and demand.

The participating schools indicated that they had purchased additional software, but details of the cost linked to the digital learning materials were not explored in this study. This study therefore cannot discuss the investment made towards acquisition of digital learning materials and whether they were of good quality or relevance. The interviews concentrated on the means of the schools.

Kennisnet (2008) argues that the importance of coordinating digital learning materials should be one of a school's overall goals, if not there is a high risk that investment in ICT will produce little or no benefit. According to Kennisnet (2008), only a few schools have managed to consider the ideas of teaching and learning as a basis for acquiring digital learning materials to support those pedagogical ideas. Given the socio-economic conditions of the rural schools in Namibia, it is improbable that the schools will acquire digital learning material that suit the pedagogical principles of the respective schools. As a result, rural schools stand a chance of meeting "low costs of digital learning materials" (Kennisnet, 2008), but not necessarily making choices based on quality.

Collaboration

From the case studies, very little collaboration was noted between science teachers of the same school or from other schools in the same educational region or beyond. This could be because most teachers lacked ICT skills and knowledge, and therefore they were not in a better position to form collaborative activities:

> *'I get assistance from fellow teachers who have knowledge in ICT'* (Science teacher C, 16 April 2010).

In addition, none of the schools had stated that they did allow community members to use their facilities. This practice was said to have ended in the past due to lack of time. However, it could generate money for the schools to use for items that are costly, such as buying toner for printers and paying for maintenance of the ICT, should the regional technician not turn up on time to do the repairs. The fundraising appeared to be justifiable, in the absence of ways the MoE could find to supply the school with toner, and also due to the schools having to pay some fees for the Internet per month, and in other cases buy electricity. This study did not dwell on how best schools could raise money to sustain these expenditures.

Pedagogical support

The science teachers were asked to comment on the pedagogical support at their schools:

> *'there are those teachers that are better that got maybe special training in computer and whether you are stuck with something on the computer and you call them for assistance they can help… they can sometimes help you'* (Science teacher C, 15 April, 2010).

From the responses, all principals and teachers agreed that there was pedagogical support amongst teachers, and those that were more skilled in ICT assisted others. However, the scope of knowledge appeared to be limited. The low level of pedagogical support could be attributed to lack of understanding of the concept of ICT integration (Iipinge, 2010; Matengu, 2006; Sutherland & Sutch, 2009). This ambiguity may result in the lack of support as the principals and the ICT technicians may not have known the kind of support needed or how to support the science teachers. From the interviews, science teachers indicated that they received support from fellow teachers who had some experience in ICT. In addition, the skills that the teachers at the school possessed were limited to allow for more exploration of innovative ways of teaching using ICT.

The role of the University of Namibia with regard to ICT implementation in schools is not pronounced. Rather, all students, including the science teachers' training programme, take a computer literacy course in the first year. It is assumed that the skills acquired during a six-month course are sufficient to teach science using ICT after graduation.

From the literature, South Africa has the same challenges explained above. In order to improve the situation, the Thutong Portal was established to support the needs of the teachers. This portal is supplied with quality educational information reviewed by a panel of educational specialists. As at 2007, about 23,635 had subscribed to this portal, of whom 11,565 were educators who shared resources and experiences on this portal.

Technical support

The science teachers were asked to answer questions about the technical support that is rendered to them and the school at large. Generally, the science teachers said that the technical support was weak:

> *'Technical support system, I think is weak. You do not get much of the assistance on that even from the region. I think is really weak. We are not very much supported in that. If something gets broken and I happen to fix it, it is by try an error'* (Science teacher C, 16 April 2010).

From the data, it can be concluded that the support system in general was not in place. The principals relied on the little expertise of the technicians to repair the computers. The science teachers, being also computer literate, appeared to attend to the problems themselves, through trial and error. In addition, the technicians were also making an effort to ensure that an effective system was in place, for example by trying to teach the school administrative assistant how to troubleshoot. Providing science teachers with technical knowledge alone is not sufficient (Hakkarainen, et al. 2001), but it is not clear from the literature as to how much of technical knowledge the science teachers should have.

Attitude

The survey finding suggests that the attitude of the science teachers was negative. Contrary to this finding, the case studies showed a positive attitude of science teachers enjoying teaching using ICT. They had confidence in the subject content as well as ICT integration; however the class sizes were large, with learners fighting to enter the classroom for chairs. There was one chair for every two learners, yet the teachers delivered their lessons as planned. The fact that the case studies participating science teachers were able to teach using ICT in such an environment, it is evidence enough that a few science teachers had a positive attitude. However, a larger number of science teachers showed a negative attitude towards ICT use.

Baylor and Ritchie (2002) argue that teachers' willingness to integrate technology into the classroom is closely tied to external factors, such as professional development and a supportive climate. In the absence of a strategy that describes how ICT is to be integrated in the curriculum, there is little hope that a considerable number of teachers' attitudes would change significantly.

Expertise

The component of knowledge, attitude and skills covered response from the science teachers as to whether they had been trained, and if so when and what software they preferred to use.

Asked if they have been trained in any of the software supplied to them, all teachers indicated that they had not. However, some felt confident in using *Encarta* as they claimed it was easy. Teacher C felt very confident using *Encarta* because of his past experiences with computers:

> *'Yes at UNAM level. Firstly, in my first year, I was doing Engineering and my brother told me that I could not*

> *continue due to financial problems. I did Computer Engineering, which involved all those stuff of ICT. Also, at UNAM there is a core module on ICT which everybody has to do. I can say that I know most of the computer things…data processing, GPS…'* (Science teacher C, 16 April 2010).

The skills that the science teachers had were acquired through various training programmes, apparently over a short period of between two weeks to a few months. From the data, it also appears that they also received training from their suppliers of software. Science teacher B said she had acquired ICT skills from a Canadian lecturer:

> *'Yes, the service Provider... When I was at UNAM we had a course called Communication Technology, I did a bit of that although that time you couldn't catch up very well. At school there came particular volunteer from America, she came to train us a bit'* (Science teacher B, 13 April 2010).

In the absence of formal in-service training on ICT for science teachers, it becomes difficult to determine teachers' ICT skills. However, from observations at all the participating schools, science teachers demonstrated a good knowledge of ICT required to conduct a lesson and also they displayed a good grasp of what equipment to use for ICT when teaching. The science teachers were asked to indicate which of the software they used frequently. Contrary to what the ICT technicians observed, the science teachers stated that they preferred to use *Encarta,* complemented by *MS Word*:

> *'When I teach in class I prefer to use Encarta the most... In fact Microsoft I can use it when for example I prepare activity as class work or test for the learners...' (Science teacher B, 13 April 2010).*

> *'... spreadsheet, mh… and also aahh… word pad and mmmm….. PowerPoint presentation'* (Science teacher A, 13 April 2010).

From the data, on average science teachers use *Encarta* more than all the other software on the computers in school. In addition, Science Teacher A listed much more than all the other teachers. It could be interpreted that Science Teacher A is much more advanced in using the software he listed, although it is doubtful whether he would use them all in one day.

When asked whether the science teachers felt the impact the introduction of ICT brought to their schools, they acknowledged it was positive for their teaching.

> *'I think the introduction of computers has a positive impact on my teaching …' (Science teacher B, 13 April 2010).*

The science teachers stated reasons such as getting an additional definition to a concept and providing a picture which is well labelled, as stated by Science teacher A:

> *'... they can contain everything that you are requesting and they can give additional definition to a certain term, mhh... term terminology, and again they can provide a photo and everything is well labelled...'* (Science teacher A, 13 April 2010).

During observations, the teachers used *Encarta* in almost all the lessons observed. The learners did some activities in class, including the search for definitions, read more and obtained more information relevant to the topic being taught at the time.

> *'...it can be also be while you are in the motion of teaching the power fails and everything is now disturbed and gone maybe for a day...'* (Science teacher A, 13 April 2010).

If the electricity repeatedly goes off, it de-motivates teachers to use ICT in their lesson for fear it may happen again at any moment. In addition, Science Teacher C stated that she was affected negatively by the test, as she was not able to use computers.

> *'…you don't complete the syllabus on time because you end up going slower because learners sometime need help. You have to tell them to stop using the computer and sometimes you have to go show them how to search information and all that'* (Science teacher B, 13 April 2010).

During the observation, the teachers walked around the class to check upon learners on whether they were actually doing the task or activity given to them during class time.

A number of studies revealed that although teachers have had training in ICT, some were not comfortable with using it. Most of the teachers had received theoretical training at colleges of education as part of their pre-service training, and some as part of the in-service training courses, yet not all have the confidence to use ICT in their classrooms (Boateng, 2007). Some teachers attributed their failure to use computers for teaching to the inadequate training in effective use and integration of computer technology in a school curriculum, as well as socio-economic factors related to living in rural areas (Boateng, 2007; Unwin, 2004). Some teachers however took the initiative to gain ICT skills elsewhere, although they still struggled with how to integrate ICT into the curriculum.

In another study in Lithuania, teacher training covers technical, information-related, social, pedagogical, and management competencies (Markauskaite, 2009). The standard for teacher training is based on the basic modules of the European Computer Driving License, plus additional modules specifically related to the use of ICT in schools (Markauskaite, 2009). This approach is criticised in that it is not sufficient to train teachers in ICDL, as it does not enable teachers to integrate ICT in the subjects they teach, rather it equips them with basic computer skills only.

In Namibia, a study by Iipinge (2010) revealed that these Colleges of Education and the University from which these teachers graduated are struggling to implement ICT due to lack of equipment, time and supportive system. There is a high likelihood that whilst there, these teachers were deprived of the opportunity to learn quality ICT.

In summary, across the cases, science teachers use computers every day for lesson plans, study notes, activities and for assessment. Appropriate ICT is chosen, depending on the theme or topic being taught. However, the science teachers are worried about the effect of ICT on completion of the syllabus. The school leadership ensures that the science teachers conduct their lessons using ICT, and provide some advice on ICT related matters. Their knowledge about ICT is very limited and much of it is evident on issues of procurement. There is collaboration between teachers of the same school. Most science teachers have not been trained in ICT therefore they are unable to offer professional pedagogical support to fellow science teachers. The science teachers are familiar with their school's vision towards ICT although it is not anywhere stated in the school documents.

There is lack of basic equipment such as desks and chairs. At least two learners have to share a computer per class of 40 learners, and there is an inconsistent supply of electricity, making it difficult for the science teachers to teach using computers and also Internet. There is also an insufficient supply of digital learning materials. Depending on the understanding of the school leadership and the funds available in the school development fund, two of the three schools were able purchase additional software, however it was very basic and followed a pragmatic approach (Kennisnet, 2008), as explained in Chapter 3 of this study.

5.6 Conclusion

This chapter has presented descriptive findings on a classroom level. In order to give insight into the rural areas, the background of the respondents and the profiles of the rural schools were presented. Further, the descriptive findings on indices were all discussed to show how ICT is being implemented in rural science classrooms. The findings showed that pedagogical use of ICT, technical support, attitude of science teachers and ICT infrastructure, fell in the low range. Science curriculum goals, collaboration, professional development, digital learning material, expertise and obstacles have mean scores that fell in the medium range. Leadership and vision had high mean scores. However, the use of ICT and pedagogical use of ICT was low. The case studies findings show an insufficient number of computers. Most schools have received a total of 20 computers each. There is lack of technical and pedagogical support towards science teachers. Science teachers lack formal training in ICT skills or integration in ICT. These findings were tested for reliability and validity of the constructs in the proposed model in Chapter 6.

CHAPTER 6

FACTORS AFFECTING ICT IMPLEMENTATION IN RURAL SCHOOLS

This chapter reports on the findings of research question three of this study which aims at exploring factors that affect ICT implementation in rural schools. Section 6.1 presents the introduction to the Chapter. Section 6.2 presents the background information of the respondent. Section 6.3 describes the profile of the rural schools and ICT use at school level. Section 6.4 discusses findings on factor analysis. Section 6.5 presents factors that predict ICT implementation. Section 6.6 discusses the context information of case studies findings at school level. Section 6.7 presents the conclusion.

6.1 Introduction

This part of the study is exploratory and designed to address research question three, '*what factors affect ICT implementation in rural schools?'*. The aim of the exploration is to identify the significant factors that affect ICT implementation in rural schools and also to determine the validity of the constructs provided in the conceptual framework of the study. For a better understanding of the context, it is important to provide the background in formation of the respondents at school level (Section 6.2) as well as the profile of rural schools and ICT use (Section 6.3). An exploratory factor analysis (Section 6.4) was employed to describe the covariant relationships amongst the constructs per respondent. In addition, Pearson's correlation was conducted to determine the strength of the relationship between the respective constructs before the regression analysis (Section 6.5) used to determine factors for the best line of fit. The outcome of the regression analysis suggests factors that should be included in the model. In addition, findings on case studies are presented (Section 6.6). The case studies comprise of interviews of principals and ICT technicians at school level. It is important to note that cross-case analysis has been presented in Chapter 5 but at classroom level. The purpose of case studies was to obtain a better understanding of what makes or hampers the implementation of the National ICT Policy. Finally, the conclusion to the Chapter is presented (Section 6.7).

6.2 Background of respondents

This section presents the background information of the principals and the ICT technicians as respondents in the survey, that of the science teachers having been presented in Chapter 5. This chapter covers the principals' years of experience, age and gender, as well as their activities over the previous few years, whether they owned computers and, if so, if they have access to Internet.

6.2.1 Background information of the principals

This section presents the principals' experiences, age, gender and computer use. Information about the principals' qualification for this job was not included in the survey as the general requirement for a principal's position in Namibia is three years of teaching experience and no extra or specific skills are needed.

Years of experience as principal

This subsection presents the working experiences of the principals in their current position.

Table 6. 1: Years of occupation of principal position (N=105)

Duration	Principal of any school (%) (SD)	Principal of the current school (%) (SD)	Working in any other profession (%) (SD)
less than 3 years	34 (4.6)	32 (4.6)	25 (4.2)
3-5 years	23 (4.1)	27 (3.8)	11 (3.0)
6-10 years	27 (4.3)	28 (3.9)	25 (4.2)
11-20 years	11 (3.0)	9 (2.5)	25 (4.2)
21 years and more	6 (2.3)	5 (1.9)	14 (3.3)
Total			**100%**

Table 6.1 (above) shows that a third (34%) of the principals held the same position at another school for less than 3 years. About a third also indicated that they had been principals of the current school for less than three years. Three sets of 25% of the principals had been working in other profession before becoming principals for less than three years, 6-10 years and 11-20 years respectively. The possibility exists that the teaching profession was very attractive after the review of the teaching structure. This explains why a third of the principals are relatively new in this position. It is also possible that the predecessors used the principalship as a steppingstone to other professions, as there is currently a trend in Namibia for principals to be promoted to the position of Education Officer at the Regional Education Offices.

Age of principals

Asked to indicate their age category, the principals provided the data for Figure 6.1:

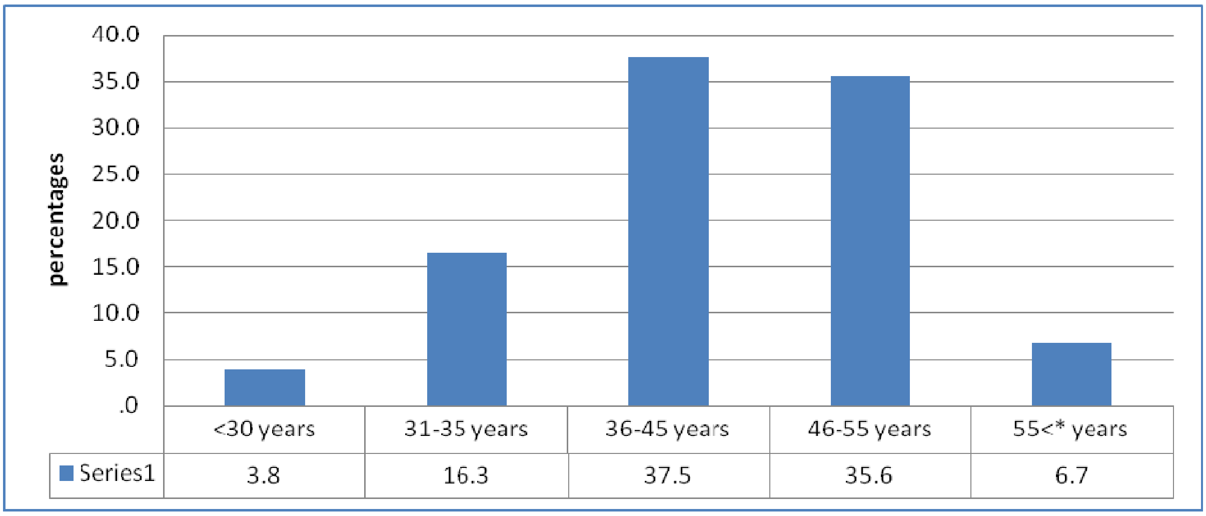


Figure 6. 1: Age distribution of principals (N=105)

Figure 6.1 (above) shows that 38% of principals who took part in the survey ranged between 36 and 45 years of age, followed by an age category of 46-55 years of age (36%). As explained above (Table 5.1), it is likely that the old principals were promoted to the positions of Education Officers or had possibly moved to other jobs. This explains why about 40% were less than 45 years old. Also, more than third of the principals were about to retire and less than 10% had reached retirement age. Retirement in Namibia starts at the age of 55.

Gender of principals

The principals were asked to indicate their gender:

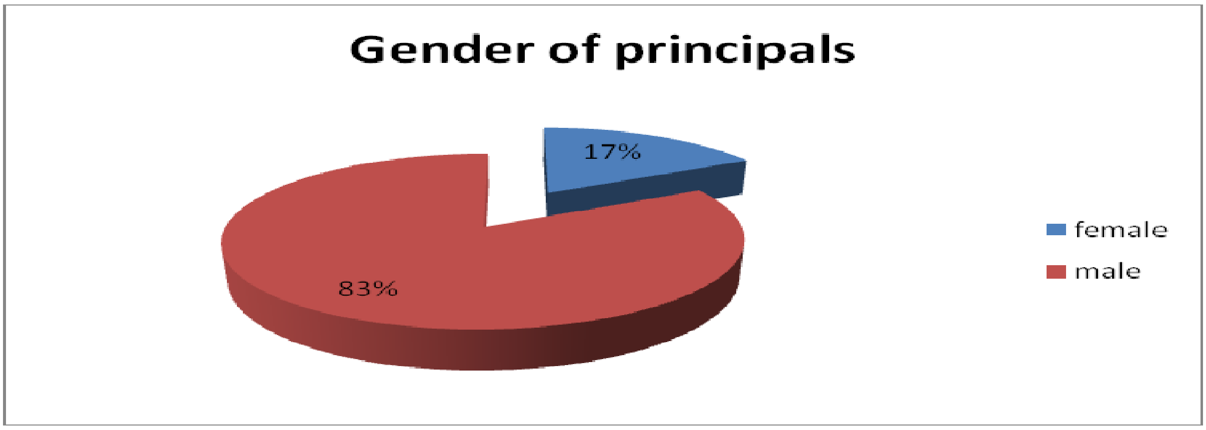


Figure 6. 2: Gender of principals (N=105)

The figure above shows that only 17% of principals were female, reflecting a common and longstanding trait that positions of principals are occupied by males.

Computer use

The principals were asked to indicate their computer use:

Table 6. 2: Activities for ICT use by principals

Activities	No	Yes (in %) (S.D)
Writing documents and letters	101	89 (3.0)
Budgeting, monitoring or controlling expenses	100	39 (4.8)
Planning purposes	101	54 (4.9)
Communicating with teachers	101	45 (4.9)
Communicating with parents	101	34 (4.6)
Teaching/instruction	100	38 (4.7)
Timetabling	101	64 (4.7)
Searching for information	101	79 (4.0)
Developing and making presentations	100	46 (4.9)
Own professional development	101	82 (3.7)

The majority of the principals reported that they used ICT to write documents and letters (89%) and search for information (79%). Much of computer use also was attributed to their own professional development (82%), which indicates that they used them to type their assignments and present work required by the institution offering the course of study, as well as for their private work. More than half of the principals used computer for timetabling (64%), and about a half for planning purposes (54%). This data shows that principals used computers for various reasons.

Ownership of computers

The principals were asked to indicate whether they owned and whether they used their personal computers for school-related activities:

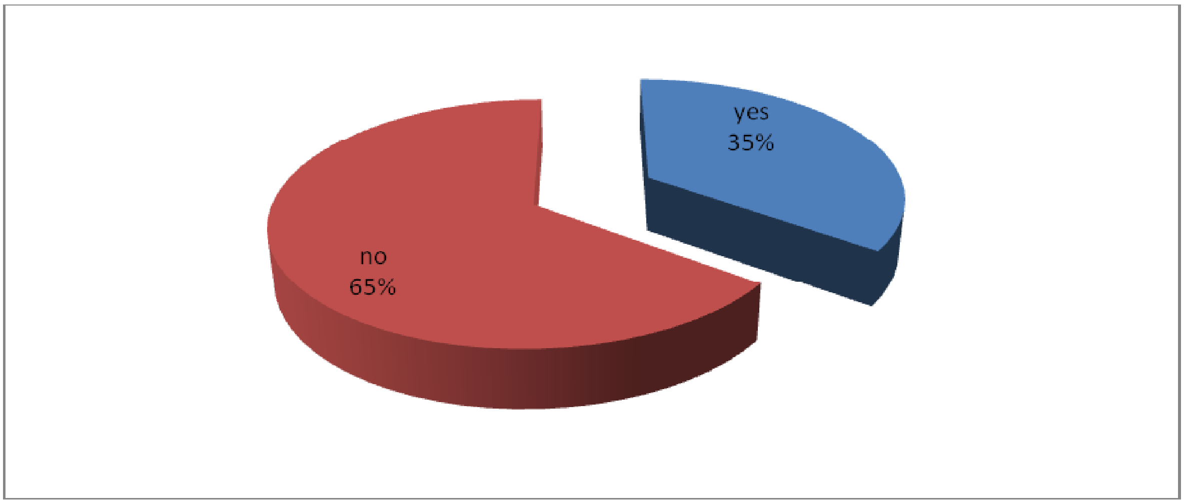


Figure 6. 3: Use of principal owned computers for school-related activities

Figure 6.3 show that about a third (35%) of the principals indicated that they use their private computers for school related activities. This can be interpreted to mean that about a third of the principals owned computers and used them for school related activities.

Access to Internet

The principals were asked to indicate whether their personal computers were connected to Internet. The response was as follows:

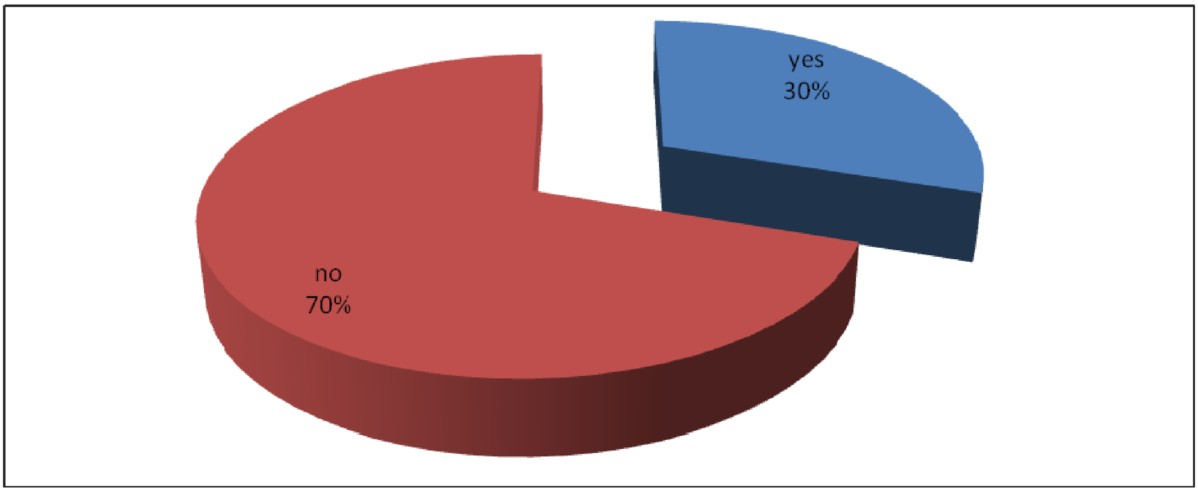


Figure 6. 4: Percentage of principals' owned personal computers connected to the internet (N=105)

Figure 6.4 (above) shows that about a third (30%) of the principals' personally owned computers were connected to the Internet. This done not mean that all the principals' in Figure 6.3 who own computers were necessarily those who had indicated that their computers were connected to Internet. Some principals could have access to Internet through alternative devices such as cellular telephones. As a result, the percentage of principals with Internet connectivity was almost the same as that of the principals who owned computers.

6.2.2 Background information of the ICT technicians

This sub-section presents the background information of the ICT technicians in terms of the positions they held and their duties. There is no designated position for ICT technicians in Namibian schools, so the number of respondents was lower than that of principals and science teachers (see Chapter 5). In addition, data on qualifications for ICT technicians was not included as it was assumed that the ICT technicians were most likely one of the teaching staff with a minimum of three years qualification.

Positions held by ICT technicians

The ICT technicians were asked to indicate the positions they hold at their schools:

Table 6. 3: Other position in school held by ICT technicians

Position	No	Percentage (in %)
Head of Departments	70	77
Principal	70	19
Teacher	68	4
Total		**100**

There was no designated position for ICT technicians. Most (77%) heads of departments acted as ICT technicians. About 20% of the principals and fewer than 5% of the science teachers also acted as ICT technicians. There was a non-response rate of 2% in the teachers' data due to ignorance.

Duties of the technicians as perceived by themselves

The ICT technicians were asked to indicate if they agreed with statements that described their duties:

Table 6. 4: Duties of ICT technicians (N=70)

Duties	No	Yes (in %)
I teach ICT courses to students.	67	40
I teach ICT courses to teachers and other school staff.	63	38
I teach Mathematics and/or Science.	62	55
I teach other subjects.	63	81
I formally serve as ICT technician.	64	25
I informally serve as ICT technician.	64	61

Table 6.4 (above) shows that most (81%) ICT technicians also taught other subjects, about a third (40%) of the ICT technicians taught either Mathematics and/or Science.

About 60% of technicians served in this position informally and about a quarter (25%) indicated that they formally served as ICT technicians. This could be because they have been issued with letters from the principal appointing them to serve in that position. Less than a quarter of the ICT technicians taught others teachers and other school staff in the schools. This finding suggests that teachers, including the science teachers, were preoccupied with what they were appointed to do. Serving as an ICT technician was voluntary.

Access to computers at home

The ICT technicians were asked to indicate if they owned computers at home:

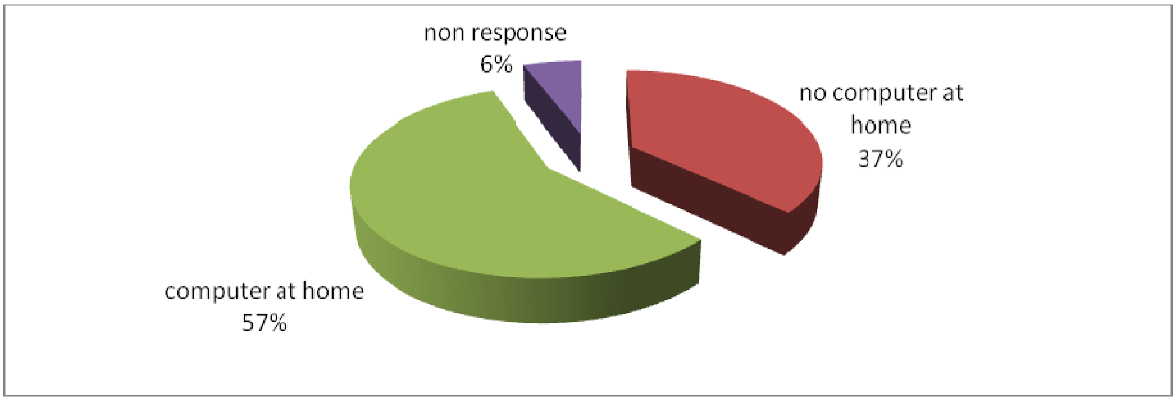


Figure 6. 5: Access to computers at home for ICT technicians (N=70)

Figure 6.5 (above) shows that 57% of the ICT technicians have their own computers at home. 6% of the ICT technicians did not respond to this question. This finding shows that more than half of the ICT technicians did own computers. This could be interpreted to mean that these teachers or school staff had an interest in computers and therefore they made an effort to own computers.

Connection to Internet

The ICT technicians were also asked if their computers were connected to Internet:

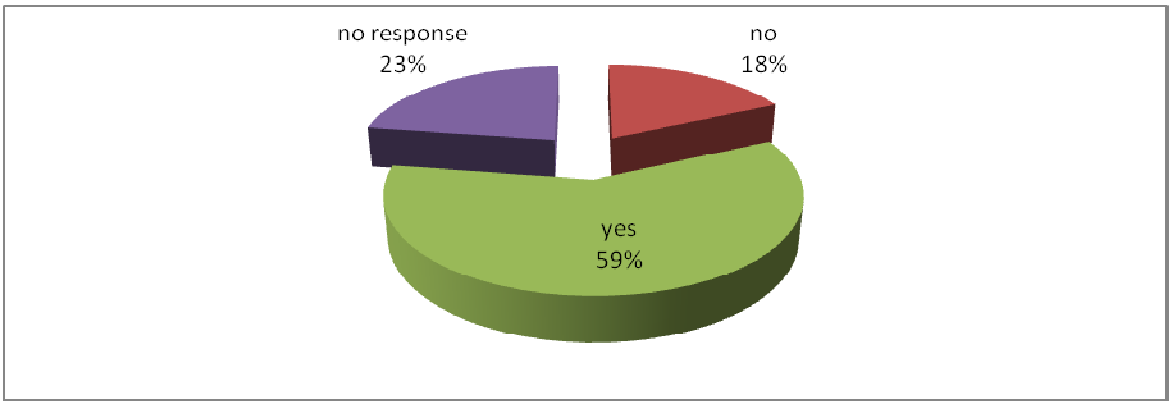


Figure 6. 6: Access to internet at home for ICT technicians (N=70)

Figure 6.6 shows that 59% of the ICT technicians had Internet connection at home and the non-response rate was 23%. More ICT technicians had Internet at home than there are technicians with their own computer at home (see Figure 6.5). This is possible, as the technicians could also access Internet through other devices or locations. This finding shows that more than half of the ICT technicians had Internet access, indicating a high probability that they used these computers to download teaching materials.

6.3 Profile of rural schools and ICT use

This section presents findings about ICT implementation in rural schools, defined in Chapter 3. For better understanding of the rural schools, background information about them is presented. This includes the average number of people living in the village, the average number of boys and girls in schools, the effort spent on upgrading the schools, classroom information, time allocated to ICT use in class per week and the level of skills of the learners in the rural schools. This information provides descriptive information about the villages in rural Namibia for a better understanding of factors that affect ICT implementation in rural schools.

People in the villages

The principals were asked to indicate the approximate number of people in the villages where the schools were located:

Table 6. 5: People in the villages (N=105)

People	Percent (%)
≤ 3 000	60.0
3001-15000	39.0
Total	**99.0**

Table 6.6 (above) shows that more than half (60%) of the principals indicated there were less than or equal to 3,000 people in the villages where the schools were located. Some principals do participate in community projects and therefore they know the number of people that live in the villages. It should be noted that the Namibian population was less than 2 million people, and although about 60% lived in the Northern regions, the areas were still sparsely populated (see Chapter 2).

Learner absenteeism

The principals were asked to indicate the percentage of student absenteeism per week:

Table 6. 6: Percentage of learner absenteeism (N=105)

absentees	Percent
<5%	75
5-10%	23
11-20%	1
>20%	1
Total	**100**

Table 6.6 (above) shows that most (75%) of the principals indicated that less than 5% of the learners were absent per week. Given the vastness of the regions, learners sometimes had to walk long distances but nevertheless attended school regularly.

Most important principals' activities during the past few years

The principals were asked to indicate the activities on which they had spent much of their energy in the previous five years. The principals' responses are illustrated in percentages and standard errors as follows:

Table 6. 7: Most important principals' activities during the past few years (N=105)

Activities	No	Yes (in %)/S.D
Making changes to pedagogical practices	95	73 (4.4)
Adopting new assessment practices	98	85 (3.5)
Installing electricity	104	68 (4.5)
Installing running water	102	81(3.8)
Setting up a storeroom	104	68 (4.5)
Acquiring a telephone line	105	72 (4.4)
Acquiring a photo copier	105	91(2.7)
Acquiring sufficient desks	104	66 (4.6)
Acquiring sufficient chairs	104	71 (4.4)

Table 6.7 (above) shows that the majority (91%, 85%, 81%) of the principals spent much of their time on acquiring photocopiers, adopting new assessment practices and on activities related to getting running water at their schools. Most (73%, 72%, 71%) of the principals spent time on making changes to pedagogical practices, on acquiring a telephone line and acquiring sufficient chairs. In addition, the principals spent more than half (68%, 66.3%) of their time on activities related to installation of electricity and acquiring desks.

The principals indicated that as a matter of priority they had been working towards changing their pedagogical and assessment practices. There were still a number of basic needs to be achieved before acquiring ICT. Some schools were working toward acquiring sufficient chairs and desks, and installing running water and electricity, and more schools felt that these topics should remain on top of the agenda. This problem was attributed to geography as developing countries are challenged to provide satisfactory level of technology and technological competence to school in remote areas which are often sparsely populated rural areas (Brandt et.al. 2008).

ICT use in rural schools

This section presents findings on ICT implementation in rural schools, with original responses by principals and ICT technicians converted to indices to allow for computation of the constructs into scales, comprising categories of low, medium and high (*see Appendix H*):

Table 6. 8: Description of independent variables

Construct	*Data source*	*N*	*Mean*	*Mini-mum*	*Maxi-mum*	*SD*
General use of ICT	Principals	105	43.76	.00	83	24.49
Leadership	Principals	105	49.03	16.00	68.00	13.34
Vision	Principals	105	42.95	0.00	50.00	11.62
Collaboration	Principals	105	83.10	0.00	100.00	19.46
Support on assessment	Principals	105	89.76	0.00	100.00	18.65
Pedagogical support	Principals	105	17.58	0.00	61.00	15.57
Technical support	ICT technicians	70	35.90	4.35	91.30	22.87
Professional development	ICT technicians	70	60.67	0.00	100.00	18.88
Digital Learning Materials	ICT technicians	70	14.71	0.00	90.00	18.16
Expertise (ICT related)	Principals	105	43.89	0.00	80.60	20.22
ICT infrastructure	Technicians	70	31.80	0.00	63.16	15.43
	Principals	105	42.99	0.00	86.36	23.15
Obstacles	ICT technicians	70	30.06	0.00	64.44	20.56
	Principals	105	24.92	0.00	64.10	14.95

The discussions on findings in Table 6.8 are presented per construct below:

ICT use by principals

The principals were asked to comment on the importance of ICT use in the target group, with responses ranging between 00.00% and 83.00%, with a mean score of

43.76 (SD=24.49). This finding suggests that the use of ICT by principals is medium. However, some principals make use of ICT more than others.

Leadership

The principals were asked if statements about leadership applied to them in their respective schools. The indices scores for the principals show a mean score at a medium level. This can be interpreted to mean that the school leadership was performing its duties as prescribed in the National ICT policy.

Vision

The respondent principals were asked if the statements about vision applied to them in their respective schools. The principals responses on the question about vision ranged between 0.00% and 50.00%, with a mean score of 42.95 (SD= 11.62). This finding suggests that the vision of the principals with regard to ICT implementation is medium.

Collaboration

The principals were asked to state whether they agreed or disagreed that the school leaderships encouraged teachers to work cooperatively in groups to share knowledge and problems, and whether the leadership encouraged teachers to use different assessments. From the table, the principals showed a range of responses between 0.00% and 100.00%, with a mean score of 19.46%. The findings could mean that some schools were not at all supportive of ICT related activities. It is also noted that the principals scored themselves high on this construct, implying that they performed their duties quite effectively, hence the high mean score.

Pedagogical support

The principals were asked to comment on the frequency of providing pedagogical support to science teachers when performing some activities using ICT. The table 6.8 shows that the average mean score for pedagogical support was about 25% (SD=14.95), indicating that the pedagogical support provided to science teachers was low. However, in some schools, science teachers were not supported at all (minimum value 0%) and in others schools the support was offered moderately (Mean=64.10%). It can be concluded that there was lack of pedagogical support in rural schools.

Technical support

The ICT technicians were asked to comment on the position they hold at their school and the duties they had besides offering technical support. In addition, the technicians were asked to state the frequency of technical support to students and fellow teachers. The table 6.8 shows that the mean score was medium (Mean = 35.90%, SD= 22.87). However, some schools had high level (Max=91.30%) of technical support while others had very little (4.35%). This can be interpreted as being that the level of support offered to science teachers was in the medium range.

Professional Development

The ICT technicians were asked to comment on statements that pertain to professional development. Particularly, the ICT technicians were asked to state whether science teachers in their respective schools had acquired knowledge and skills in ICT for teaching and learning. The technicians were also asked to indicate whether the courses on ICT were available at the school and could be offered at school or by an external organization. Table 6.9 shows that the mean score (60.67%, SD 18.88) was in the medium range. This finding suggests that science teachers were being trained, and it was probable that some schools created opportunities to train more of their science teachers.

Digital Learning materials

The technicians were asked to indicate the types of digital learning materials available in their school, and whether they needed them. The responses ranged between 0.00% and 90.00%. The table 6.8 shows that the mean score on digital learning materials was low (Mean=14.71%, SD= 18.16). The use of digital learning material was low because there was lack of it in rural schools. However, the ICT technicians showed that some or few schools had digital learning materials available. It is possible that these schools had bought them out of their school fund.

Expertise

The principals were asked to state if they encouraged knowledge and skills acquisition. The principals indicated that they did encourage science teachers to use ICT. The level of encouragement offered ranged between 0.00% and 80.60% with a mean score of 43.89%. It is probable that the schools that conduct ICT-related activities in the science classrooms were also those that were being encouraged by the school leaderships.

ICT infrastructure

The technicians indicated that the availability of ICT in the schools ranged between 0.00% and 63.16% with Mean=31.80% (SD=15.43). The principals indicated that the decision-making powers on ICT-related matters ranged between 0.00% and 86.36%, with a Mean=42.99% (SD=23.15). On average, it can be said that the ICT infrastructure in schools was medium in terms of acquisition and availability, but poor with regard to decision-making about acquisition and maintenance.

Obstacles

The ICT technicians were asked to comment on the extent to which the schools were affected by a number of obstacles. Contrary to that, the principals were asked to state the extent to which the school's capacity was able to overcome those obstacles. The mean (30.06%, SD=20.56) showed that the obstacles were in the low range. The principals indicated that the efforts they applied to minimise the obstacles were in the low range (Mean=24.92%, SD=14.95). There is a possibility that the ICT technicians and the principals were not well versed in ICT-related matters and therefore the demands on the Namibian Government or the expectation by the school leadership were unknown. The school leadership may not be in a position to offer the unknown.

Summary on indices

Findings on indices have been presented per construct that appear in the conceptual framework of this study. The origin of the categories of low, medium and high has been referred to in Chapter 4 (*also see Appendix H*). The findings showed that, generally, the use of ICT, digital learning materials, ICT infrastructure, and obstacles were in the low range. Leadership, vision, and expertise had mean scores that were in the medium range. Collaboration and support on assessment had high mean scores. However, the use of ICT was low. Interestingly, the principals rated themselves high on matters related to collaboration and support on assessment, implying that they did offer the necessary support.

Conclusion

In conclusion, the profile of rural schools has been presented, describing the population in the village, learner absenteeism and efforts by the principals to make the school ICT-ready. The findings of constructs show that the most villages had a population of about 3,000, and learner absenteeism was very low. The principals spent most of their time acquiring the basic needs for the schools. Analysis of factors related to ICT implementation in rural schools show low rate of use of ICT due to other relevant variables also being low, such as digital learning materials and ICT infrastructure, with additional obstacles. Collaboration and support had a high score because the principals rated themselves very high. Further, relational analysis was conducted to identify factors that affect ICT implementation.

6.4 Interpretation of factors related to ICT implementation

An exploratory factor analysis is used in the description of the covariance relationships among the many variables in terms of a few underlying but unobservable, random quantities known as ‘factors’. Factor analysis is a special case of the principal component method in which the approximations are more elaborate. In the context of factor analysis, various methods can be used in the selection of variables that are contributing to the dependent variable of interest. The two most popular methods of parameter estimations are the principal component, its

related principal factor method and the maximum likelihood method. As Richard and Dean (2002) pointed out, the solution from these two methods can be rotated in order to simplify the interpretation of the factors. The two approaches are discussed.
The principal component solution of the factor component: In this case two methods can be used to determine the factor analysis solution, which is the number of factors that are significantly explaining suitable proportion of the total variance in the sample. These are mainly the eigenvalue tabulations and the scree plots. In particular, the eigenvalues (λ) are real numbers representing the variation accounted for by each component (factor) and that satisfy the equation $|A-\lambda|x=0$, where A is a correlation matrix calculated from the observations to be classified and x a non - zero solution vector. On the other hand a scree plot is a plot of all eigenvalues in their decreasing order. Hence as a rule of thumb, the number of factors are then given by those factors with $\lambda \geq 1$ which are equivalent to the substantial elbow in the scree plot. These two methods can be used to supplement each other (concurrently), however we have only presented the results of the eigenvalue tabulation as those of the scree plot at times are difficult to determine exactly the position of the elbow in the plot.

On the other hand, the maximum likelihood estimates of the factor loadings and specific variance can be used when the factors (common and specific) are assumed to be normally distributed. It is also important to point out here that both of these methods were calculated based either on a sample covariance or a correlation matrix of the sample data. The maximum likelihood is more common in the estimation of the rotating factor loadings from a principal component analysis through the varimax procedure by Kaiser (1958), and will be used as such in this study.

In this study, several variables under various constructs are considered. These constructs are as follows: Principal and its relevant constructs, science teachers (see Chapter 5) and its relevant construct, and the ICT Technicians and their relevant constructs. The findings on the constructs are discussed below:

Principal

Findings on relational statistics about constructs in the principals' data set are discussed. Specifically, constructs on effort, vision, and leadership have been discussed in detail. From of consideration of space in the thesis, the rest of the constructs are merely summarised. The constructs are broken down into various factors as indicated for reference in the principals' questionnaire (Appendix E).

Effort

The resulting outcome of the principal component (PC) analysis in Table 6.9 (below) shows that the first six factors have eigenvalues ranging from 4.058 to 1.032, as a result had been retained by the PC criterion. These six factors accounts for a cumulative percentage of about 68.7% of the total (standardized) variation in the sample data. In addition the communalities and the rotated factors loadings (through the varimax procedure) for the first six factors are shown in Table 6.10. It is therefore clear from this figure that the variable of installing electricity, installing running water, acquiring a telephone line, and acquiring a photocopier, define factor 1 (high loadings on factor 1 and small or negligible loadings on other factors) while the variable of flushing toilet, setting up a science laboratory, setting up a school library and acquiring a fax machine define factor 2. A variables on connecting to the Internet and installing computer laboratory define factor 3; the variable of acquiring sufficient desks and chairs define factor 4; a variable of making changes to pedagogical practices, adopting new pedagogical practices and setting up a store room define factor 5; and a variable of adopting buildings to suit ICT approaches and setting up computers in classrooms makes up factor 6 respectively.

One might therefore label factor 1 as *basic needs for rural schools*; factor 2 as *laboratory needs*, factor 3 as *ICT readiness*, factor 4 as *classroom furniture*, factor 5 as *classroom changes* as well as factor 6 as *setting up of computer laboratories*.

Table 6. 9: Effort Total variance explained

Component	Total	Initial Eigenvalues % of Variance	Cumulative %
1	4.058	23.871	
2	2.000	11.763	
3	1.684	9.903	
4	1.573	9.255	
5	1.330	7.821	
6	1.032	6.069	
7	0.883	5.194	73.876
8	0.819	4.818	78.693
9	0.764	4.496	83.190
10	0.674	3.967	87.156
11	0.528	3.106	90.262
12	0.453	2.663	92.925
13	0.402	2.362	95.287
14	0.322	1.893	97.180
15	0.226	1.329	98.510
16	0.167	0.981	99.491
17	0.087	0.509	100.000

Extraction Method: Principal Component Analysis

Table 6. 10: Effort Rotated component Matrix

Variables	Component 1	2	3	4	5	6
Making changes to pedagogical practices					0.866	
Adopting new assessment practices					0.740	
Connecting to the Internet			0.785			
Adapting buildings to suit the school's pedagogical approaches						0.495
Setting up computers in classrooms						0.789
Installing computer laboratories			0.831			
Installing electricity	0.828					
Installing running water	0.827					
Installing flushing toilets		0.532				
Setting up a science laboratory		0.693				
Setting up a school library		0.830				
Setting up a storeroom					0.560	
Acquiring a telephone line	0.720					
Acquiring a fax machine		0.515				-0.413
Acquiring a photo copier	0.482					
Acquiring sufficient desks				0.941		
Acquiring sufficient chairs				0.945		

Vision

For constructs about vision, the PC analysis retains two factors with eigenvalues of $\lambda_1 = 6.093$ and $\lambda_{2_2} = 1.064$. These two factors accounts for a cumulative percentage of about 71.6% of the total variation in the sample (Table 6.11, below). In addition, the results of the communalities and the varimax rotated factor loadings are made up of variable fostering students' ability and readiness, providing activities which incorporate real world examples, providing learners with opportunities to learn, fostering face-to-face communication skills, and preparing students for responsible Internet for factor 1. Factor 2 constitutes variable cover of prescribed curriculum content, promoting learners' performance on assessment, individualising learners' learning experiences, increasing learning motivation and fostering collaboration. It is also important to point out here that the loadings for both variables on individualised learners' learning experiences and fostering learners' ability and readiness are very close to that of factor 1 (in the case of variable on individualised learners' learning experiences) and factor 2 (in the case of variable on fostering learners' ability and readiness) respectively, thus they can be equally allocated to any of the two factors. However in this case, the respective variables have been allocated to that factor for which it has the highest loading of belonging, irrespective of how close they are (Table 6.12). Therefore, one can refer to factor 1 as *learner preparation for ICT world* and factor 2 as *learner assessment on curriculum content*.

Table 6. 11: Vision: Total Variance explained

		Initial Eigenvalues	
Component	Total	% of Variance	Cumulative %
1	6.093	60.934	
2	1.064	10.644	
3	0.603	6.028	77.606
4	0.552	5.522	83.128
5	0.429	4.294	87.422
6	0.360	3.598	91.020
7	0.305	3.045	94.065
8	0.229	2.291	96.356
9	0.213	2.127	98.483
10	0.152	1.517	100.00

Table 6. 12: Vision: Rotated component Matrix

Variable	**Component** 1	**Component** 2
To cover the prescribed Curriculum		0.891
To improve students' performance on assessments/examinations		0.914
To individualize student learning experiences in order to address different learning needs	0.525	0.527
To increase learning motivation and make learning more interesting	0.504	0.601
To foster students' ability and readiness to set own learning goals and to plan, monitor and evaluate own progress	0.593	0.575
To foster collaborative and organizational skills when working in teams	0.494	0.649
To provide activities which incorporate real-world examples/settings/applications for student learning	0.665	0.580
To provide opportunities for students to learn from experts and peers from other schools/organizations/countries	0.793	
To foster communication skills in face-to-face and/or on-line situations	0.837	
To prepare students for responsible Internet behavior (e.g., not to commit mail-bombing, such as spam, etc.) and/or to cope with cybercrime (e.g., Internet fraud, illegal access to secure information, etc	0.796	

Leadership

With respect to leadership, the result of the PC analysis in Table 6.13 (below) shows that three factors with eigenvalues between $\lambda_1 = 4.730$ and $\lambda_{3_2} = 1.050$ will be returned by the PC criterion. These factors explain about 66.5% of the cumulative total variation in the sample data. Furthermore, according to the communalities and the varimax rotated factor loadings in Table 6.14, factor 1 is made up of variable meetings with teacher to review the pedagogical approaches, monitoring and evaluating the implementation approach, establishing new teacher teams encouraging teacher collaboration and featuring new instructional methods. Factor 2 constitutes organising workshops to demonstrate ICT use, changing class schedules for innovation implementations, implementing incentive schemes and involving parents in ICT related activities. Factor 3 comprised variables on re-allocating workload to allow for collaboration and re-allocating workload to allow for the provision of technical support. Therefore, one can refer to these factors as *Teacher mentoring* (factor 1), *Innovations* (factor 2) and *creating schedule for collaboration and technical support* (factor 3) respectively.

Table 6. 13: Leadership: Total Variance Explained

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	4.730	42.996	
2	1.531	13.919	
3	1.050	9.545	
4	0.879	7.991	74.451
5	0.606	5.505	79.957
6	0.546	4.963	84.920
7	0.476	4.328	89.248
8	0.379	3.448	92.696
9	0.336	3.054	95.751
10	0.244	2.217	97.968
11	0.224	2.032	100.000

Table 6. 14: Leadership: Rotated Component Matrix

Variable	Component 1	2	3
Re-allocating workload to allow for collaborative planning for innovations in the classrooms			0.899
Re-allocating workload to allow for the provision of technical support for innovations		0.416	0.753
Organizing workshops to demonstrate the use of ICT-supported teaching and learning		0.788	
Meeting with teachers to review their pedagogical approach	0.776		
Monitoring and evaluating the implementation of pedagogical changes	0.885		
Establishing new teacher teams to coordinate the implementation of innovations in teachers' teaching and learning	0.758		
Changing class schedules to facilitate the implementation of innovations		0.572	
Implementing incentive schemes to encourage teachers to integrate ICT in their lessons		0.804	
Encouraging teachers collaborate with external experts to improve their teaching and learning practices	0.687		
Featuring new instructional methods in the school newspaper and/or other media (e.g., the school website)	0.460		
Involving parents in ICT related activities		0.720	

Overall, in similar ways, findings for construct Leadership, Collaboration, Support towards assessment, ICT infrastructure, Importance of ICT use, Expertise, General use of ICT, Pedagogical support, and Obstacles are summarized below:

Collaboration

With respect to collaboration, the result of the PC analysis shows that one factor with eigenvalues of $\lambda_1 = 2.160$ will be returned by the PC criterion. These factors explain about 54.0% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield the factor as *teachers' collaborative activities* (*see Appendix E*, item 11).

Support towards assessment

With respect to support towards assessment, the result of the PC analysis shows that two factors with eigenvalues between $\lambda_1 = 4.526$ and $\lambda_1 = 1.169$ will be returned by the PC criterion. These factors explain about 71.2% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *encouragement to use different modes of assessments* and factor 2 as *encouragement towards use of written tasks* (*see Appendix E*, item 12).

ICT infrastructure

With respect to ICT infrastructure, the result of the PC analysis shows that 3 factors with eigenvalues between $\lambda_1 = 5.272$ and $\lambda_1 = 1.040$ will be retained by the PC criterion. These factors explain about 61.4% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *access to computers*, factor 2 as *decision related to use of ICT* and factor 3 as *use of handheld devices* (*see Appendix E*, item 13 and 14).

Importance of ICT use

With respect to importance of ICT use, the result of the PC analysis shows that two factors with eigenvalues between $\lambda_1 = 9.722$ and $\lambda_1 = 2.701$ will be retained by the PC criterion. These factors explain about 64.8% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *learner orientation* and factor 2 as *teachers' encouragement* (*see Appendix E*, item 15 and 16).

Expertise

With respect to expertise, the result of the PC analysis shows that four factors with eigenvalues between $\lambda_1 = 8.404$ and $\lambda_1 = 1.192$ will be retained by the PC criterion. These factors are explaining about 72.3% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *pedagogical use of ICT*, factor 2 as *priority with regard to ICT use*, factor 3 as *managing collaborative activities*, and factor 4 as *pedagogical use of ICT* (*see Appendix E*, item 17 and 18).

General use of ICT

With respect to general use of ICT, the result of the PC analysis shows that three factors with eigenvalues between $\lambda_1 = 5.978$ and $\lambda_1 = 1.078$ will be retained by the PC criterion. These factors explain about 63.4% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *use of computers for various activities*, factor 2 as *information search* and factor 3 as *communication* (*see Appendix E*, item 19).

Pedagogical support

With respect to pedagogical support, the result of the PC analysis shows that two factors with eigenvalues between $\lambda_1 = 6.323$ and $\lambda_1 = 2.770$ will be retained by the PC criterion. These factors are explaining about 72.3% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *pedagogical support towards students* and factor 2 as *pedagogical support towards teachers and administrative staff* (*see Appendix E*, items 23 and 24).

Obstacles

With respect to obstacles, the result of the PC analysis shows that two factors with eigenvalues between $\lambda_1 = 9.351$ and $\lambda_1 = 1.710$ will be retained by the PC criterion. These factors are explaining about 72.3% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *hindrance due to lack of necessary equipment* and factor 2 as *hindrance due to pedagogical related issues* (*see Appendix E*, item 25).

ICT TECHNICIANS

This section presents relational findings on the description of ICT implementation in rural schools from the point of view of the ICT technicians. The constructs discussed in detail are ICT in school and Digital Learning Materials. For the sake of space, other constructs are presented in summary. Reference to the factors the variables form is made in the ICT technicians' questionnaire (*see Appendix G*).

ICT in school

It is observed from Table 6.15 that the resulting analysis of PC retains four factors with eigenvalues ranging between $\lambda_1 = 4.428$ and $\lambda_1 = 1.138$. These factors cumulatively explain about 71.5% of the total variation in the sample data. The communalities and the varimax rotated factors loadings as presented in Table 6.16 shows that variable on time used in Mathematics, time used in Natural Science, time used in Social sciences, time used in mother tongue, and time used in foreign language define factor 1; with variables on the level of ICT integration, use of ICT in teaching and learning and the time use in a separate subject defining factor 2; and variable on the number of years the school used ICT and the known ICT application types useful for school defining factor 3 whereas factor 4 is only made up of variable on the degree of ICT integration and the constraints outweighs ICT at school. As a result, we can now safely refer to factor 1 as *ICT use in school subjects;* factor 2 as *ICT integration in a school subject*; factor 3 as *ICT use of applications;* and factor 4 as ICT *integration and challenges.*

Table 6. 15: ICT use in School: Total Variance Explained

		Initial Eigenvalues	
Component	**Total**	**% of Variance**	**Cumulative %**
1	4.428	36.900	
2	1.693	14.106	
3	1.318	10.980	
4	1.138	9.486	
5	0.860	7.167	78.639
6	0.593	4.938	83.578
7	0.526	4.387	87.964
8	0.501	4.177	92.142
9	0.398	3.315	95.456
10	2.80	2.330	97.786
11	0.181	1.511	99.297
12	0.084	0.703	100.000

Table 6. 16: ICT use in school: Rotated Component Matrix

	Component			
Variables	1	2	3	4
No of years of using ICT			0.520	
ICT is considered relevant in our school			0.491	0.577
Our school has integrated ICT in most of our teaching and learning practices		0.812		
We have started to use ICT in the teaching and learning of school subjects		0.662		
We still do not know which ICT applications are useful for our school			-0.878	
Constraints rule out the use of ICT in our school				0.888
Mathematics	0.764			
Natural Sciences	0.707	0.450		
Social Sciences	0.679	0.419		
Language of instruction (mother tongue)	0.775			
Foreign languages	0.767			
ICT as separate subject	0.787			

Digital Learning Materials

However, with respect to Digital Learning Materials, the PC analysis retains three factors with eigenvalues in the range of $\lambda_1 = 3.329$ and altogether they are accounting for about 61.2% of the total variation in the sample (Table 6.17). In addition, the results of the communalities and the varimax rotated factor loadings (Table 6.18) shows that factor 1 comprises variable: availability of equipment and hands-on material, availability of simulation software, availability of communication software, availability of mail accounts for teachers and availability of mail account for learners, factor 2 has a variable of availability of multi-media production tools, availability of digital resources and availability of mobile services, and with variable availability of office suite and availability of mail account for learners making up factor 3. These factors can therefore be referred to as *software availability* (factor 1) *Digital resources* (factor 2) and also *software application* (for factor 3).

Table 6. 17: Digital Learning Material: Total Variance Explained

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	3.329	33.291	
2	1.478	14.783	
3	1.314	13.141	
4	0.988	9.877	71.092
5	0.915	9.146	80.237
6	0.605	6.046	86.284
7	0.510	5.103	91.387
8	0.428	4.280	95.667
9	0.265	2.647	98.314
10	0.169	1.686	100.000

Table 6. 18: Digital Learning Material: Rotated Component Matrix

	Component		
Variables	1	2	3
Equipment and hands-on materials (e.g., laboratory equipment, overhead projectors, slide projectors, graphic calculators)	0.742		
General office suite (e.g., word-processing, database, spreadsheet, presentation software)			0.707
Multimedia production tools (e.g., media capture and editing equipment, drawing programs, webpage/multimedia production tools)		0.769	
Simulations/modeling software/digital learning games	0.595	0.402	
Communication software (e.g., e-mail, chat, discussion forum)	0.723		
Digital resources (e.g., portal, dictionaries, encyclopedia)		0.547	
Mobile devices (e.g. Personal Digital Assistant (PDA), cell phone)		0.767	
Smart board/interactive whiteboard			-0.726
Mail accounts for teachers	0.883		
Mail accounts for learners	0.627		

As in part one, the results for Professional development, Support, and Obstacles are presented in the same way and are summarized below:

Professional development

With respect to professional development, the result of the PC analysis shows that five factors with eigenvalues between $\lambda_1 = 5.533$ and $\lambda_1 = 1.122$ will be retained by the PC criterion. These factors explain about 72.8% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *knowledge acquisition*, factor 2 as *mode of training*, factor 3 as *ways of knowledge transfer*, factor 4 as *knowledge acquired through print media*, and factor 5 as *impact of news letters on ICT* (*see Appendix G*, item 11 and 12).

Support (technical)

With respect to technical support, the result of the PC analysis shows that 4 factors with eigenvalues between $\lambda_1 = 4.428$ and $\lambda_1 = 1.138$ will be retained by the PC criterion. These factors are explaining about 71.5% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *availability of technical support in general*, factor 2 as *level of ICT integration*, factor 3 as *frequency of ICT use* and factor 4 as *constraints experienced* (*see Appendix G*, item 13, 14, and 16).

Obstacles

With respect to obstacles, the result of the PC analysis shows that three factors with eigenvalues between $\lambda_1 = 6.757$ and $\lambda_1 = 1.215$ will be retained by the PC criterion. These factors are explaining about 72.3% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *lack of the necessary resources*, factor 2 as *lack of teaching resources*, and factor 3 as *curriculum related issues* (*see Appendix G*, item 17).

ICT infrastructure

The results for ICT infrastructure show that there are fewer than two cases, of which one of the variables has zero variance. There is only one variable in the analysis, and therefore the coefficients could not be calculated.

Science teachers

This section presents findings on constructs that appear in the science teachers' data. The constructs discussed in detail are ICT in school and Digital Learning Materials. For the sake of space, other constructs are presented in summary only. Reference to the factors the variables form is made in the ICT technicians' questionnaire (*see Appendix F).*

Technical support

In the case of Technical support, the result of the PC analysis is presented in Table 6.19. From the table, it can be observed that the analysis retains one factor (eigenvalue = 2.093) which is explains about 69.8% of the total variation in the sample data. It is therefore important to point out here that the communalities and the varimax rotated factor loadings do not exist as only one factor is retained. As such Table 6.20 shows that all the variables were retained in the factor.

Table 6. 19: Technical support: Total Variance Explained

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	2.093	69.760	
2	0.668	22.263	92.023
3	0.239	7.977	100.000

Table 6. 20: Technical support: Rotated Component Matrix

	Component
Variables	1
Evidence of technical support received from the technician	0.705
Evidence of access to computers	0.876
Evidence of administrative work	0.910

Digital Learning Materials

However, with respect to Digital Learning Materials, the result of the PC analysis shows that four factors with eigenvalues ranging between $\lambda_1 = 5.543$ and $\lambda_{4_2} = 1.023$ accounting for a cumulative percentage of about 67.1% of the total variation in the sample (Table 6.21) were retained. The respective communalities and the varimax rotated factor loadings (Table 6.22) show that factor 1 comprises variables on extended projects (2 weeks or longer), short-task projects, product creation, self-accessed courses and/or learning activities, and scientific investigations. Factor 2 comprises variable exercises to practice skills and procedures, laboratory experiments with clear instructions and well-defined outcomes, discovering science principles and concepts, studying natural phenomena through simulations, and looking up ideas and information. Factor 3 takes on variables in field study activities and teachers' lectures and processing and analyzing data making up factor 4 respectively. As a consequence one can therefore refer to these factors as *Science projects* (factor 1) *Instructional learning* (factor 2) *Investigation of scientific principles* (factor 3) as well as *Data analysis* (factor 4).

Table 6. 21: Digital Learning Material: Total Variance Explained

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	5.543	39.595	
2	1.498	10.701	
3	1.330	9.499	
4	1.023	7.305	
5	0.834	5.957	73.057
6	0.687	4.907	77.964
7	0.589	4.208	82.172
8	0.560	3.998	86.169
9	0.511	3.648	89.818
10	0.393	2.809	92.626
11	0.344	2.459	95.086
12	0.262	1.872	96.958
13	0.223	1.594	98.552
14	0.203	1.448	100.00

Extraction Method: Principal Component Analysis

Table 6. 22: Digital Learning Material: Rotated Component Matrix

	Component			
Variables	1	2	3	4
Extended projects (2 weeks or longer)	0.797			
Short-task projects	0.710			
Product creation (e.g., making a model or a report)	0.750			
Self-accessed courses and/or learning activities	0.671	0.455		
Scientific investigations (open-ended)	0.816			
Field study activities			0.871	
Teacher's lectures			0.649	
Exercises to practice skills and procedures		0.661		
Laboratory experiments with clear instructions and well-defined outcomes	0.528	0.619		
Discovering science principles and concepts		0.813		
Studying natural phenomena through simulations		0.732		
Looking up ideas and information		0.611		
Processing and analyzing data				0.967

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalisation

Expertise

Similarly, the outcome of the PC analysis for Expertise from Table 6.23 retains only two factors with the corresponding eigenvalues of $\lambda_1 = 6.439$ and $\lambda_{2_2} = 1.117$. The cumulative total variation in the sample data that is explained by the two factors is about 63.0%, while the communalities and the varimax rotated factor loadings as presented in Table 6.24, shows that variables making up factor 1 are to:

- present information/demonstrations and/or give class instructions
- provide remedial or enrichment instruction to individual students and/or small groups of students
- help/advise students in exploratory and inquiry activities

- organize, observe or monitor student-led whole-class discussions, demonstrations, and presentations
- assess students' learning through tests/quizzes,
- provide feedback to individuals and/or small groups of students,
- use classroom management to ensure an orderly, attentive classroom
- organize, monitor and support team-building and collaboration among students

Factor 2 mainly comprises variables on

- organising and/or mediating communication between learners and experts/external mentors
- liaising with collaborators (within or outside school) for learners' collaborative activities
- providing counselling to individual students
- collaborating with parents, guardians and caretakers in supporting and monitoring students' learning
- providing counselling

Therefore, one can refer to these factors as *Collaborative activities* (factor 1) and *Learner mentoring* (factor 2) respectively.

Table 6. 23: Expertise: Total Variance Explained

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	6.439	53.658	
2	1.117	9.308	
3	0.960	8.002	70.968
4	0.683	5.689	76.656
5	0.511	4.255	80.912
6	0.478	3.982	84.893
7	0.438	3.646	88.539
8	0.366	3.047	91.586
9	0.312	2.601	94.186
10	0.277	2.307	96.494
11	0.227	1.892	98.386
12	0.194	1.614	100.000

Extraction Method: Principal Component Analysis

Table 6. 24: Expertise: Rotated Component Matrix

Variables	Component 1	2
Present information/demonstrations and/or give class instructions	0.768	
Provide remedial or enrichment instruction to individual students and/or small groups of students	0.554	0.460
Help/advise students in exploratory and inquiry activities	0.727	
Organize, observe or monitor student-led whole-class discussions, demonstrations, presentations	0.676	0.423
Assess students' learning through tests/quizzes	0.778	
Provide feedback to individuals and/or small groups of students	0.771	
Use classroom management to ensure an orderly, attentive classroom	0.832	
Organize, monitor and support team-building and collaboration among students	0.584	0493
Organize and/or mediate communication between students and experts/external mentors		0.770
Liaise with collaborators (within or outside school) for student collaborative activities		0.768
Provide counselling to individual students		0.722
Collaborate with parents/guardians/ caretakers in supporting/monitoring students' learning and/or in providing counseling		0.701

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalisation

Science curriculum goals

The outcome of the PC analysis for Science curriculum goals from Table 6.25 retains two factors ($\lambda_1 = 5.939$ and $\lambda_{2_2} = 1.900$), explaining about 60.3% of the total variation in the sample data. Furthermore, the communalities and the varimax rotated factor loadings in Table 6.26 indicates that variables for factor 1

- to prepare students for the world of work, to prepare them for upper secondary education and beyond,
- to provide activities which incorporate real-world examples, settings and applications for student learning,

- to improve students' performance in assessments/examinations, to increase learning motivation and make learning more interesting,
- to individualize student learning experiences in order to address different learning needs,
- to foster students' ability and readiness to set their own learning goals and to plan, monitor and evaluate their own progress,
- to foster students' collaborative and organizational skills for working in teams, and
- to satisfy parents' and the community's expectations made up factor 1.

Factor 2 comprises the following variables:

- to provide opportunities for students to learn from experts and peers from other schools/countries,
- to foster students' communication skills in face-to-face and/or online situations, to prepare students for competent ICT use and to prepare students for responsible Internet behaviour.

These factors can be referred to as *learner skills preparation* (factor 1), *technological challenges* (factor 2) respectively.

Table 6. 25: Science curriculum goals: Total Variance Explained

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	5.939	45.685	
2	1.900	14.614	
3	0.822	6.324	66.623
4	0.746	5.738	72.362
5	0.696	5.352	77.713
6	0.597	4.596	82.309
7	0.525	4.037	86.346
8	0.472	3.634	89.979
9	0.387	2.976	92.956
10	0.344	2.648	95.604
11	0.252	1.939	97.543
12	0.168	1.292	98.835
13	0.151	1.165	100.000

Extraction Method: Principal Component Analysis

Table 6. 26: Science curriculum goals: Rotated Component Matrix

Variables	Component 1	Component 2
To prepare students for the world of work	0.483	0.461
To prepare students for upper secondary education and beyond	0.715	
To provide opportunities for students to learn from experts and peers from other schools/countries		0.579
To provide activities which incorporate real-world examples/settings/applications for student learning	0.777	
To improve students' performance in assessments/examinations	0.812	
To increase learning motivation and make learning more interesting	0.852	
To individualize student learning experiences in order to address different learning needs	0.624	
To foster students' ability and readiness to set their own learning goals and to plan, monitor and evaluate their own progress	0.729	
To foster students' collaborative and organizational skills for working in teams	0.765	
To foster students' communication skills in face-to-face and/or online situations	0.445	0.535
To satisfy parents' and the community's expectations	0.557	
To prepare students for competent ICT use		0.918
To prepare students for responsible Internet behavior (e.g., not to commit mail-bombing, etc.) and/or to cope with cybercrime (e.g., Internet fraud, illegal access to secure information, etc.)		0.903

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalisation

Overall, the rest of the results for Instruction, ICT infrastructure, Confidence on Pedagogical use of ICT, Obstacles, Professional development and Pedagogical use of ICT are summarised below:

ICT infrastructure

With respect to ICT infrastructure, the result of the PC analysis in Table 6.31 shows that one factor with eigenvalue of $\lambda_1 = 5.621$ will be retained by the PC criterion. These factors explain about 70.3% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *insufficient infrastructure* (*see Appendix F*, item 19).

Attitude

With respect to science teachers' attitudes, the result of the PC analysis in Table 6.31 shows that one factor with eigenvalue of $\lambda_1 = 5.779$ will be retained by the PC criterion. These factors explain about 72.2% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *confidence in ICT use* (*see Appendix F*, item 20).

Obstacles

With respect to obstacles, the result of the PC analysis in Table 6.31 shows that three factors with eigenvalues between $\lambda_1 = 4.000$ and $\lambda_1 = 1.486$ will be returned by the PC criterion. These factors explain about 62.1% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *lack of knowledge to identify the appropriate equipment*, factor 2 as *learners' lack of skills* and factor 3 as *lack of confidence and time* (*see Appendix F*, item 24).

Professional development

With respect to professional development, the result of the PC analysis in Table 6.31 shows that three factors with eigenvalues between $\lambda_1 = 2.588$ and $\lambda_1 = 1.026$ will be retained by the PC criterion. These factors are explaining about 69.2% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *participation in technical and media operations courses*, factor 2 as *participation in Internet courses*, factor 3 as *participation in pedagogy related courses* (*see Appendix F*, item 25).

Pedagogical use of ICT

With respect to pedagogical use of ICT, the result of the PC analysis in Table 6.31 shows that 6 factors with eigenvalues between $\lambda_1 = 8.799$ and $\lambda_1 = 1.092$ will be retained by the PC criterion. These factors explain about 26.7% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *use of ICT for assessment*, factor 2 as *collaborative activities*, factor 3 as *classroom management*, factor 4 as *giving feedback to learners*, and factor 5 as *assessment*, and factor 6 as *ICT use for collaboration* (*see Appendix F*, item 16, 17, and 18).

Vision

Factor analysis was also performed for construct on vision. It was therefore evident from the table that the PC analysis retained a single factor with an eigenvalue of 2.123 and account for about 70.8% of the total variation in the sample. The communalities and the varimax rotated factor loadings yield factor 1 as *development of school's vision*.

Collaboration

Similarly, with respect to the collaboration, the PC analysis shows that only one factor accounting for only 45.9% of the total variation in the sample data is retained (eigenvalue = 1.835). Therefore as in the vision construct, all the variables were retained in this factor, as *evidence of collaboration within and between schools*.

Summary of the factor analyses

In order to determine factors that affect ICT implementation in rural schools, exploratory factor analyses were conducted on the principals, science teachers and the ICT technicians' data respectively. An exploratory factor analysis is used in the description of the covariance relationships among the many variables called factors. The total variance in the samples was calculated. The findings for each construct are shown in terms of the number of variables or factors grouped per theme that they explain. ICT infrastructure as perceived by the ICT technician only had one variance and therefore could not be calculated further.

Having presented the variances between factors, the factors predicting ICT implementation in rural areas are presented below:

6.5 Factors predicting ICT implementation in rural areas

This section presents findings on factors that predict ICT implementation in rural areas. The findings of this study are presented at school level, although a distinction is made about principals' and the science teachers' factors respectively. It is important to point out that the responses of the principals and the science teachers were combined at school level. In the case of the school having two science teachers respond to the questionnaire, the responses were averaged to elevate the scores at school level. The Pearson's correlation analysis (see Chapter 4) is presented in Table 6.32 only for factors with values above ±0.30 as moderate fit for explanation (Cohen, Manion & Morrison, 2007). The rest of the correlation table is in Appendix P. In addition, the regression analysis is presented to determine the best fit using the dependent variable as pedagogical use of ICT by the science teachers. This section presents the correlation analysis in Section 6.5.1 and regression analysis in Section 6.5.2 respectively.

6.5 1 Correlation analysis

The findings on Pearson's correlation analysis are presented in the Table 6.32 (below), and suggest pedagogical use of ICT has relationships with a considerable number of constructs, such as attitudes, expertise, ICT infrastructure and professional development of the science teachers. The other constructs had fewer relationships between them.

Table 6. 27: Correlations of the principals and the science teachers

Variables	Pearson's Correlation	Variables			
Pedagogical use of ICT		Science teacher's attitude	Expertise of science teacher	ICT infrastructure	Professional development
	Correlation	0.307	0.387	0.421	0.339
	Significance level	0.003	0.000	0.000	0.001
	N	91	91	91	91
Support by principal		Collaboration by principal			
	Correlation	0.457			
	Significance level	0.000			
	N	91			
Leadership of principal		Curriculum goals	Vision of principal		
	Correlation	0.421	0.469		
	Significance level	0.000	0.000		
	N	91	91		

Vision of principal		Curriculum goals by science teachers	Collaboration principals
	Correlation	0.470	0.317
	Significance level	0.000	0.002
	N	91	91

Leadership by science teachers		ICT infrastructure by science teachers
	Correlation	0.334
	Significance level	0.001
	N	90

Support for science teachers		ICT infrastructure by science teachers
	Correlation	0.368
	Significance level	0.000
	N	91

ICT use by principals		Vision of principal	
	Correlation	0.476	
	Significance level	0.000	
	N	90	
Pedagogical support by principals		Vision	Leadership by principals
	Correlation	0.446	0.434
	Significance level	0.000	0.000
	N	91	91

The findings show that there is a significant relationship at $p \leq 0.01$ between the factor pedagogical use of ICT with attitude (p=0.307), expertise (p=.387), ICT infrastructure (p=0.421), and professional development (p=0.339) of the science teachers. This means that principals and the science teachers are likely to agree on matters regarding science teachers' attitude, expertise and professional development. They are also likely to agree on statements about ICT infrastructure as perceived by the science teachers.

The leadership of the principals has a strong positive relationship between curriculum goals (p=0.421) and vision of the principal (p=0.469) respectively. This finding suggest that both the principal and the science teachers are likely to agree on statements that reflect views on curriculum goals of the science subject as expressed by the science teachers and the vision of the principals in relation to the leadership style.

The vision of the principal has a strong relationship with the science teachers' views on collaboration (p=0.317) and also with science curriculum goals (p=0.470). This finding suggests that both the principals and the science teachers are likely to agree on issues of collaboration as perceived by the science teachers, as well as issues about science curriculum goals in relation to the vision of the principals.

There is a strong relationship between ICT use and the vision of the principals (p=0.476). This finding suggests that the principals and the science teachers are likely to agree on statements about the vision of the principal with regard to ICT use.

There is a strong relationship between pedagogical support and vision of the principals (p=0.446). This finding suggests that the principals and the science teachers are likely to agree on matters related to the vision of the principal in relation to pedagogical support towards the science teachers.

6.5.2 Regression analysis

This section presents findings based on the regression analysis of the principals and the science teachers' data. The calculation of scores was conducted whereby the responses in all the questionnaires were converted into indices to allow for regression analyses. Arguments for computation and the processes followed are presented in Chapter 4 (also see Appendix O). Variable selection or regressions procedure calls for consideration of all possible subsets of the pool of potential independent variables (factors) and identifying some for detailed examination of a few or good subsets according to selection criteria. The dependent variable of interest is pedagogical use of ICT by the science teachers. This study will therefore undertake model building for the dependent variable.

In order to assess the magnitude of the contribution of various constructs to the pedagogical use o ICT by science teachers, a simple regression model was fitted. The independent constructs of interest in the model include: professional development, vision, obstacles, digital learning materials, support, collaboration, expertise, general use of ICT, leadership, curriculum goals, infrastructure, and attitude of the science teachers, while the principals mentioned the support, expertise, vision, effort, leadership, collaboration, ICT use, infrastructure, pedagogical support and obstacles. The proportionate reduction in the variability of the pedagogical use of ICT when all the above constructs were included in the regression model is about 85.2%, while the outcome of the analysis of variance (ANOVA) for the fitted model presented in Table 6.33 shows that at 5% level there is a significant difference in the contribution of the constructs toward pedagogical use of ICT by science teachers.

Table 6. 28: ANOVA result

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	73416.349	22	3337.107	17.493	.000[a]
	Residual	12781.748	67	190.772		
	Total	86198.097	89			

The individual coefficient of the model parameters indicates that the only constructs that were found to be significant in the model at the 5% level of significance were leadership by principals (0.022), expertise (0.041) and general use by science teachers (0.000). As a result, for every activity added to leadership, the pedagogical use of ICT increases on average by 0.022. An increase in expertise, that is, adding knowledge and skills-related activities, pedagogical use of ICT increases on average by 0.267. Similarly, for every activity added to the general use of ICT, the pedagogical use of ICT increases on average by 0.877. This finding suggests that the model can be applied to rural schools in the same situation. In addition to the quantitative findings, the case studies are presented below to dig deep into the actual events as they happen in the natural environment.

6.6 Findings of school level case studies

This section presents three case studies of three schools (School A, B and C), discussed in Chapter 5 of this study. Case studies were analysed in order to deepen understanding of the findings from the survey. To obtain a full picture of factors that affect ICT implementation in rural schools, the cases were cross-analysed by combining findings from the respondents occupying the same profiles at the respective schools per factor.

Context information of the cases

The three case studies participating schools are all rural based, one in each of the three educational regions. As explained in Chapter 2, these educational regions were war zones before the years 1990. In terms of resources available, none of the schools is said to be better equipped than the others. All the three schools depended on the Namibian Government to provide them with basic resources. Over time, the principals had realised that they needed to source for additional teaching materials if their schools were to perform better at Grade 10 level. As a result, at least two of the three schools demonstrated innovative ideas on how to acquire more resources, without the assistance of the Namibian Government. The innovative ideas also perhaps depended on the characteristics of the school leadership or the principals. The background information of the school principals, science teachers and ICT technicians are presented below:

Table 6. 29: Characteristics of the school principals, science teachers and ICT technicians

Principals	**School A**	**School B**	**School C**
Age	50	55	32
Training	MA	BA, PGDE	BEd.
No of years as principal at that school	5	20	1
Science teachers	**School A**	**School B**	**School C**
Age	25	32	32
Training	BETD	BEd	BEd
No of years as teachers	2	5	5
ICT technician	**School A**	**School B**	**School C**
Age	27	23	40
Training	BETD	No formal training	BEd
No of years as ICT technician	5	3	8
Teaching subjects	Geography	Computer studies	Entrepreneurship

The background information of the principals, science teachers and ICT technicians show that the level of qualification for two of the principals is a bachelor's degree and for School A, is a master's degree. Two of the principals are between 50 and 55, with principal C by far the younger. The years of occupation as principal vary between 1 and 20. Principal B is the most experienced with 20 years of experience, followed by Principal A with 10 years and Principal C with about a year of experience in their respective schools. The science teachers are all young, between the ages of 25 to 32. Two of the three teachers have bachelor's degrees with five years of teaching experience, and one has a BETD diploma with two years of teaching experience.

The ICT technicians' ages range between 27 to 40 years. Two had formal qualifications and one did not. The number of years of teaching experience varied between 3 and 8, with the oldest ICT technician having the greatest teaching experience. In addition, to serve as an ICT technician these had other teaching subjects allocated to them.

This background information is important as it might have influenced the responses of the principals, science teachers and ICT technicians. The responses are presented in the matrices below:

Cross case analyses

This section presents the cross case analyses findings of principals, science teachers and ICT technicians. The aim of crossing the cases was to understand innovative pedagogical ICT uses, how these changed in what science teachers do, the support systems made available to them and how these practices are associated with contextual conditions. The data was analysed manually, based on statements made in the case report.

Vision

The principals as well as the ICT technicians were asked to answer questions about the vision they held, whether the school board and/or the school leadership was involved in the implementation of ICT in their schools, and also what the role of the school leadership was. All the principals and technicians had the same vision towards ICT implementation, articulated by principals as follows:

'The point is for everyone in the school to be able to use ICT or computers (Principal C, 15 April, 2010)

'…because in the 21st century there will be no one who will call oneself a better teacher or best teacher unless you are able to use technology in the classroom' (Principal A, 12 April 2010).

In order to realise this dream, Principal C had expanded the schedule so that '*all the learners are exposed to at least to 2 to 3 periods per cycle to ICT'* (Principal C, 15 April, 2010). This effort explains why the vision is in the medium category (42.92%). Schools have vision statements posted on the walls, being the first thing the researcher observed at the entrance of the schools. However, the statements did not reflect any technology. The ICT implementation component appears to be secondary on the priority list of the school activities. The level of ICT implementation is still low and, as observed, is still at the provision level of ICT.

From the literature, the vision statements of the interviewee as stated during the interview have elements of social rationale as well as vocational rationale (see Section 3.3). In the spectrum of the social rationale, ICT is being implemented with the hope that both the teachers and learners will get ready for the challenges of the 21st century. All children in all societies therefore need to be prepared for an ICT and communication society (Doornekamp, 2002; Valentine & Holloway, 2001). Complementary to that view, the emphasis of the vision is on skills acquisition for both the teachers and the learners, with the hope that ICT skills would be required in the world of work and subsequently make a contribution to the MDGs. It can be interpreted that this hope will result in Namibia becoming an industrialised country (Vision 2030).

Leadership

Asked who was responsible for the implementation process, some interviewees, particularly the principals, responded that it was the school board. The principals said the following:

Hmmm… the school board because the school board members most of them obviously would like all of us to use ICT at school and that all computers be kept safe… And they don't want the ICT to be used for personal reasons since they are for the school unless the person who want to make use of it gets permission from them, otherwise …we may experience breakage among the computers and nobody will be responsible for that. Therefore they are always informed or instructed to get permission before they make use of the computer… at parents' meetings …. (Principal B, 13 April 2010).

They attend to lessons for ICT and teachers must make sure that all the twenty computers that we have in the lab are working and more learners are exposed to ICT. Rather than having about three or four computers only working. We, the management only make sure that whenever there is a computer that is not functioning, we make sure that it is repaired as soon as possible and we encourage learners to make sure that they attend the lessons. All in all, they do enjoy it and they do go. (Principal C, 15 April, 2010).

From the data it is noted that all principals knew more or less what the roles of the school leadership were, hence the medium score (Mean=49.03%). The school board ensured effective use of ICT by both teachers and learners by way of encouraging more teachers to use ICT. Faults detected with the operations of ICT were to be reported to the school board.

The school boards did not necessarily prescribe what ICT the science teachers should use in their classes (Principal A and C). However, Principal B indicated the need to inform the school management about how teachers used ICT. Contrary to this answer, the technicians think that the school leadership is responsible. Technician A responded:

'the leadership supports ICT a lot. They try and….and maintain the computers. They make sure that there is also electricity at school which is a bit of a challenge to our school. Most of the…most of the

leaders try to encourage learners to make use of these facilities. (Technician A, 13 April 2010).

It is interesting that divergent views emerged on this question. The principals report to the school board and in their meetings they are obliged by the structure of the Ministry of Education to report on issues of progress towards ICT implementation, breakage and possibly new projects that are being initiated in the areas of ICT. However, at the level below the school management, technicians think that the school leadership is responsible for the implementation of ICT. It is sensible for the ICT technicians to respond that way, since they may not be part of the school management, and it is possible that they would not know what is discussed in school board meetings. The technicians and the science teachers report their complaints to the school management, who in turn report to the school board for any decision to be made.

From the data, it is noted that all interviewees knew more or less what the roles of the school leadership were. The school board ensures effective use of ICT by both teachers and learners, by way of encouraging more teachers to use ICT:

"Where possible, teachers are also encouraged to learn ICT on their own" (Principal A, 12 April 2010).

However, from the answer about the exclusion of the school board it can be interpreted that the involvement of the school board is somehow limited. The school board is composed of the school management, heads of department, and the community members, of whom many will be immediate parents of learners attending a particular school. These parents are from the nearby village and, given their socio-economic status, have little knowledge of ICT.

Howie et al. (2005) argue that the extent to which school principals promote the use of ICT in their schools depends largely on how useful they consider these technologies to be. In a different study, principals see their role as catalysts and facilitators of ICT integration in the classroom (Tondeur et al., 2008). Assuming that most principals see their role as such, about 50% of the schools that participated in SITES M2 have developed policies concerning ICT use in line with their vision and also towards establishing positive attitudes. Many were found to be implementing at least half of the policy objectives (Howie et al., 2005). This is confirmed by a study by Tondeur et al. (2008) which revealed that school policies were often underdeveloped and underutilised due to lack of various types of resources.

Digital Learning Material

In order to establish the different types of educational software available at school and to determine whether that provided to the schools was relevant, the interviewees' views were sought. The Ministry provided the schools with computers in which the *Encarta* and MS Office programme were pre-installed. Some school acquired more software to enhance the effectiveness of their work.

Regarding the software provision, all interviewees appeared to know what was available in their respective schools. The technicians answered:

> *' We have only a mathematical one …oh not only a mathematical one ..but also Encarta.'* (Technician C, 13 April 2010).

> *'Yes we have… Microsoft, and Encarta.'* (Technician B, 13 April 2010).

Regarding the data, *Encarta* and *MS* package was common to all participating schools. In addition to the pre-installed software by the Ministry of Education, School B and C bought extra software, such as that used to do timetabling and the other for producing report cards for learners. This is a sign of commitment towards ICT integration and working fruitfully towards the vision of their school. The acquisition of extra software is dependent on the vision of the principals and the affordability of software by the schools. Ten Brummelhuis, de Heer and Plomp (2008) argue that no accurate information concerning the educational software and its content actually used by teachers and students is presently available in the Netherlands, with a long tradition of ICT in schools. However, teachers wish to be ready to use software for unknown reasons, but they speculate that it may be due to lack of awareness of the programmes and content available, an inability to find software that meets the needs of the schools, and/or mismatch between supply and demand.

On the relevance of the software, the interviewees mentioned that the introduction of ICT and particularly the introduction of certain software caused excitement at the schools. The interviewees shared the sentiment that the work was done faster and more easily with regard to creating report cards for the learners. Principal B commented as follows:

> *'They are very much relevant and they make teachers work easier, more especially when it comes to compiling their schedules, teachers do not need to scratch their heads and used a lot of their energy. They seems to enter the marks on the computer, the computer do everything for them… and when it comes to writing report cards , the time you enter the marks on the computer is the time when the computer is writing down the report on the card'* (Principal B, 13 April, 2010).

From the data, all interviewees agreed that the software was relevant for administrative and for pedagogical purposes. The details of the cost linked to the digital learning materials were not explored in this study, making it difficult to describe the investment towards acquisition of material which could be of good quality and relevance. The interviews concentrated within the means of the schools. Kennisnet (2008) argues that the importance of coordinating digital learning materials should be done with the school's overall goals. In cases when this is not done there is a high risk that investment in ICT will produce hardly any benefit. According to Kennisnet (2008), only a few schools have managed to consider the ideas of teaching and learning as basis for acquiring digital learning materials to support those pedagogical ideas. Given the socio-economic conditions of the rural schools, it is improbable that digital learning material that suits the pedagogical principles of the respective schools will be acquired. Rural schools therefore stand a chance of acquiring digital learning materials at lower costs (Kennisnet, 2008).

With regard to the most used digital learning materials, the technician mentioned that *Microsoft Word* was the software most used by the teachers and learners. The responses were also limited because the school did not have a wide variety of software available to it. Within their limit, the technicians indicated that *MS Word* was used the most, in line with findings by Howie et al. (2005) that at lower secondary school level the most satisfying experiences with technology appear to be information retrieval and presentation. The technician's response was "*Microsoft word.'* (Technician B, 13 April 2010). The technicians further indicated that *MS Word* was being used for lesson preparation and complimented by information obtained through a search on the Internet:

> *'I think is an important programme on the computer cause most people are using computer to type and on top of that Encarta is also important cause they are using it to search their information.'* (Technician B, 13 April 2010).

Most computers have MS packages, and from observation most if not all the supplied by *School-net* are obsolete. Thus, *School-net Namibia* is almost non-functional in the participating schools. Teachers will not be able to use the free software through the *Linux* system, thus limiting them to access of more digital learning materials.

On the question of whether the ICT technicians had been trained on how to use the digital learning materials available at their schools, some indicated that they had not been trained:

> *'Not really, it is a matter of getting used to the software and getting to know how they work but I was not given a formal on how they work'* (Technician A, 13 April 2010).

> *'Yes, I have been trained to use the Linux but this Microsoft from the Ministry, they did not give us any but they are planning to come here from the holiday the 26th May to train us ICDL. [Encarta] No, I just learn it myself'* (Technician B, 13 April 2010).

From the data, neither the technicians nor the science teachers had been trained in using any of the software made available to the schools. Each possessed ICT skills acquired through a different platform. The technician conversant with *Linux* had been trained some years previously, when schools were provided with computers by *School-net Namibia*. It is assumed by the ICT National Coordinator at the MoE that learning how to operate software is something that can be self-taught, and therefore teachers did so without assistance. However, at the time of conducting this study, training in ICDL was about to start within a month.

Expertise

The interviewees were asked to answer questions on the knowledge, skills and attitude with regard to ICT implementation. The knowledge possessed by each interviewee varied considerably between technical and software engineering, and was informally acquired by self-teaching through trial and error, from a brother who was a technician and through volunteers at the respective schools. This could be the case with many principals and ICT technicians, contributing to the placing of expertise in the medium category. However, some principals had received little or no training while holding the office of principal. Only one, principal A, had been trained in *MS Word*. Principal B was self taught whilst Principal C had acquired skills at school as a learner and during pre-service. Asked whether the interviewees were trained during their reign of principal position, Principals A and B responded:

> *'Ya, I had some elementary training some years back, 2004 but it was not intensive. I really wanted to do Excel and PowerPoint but unfortunately it was just limited to Microsoft Word and document writing and staff… I would really like to be trained…. it was just Microsoft Word, on how to write letters and design and how to open and create folders. I really wanted to be trained in PowerPoint. These days when you go to a conference and you are asked to present, one uses PowerPoint'* (Principal A, 12 April 2010).

> *'Myself, hmmm I was not…. I simply started typing with the manual typing machine and then I decided no, no, no… I should also try the computers. In most cases I used to call the computer teacher just to show me what to do'* (Principal B, 13 April, 2010).

> *'Yes, I was when I was in high school I did Computer practice from Grade 8-10. From there I learnt on my own. In fact that is where I acquired a lot, especially in how to use Microsoft package. I am not very skilled in using the other one, Linux. Microsoft is easier to me. Microsoft Word, Excel...then searching through Internet and whatever…'* (Principal C, 15 April 2010).

The data shows that the principals had not been adequately trained in ICT. They did have some knowledge about ICT, especially in the *MS* package. Principal C seemed more knowledgeable about ICT issues because of his school background. Similarly, the technicians had the following to say:

> *'I acquired this knowledge through my brother who is an ICT technician. He has been working with computers and most times he was teaching at some institutions and he also tried to attend classes. I did not get any formal training in ICT and therefore no formal qualification in it'* (Technician A, 13 April 2010).

> *'I got my training at School-net Namibia on how to give basic computers to learner.'* (Technician B, 13 April 2010).

> *'I was trained by the institution where I studied.'* (Technician C, 16 April 2010).

From the data it is evident that none of the interviewees was trained in ICT suited for his or her employment. The knowledge about ICT is acquired through different means and served different purposes, yet, it is expected from the MoE that these individuals perform their duties effectively. The general observation made about the participants of the case studies is that the interviewee in the teaching positions are relatively middle aged and have undergone training during their in-service training programme at the University or colleges.

On the questions of what skills the interviewee possessed, the responses ranged from *MS Word, Excel, PowerPoint,* the Internet, operations of *Encarta*, *Equation 3.0*; to timetable software and report card development software. The responses were:

> '*They are quite a lot. From the technical aspect, PC Engineering, I know quite a lot. From the software, I learnt quite a number of them, how to use the different type of software. The basic software that we use, like Microsoft word, Excel, Publisher,… and this one for the database, and Internet.'* (Technician A, 13 April 2010).

> *'We got practical and theory but just the basic. How to use Microsoft Word, spreadsheet presentation and how to use Internet and we also learn how to troubleshoot the computer, the little technical signs.'* (Technician B, 13 April 2010).

Given these responses, it becomes questionable as to what is expected from these technicians. They have minimal skills, and what qualifies a technician in this context is unclear. It is also apparent that the repairs by the technician could be based on trial and error, and thus the ICT durability would not be guaranteed. In the midst of this process, Technicians A and B have acquired some technical skills in PC Engineering. From the data, it is evident that the technicians are better skilled in software applications than they are in hardware operations. This situation makes the technicians use trial and error to repair the computers and other ICT, as they may not possess the necessary skills to do a good job.

The technicians were also asked to describe the strategy used in their respective schools to increase ICT use by fellow science teachers. Two of the three wished that all teachers had time so that they could attend ICT training that they have initiated. It is also anticipated that the teachers would be encouraged to attend the ICDL training planned by the Ministry of Education, which was to give a laptop to the school as an incentive, should a teacher complete all seven modules. Technician B commented by saying:

> *'...most of them are eager to learn. It is only that they don't have time but if that ICDL thing they have to come cause they are going to get something at the end and everybody want them to be trained…Yes and they will be a laptop to be awarded to a person to complete all the modules.* (Technician B, 13 April 2010)*.*

The finding confirmed the quantitative results that science teachers were being trained. From the qualitative data the technicians were not clear on what specific strategy they were proposing in order to increase ICT use in their schools, but rather they depended on the wider Ministry of Education project to introduce ICDL Modules to the schools. However, the focus was going to be on basic ICT skills acquisition. It still remains questionable if all the hardware operations skills by teachers would be achieved in the school so that technical problems would be solved within a reasonable time. In addition, it was unclear whether the teachers acting as technicians would be able to detect the technical problems confidently to a level at which they would be given instructions telephonically that they could easily perform.

Attitude

The interviewees were also asked to answer questions about whether the attitudes of science teachers had changed since the introduction of computers to their respective schools. On average, the responses were positive, reading from these comments:

> *'I think embracing of ICT is low in the sense that I do not know what is wrong with our people. They just do not have the interest. I think they still need some motivation for them to participate. I heard some of them say… no we are old and stuff… one is never too old to learn. Like the workshop we had recently with the new Minister of Education, he said, nowadays in the 20th century, there is no way that you can become a good teacher if you are not given access to computers'* (Principal A, 12 April 2010).

> *'It had a positive impact on the teaching although it depends on teacher to teacher and the skill they have and how they can apply ICT'* (Technician A, 13 April 2010).

> *'Some use ICT and others not because they ask other people to do things for them. For those that use ICT often, they normally come to the laboratory and check things on the Internet, print out and give the printout to the kids'* (Technician C, 16 April 2010).

From the quantitative data it could be concluded that the attitude towards ICT use was low. Through the interview responses a negative attitude was also detected in Principal A's response. The low use of ICT could be attributed to the negative attitude of some science teachers. For some who were confident in using ICT, the attitude had changed. For those who did not know how to use ICT, they repeatedly asked for assistance from their fellow colleagues. Currently, their attitude is said to be negative.

ICT infrastructure

The interviewees were asked to state the number of computers available in their schools, including those the schools had bought and those donated. The principals also related the procedure for maintenance and the procedure to be followed to get their schools connected to the Internet:

Table 6. 30: Response of principals to the number of computers per school

Principal	No of computers available at the school
A	27
B	26
C	26

The supply of computers to schools from the Ministry of Education seemed consistent across all schools. Every school had been provided with 20 computers, irrespective of the number of students per school. The quantitative findings suggest that ICT infrastructure is in the medium range, because some schools managed to acquire more computers by purchasing some, or offered as a donation from *School-net Namibia*. However, during the time of the data collection, most computers from *School-net Namibia* were 'dumped' on the floor and appeared not to be in use. Some schools bought a number of computers, according to the principals' response:

> *'We have six (6) computers which we acquired in 2004 from School-net and their system is different. They use Linux* (Principal A, 12 April 2010).

> *Mmm, the ones that are in the computer lab, were donated to us by the ministry whereas the ones that we have in the offices, we bought out of the school development fund. The ones in the staff room were donated to us by School-net* (Principal B, 13 April, 2010).

The principals' responses to the way in which the computers were acquired can be interpreted to mean that the principals kept good records of their acquisition. From the observation notes, each computer was placed on its desk with a chair. In all the schools observed, the learners would rush to the computer laboratory for a lesson in order to try and choose a fellow learner of the same sex with whom to share a chair. Thus, two learners were forced to share a chair, creating discomfort in the learning environment for some learners, an also inconvenience when trying to write down notes. In addition, the boys dominated the girls and tried to do all the activities given to them in class.

The computers acquired through donations from School-net Namibia had a Linux operating system built in. The condition was that no proprietary software is to be used on those computers. Thus, excluding MS programme to be installed onto the same computers. All software on these machine are said to be free of charge. After the acquisition it is imperative that the computers be maintained. The principals explained the procedure followed to maintain them should breakage occur. The computers acquired from the Ministry of Education follow a maintenance procedure different from the one for self-acquired computers. The principals comments were:

> *'When it comes to the ones that we bought ourselves, we are maintaining them. And the ones that were donated by School-net, when they break...[we] take to their branch in Ondangwa for their technician to repair them. Fortunately this one from the ministry up to now did not have any breakage… We consult the people from where we bought them. We take them to those people and they repair them when they have breakage and they install a software if there is a need to install and then we pay for the service'* (Principal B, 13 April, 2010).

> *'The computer practice teachers are the ones to always attend to the computers. If the problem is beyond their knowledge, then we call in someone from outside…Yes, someone that we pay but there is also a gentleman from the Ministry's side but more often you call him and he does not help you much because he also does not know… He does not come a lot. It is very difficult for him to come. For example,*

> *this year, we tried to call him but he did not come'* (Principal C, 15 April, 2010).

On the same question about how the computers should be maintained, Technicians A and B had set up basic rules to which the users had to adhere:

> *'Mhh…we have basic rules that guide us through the use of computers. We make sure that they are all well looked after by al the users…everyone who uses them. The rules are just there to just basically to encourage people to use the computers in a good way'* .(Technician A, 13 April 2010).

> *'We make sure that they are in a good …[laugh]…condition. They are clean. We keep them away from dust'* (Technician B, 13 April 2010).

Technician C somehow felt that the regional technician should do the maintenance for his school:

> '*Mh..We do not have a technician. I understand we have a [regional] technician in Ondangwa but he does not come here. It is only this girl who is a volunteer who try to fix some of them'* (Technician C, 16 April 2010).

From the data, it is evident that in addition to what the Ministry of Education does to maintain the computers deployed to schools, two of the three had taken the initiative to do the basic maintenance. As stated by all the principals, the regional technicians did not respond punctually to technical problems, making it difficult for the teachers to teach using ICT.

From the observation notes, some of the computers, especially those donated by *School-net,* were put on the floor as they could not be repaired and occupied large space in the computer laboratories. Other ICT, such as the television, were kept in the library and the DSTV donated by *Multichoice Namibia* was said to be not working, as the reception was weak during certain sometimes of the day.

From the findings, it was evident that the maintenance of computers was fragmented. The Ministry of Education had put in place the structure for maintenance at regional level, which was not efficient. Despite several calls from the schools, the technician did not come, probably for reasons suggested by Principal C:

> *'…overloaded because he is the only one in the whole region. You call him and he is always telling you that he is at another school. It is difficult to see him'* (Principal C, 15 April, 2010).

It also appears that the technician did not have a designated car allocated to him for these functions. Again Principal C said:

> '*He will always cite problems such as transport'*
> (Principal C, 15 April, 2010).

The computers purchased by the school were serviced by the supplier for a fee, implying that only schools with a good financial standing of the school development fund could use them. Schools that were unable to generate income for their school development fund may not be able to maintain their computers. This is prevalent in cases where the computers are donated and the agreement between the donor and the school does not include a servicing plan. These projects are doomed to fail (Thomas, 2007). Matengu (2006) noted that computers donated by *School-net Namibia* were broken and had not been repaired in some schools, specifically Katima Mulilo and Windhoek areas. Matengu (2006) noticed that out of 25 computers from *School-net* only two were working for a period of six months. Matengu (2006) therefore had doubts that these would be repaired. The breakage was also mentioned but how long the technician would take to repair them was not pursued.

This study also argues that the idea of using computer teachers to do the troubleshooting was short-lived. One questions their troubleshooting skills and the time it takes to detect and repair the computers. In the event that the computer teachers are used, it is likely that they may also aggravate the problem and cause more damage. Again, technicians from outside companies are used to repair at a fee should teachers fail. Schools with low income in the school development fund will still not manage. Kennisnet (2008) advocates that the obsolete computers be replaced, something that is unlikely to happen in the near future in Namibia, given the National ICT Project Budget and the extent to which the implementation process is moving.

In the effort to enhance teaching and learning, the Ministry of Education has provided Internet connection to some schools. The findings of this study show that only one of the schools has Internet through the Ministry of Education ICT project. Principal B had acquired a 3G device for which the school paid N$ 500.

> *'Those ones we bought a 3G but it's not always in use, we just bought it to update our Anti-virus. And if the teacher wants to use Internet then they just use the 3G but not always.'* (Technician B, 13 April 2010).

> *'Yes we have [Internet]. Yes, it is cheap. It is a flat rate of N$ 500.00 per month. It is within the school's affordability.'* (Principal C, 15 April, 2010).

From the data it is evident that only a few schools are connected to the Internet. For example, Principal A responded to one of the questions by saying they had had computers since 2004, from *School-net*, though it was not clear why the school did not have the Internet up to that time. Principal C had also had computers for a considerable time, but already the school was connected to the Internet. The question arises as to what parameters determine connectivity to the Internet. According to Howie et al. (2005), governments internationally are aware of potential unequal access to technologies. There were substantial differences noted in quality and functioning of ICT equipment between schools.

With regard to Internet connectivity, only two schools were connected, Schools B and School C, the former having acquired it through a 3G connection that the school was paying for. School C had acquired Internet connectivity through the Ministry of Education ICT project. School A had not been connected. From the data, School B had taken an initiative to be connected to the Internet to upload anti-virus for protection of their computers. Protection against viruses will increase the durability of the computers and allow teachers and students to use them for a longer time. As with School A, it can be assumed that School B was ready to access the Internet via the Ministry of Education project, although it was not known how far they were in the queue.

Use of ICT

The frequency of ICT use was sought to determine if indeed teachers used it to enhance their teaching and learning of science. The principals used ICT mainly for administrative work. All principals used ICT to write reports of principals; trimester; dropout and financial. In addition, the principals wrote letters to parents. When asked what principals used ICT for, Principal C responded:

> *'Like now, we are approaching towards the end of the term. I have to compile the reports: the principal report, the trimester report, dropouts report, and the financial report. I have to make use of the computer to prepare report being required by the inspector of education or maybe by the region. Then I also use to write letters to the parents where I inform them as how much they should pay for the examination, how much for the next term, hostel fees, school development fund, hostel development fund they need all those information'* (Principal B, 13 April, 2010).

From the quantitative data, it is evident that ICT use by principals was low. This contradicts the quantitative finding which suggests that ICT use by principals was medium. It appeared that the principals use *MS Word* most of the time to write reports. The principals hardly used other *MS* programmes, although they mentioned reports such as hostel fees and a hostel development fund that may require the use of *Excel*. The Kennisnet (2008) reported that the most highly used software was practice programmes, followed by *MS Word*, and finding information on the Internet.

A study by Kennisnet (2008) found that the managers in Dutch secondary schools use ICT about 13-18 hours a week. Of South African schools that participated in SITES M2, about 4/5 (80%) were found to be using them increasingly for monitoring and school administration, providing routine work for school administrations. The South African principals worried more about how their schools could gain maximum benefit from using computers and less about preparation time (Howie, et al. 2005; Thomas, 2006). Instead, the principals wanted to be shown how to encourage teachers in order to increase participation in the use ICT, and how they, their pedagogy and students' learning could benefit from computer use.

Collaboration

The principals and technicians commented on whether they allowed community members to use their ICT facilities, and also on the gains generated from them. Both the principals and the technicians responded that they did not allow community members to make use of their facilities. They cited reasons such as lack of time and the non-promotion of the idea to allow community members to use the facilities at the expense of learners and teachers. The principal and the ICT technician comments were:

> *'We wanted to and also make a little bit of money there… but the problem is the time. It is clashing with our timetable. There are so many teachers who want to use the computers and our learners are also keen to learn. So for the time being, they are out now'* (Principal A, 12 April 2010).

> *'… normally we do but now we are no more doing it because I'm also studying and I don't have time to train them. They only used to come and get training… Yes they used to pay a N$100.00 per month'* (Technician B, 13 April 2010).

From the data, it is evident that collaboration with the community is possible, depending on the availability of the technician and also pending the decision of the school board. However, from the quantitative data, the principals indicated that collaboration was high. This type of collaboration refers to that of teachers within the schools. In addition, collaboration with the communities seemed possible, To cover training in basic computer at a fee which will be used to pay for other expenses, such as maintenance of computers and purchase of toner for the printers, and also to pay for the Internet, as stated by the two technicians:

> *'The benefit would be that the school can make some income for them even though it is not allowed. The school can use this money for maintenance, even to buy toner.' (Technician A, 13 April 2010).*

> *'It goes to the school fund; I don't know but they normally we used to pay N$300.00 for internet' (Technician B, 13 April 2010).*

From the data, the availability of ICT at schools could generate money for the schools, to be used for items that are costly, such as buying toner and paying for the maintenance of the ICT, should the regional technician not turn up on time to do the repairs. The fund-raising sounded justifiable in the absence of ways the Ministry of education would supply the school with toner, and also because the schools had to pay some fees for the Internet per month. This study did not examine how schools could best raise money to sustain these expenditures.
As to who decides on issues of collaboration with the community, the principals mentioned the school board:

> *'The school-board comes in because we have to inform them, they are our supervisor otherwise if something happens to our computers by the community members and we don't inform them then they may say 'no but we the community people are not using the computers'. Therefore we make it a point that we inform them so that they know about the community people using our computers' (Principal B, 13 April, 2010).*

> *'The school management. These are day to day issues, so the school board does not really get involved' (Principal C, 15 April, 2010).*

From the data it is clear that the school board decided on issues of collaboration. The school management was responsible for the day-to-day ICT implementation. The structure and rationale for reporting were explained in the subsection of Vision and Leadership, and the collaboration between schools has been observed. During the observation period at School A, the secretary from a nearby school was observed typing question papers for examinations at their school. However, collaboration between science teachers through ICT was, non-existent possibly due to lack of resources to create online communities and also because the schools had limited time within which to use ICT.

Technical support

The principals were asked about the technical support rendered to them and the school at large. Two principals expressed their satisfaction with the technical support established at their school. Principal C stated that:

> *'It is not good, sometimes you sit for the whole week or whole month without computers and you do not know what to do and you do not know who to contact. Some of the computers are pre-programmed in Windhoek and also all the people who did it are in Windhoek. Sometimes it is not the same as having a person on site. I still feel a lot needs to be done… We do not have a technician per se, only teachers who are teaching the subject help where they can. If they can't, we call a gentleman from the region, Ondangwa and sometimes we call the head office. What they do is give instructions over the phone if there is something that can be done' (Principal C, 15 April, 2010).*

From the data it can be concluded that the support system in general is not in place. This finding confirms the quantitative finding on low technical support. The principals rely on the little expertise of the technicians to fix the computers. Since the technicians are also full time teachers, they have only limited time within which to do troubleshooting or software-related supports. The technicians are also making an effort to ensure that an effective system is in place, for example, by trying to teach the school secretary how to trouble shoot, as related by Technician A:

> *'I normally try and teach the school secretary so that when I am not available at least he can do the job. I normally teach him most of the basic trouble shooting. I am also just available during break or when I am off. I can just help anytime' (Technician A, 13 April 2010).*

Sometimes these problems intensify to an extent that the technicians have to leave their class to attend to a problem considered urgent. Technician C explained:

> *'They normally call me. There's a time table for the subject I teach and I also have to attend to my lessons. So, I can only help them when I am free. But if anything urgent comes up then, I have to leave my class… After hours, I also help them when I am free. Like the secretary calls me to help her but if it is something urgent then that means I have to leave my class and help her out' (Technician C, 16 April 2010).*

From the data it appears that the technical support at both schools is complicated because the technicians who attend to technically related problems are also full-time teachers. It is expected that they prioritise their duties before embarking on their voluntary activities. Should the technical fault occur in the middle of a lesson by a science teacher, it is only dependant on the technician to judge whether to continue teaching his lesson or go to help out with the crisis. The idea of training the administrative assistant would be ideal, depending on whether he was also not too busy for him to do extra jobs outside his job description. A problem would arise if the administrative assistant or the teacher broke the devices beyond repair, begging the question of who was to blame or hold liable for the damage caused, when both parties were not formally assigned to do troubleshooting. Beyond that, schools are depended on the technicians assigned to their respective educational regions, who are not responsive on time. Principal C though much needed to be done in order to get a timely response during a crisis.

Pedagogical support

Principals were asked to comment on the pedagogical support at their schools. When asked about pedagogical support that is taking place at their respective school, Principal C said:

> *'You find that teachers who are more knowledgeable about computers help others by showing them all that needs to be done' (Principal C, 15 April, 2010).*

From the responses, all principals agreed that there was pedagogical support amongst teachers. The more skilled in ICT do assist others. This response is only applicable to a small sample of case participating schools. However, this contradicts the quantitative response on the same issue. The majority of the respondents through the survey indicated that pedagogical support was low. It can be interpreted that the assistance is more of a technical nature than it is pedagogical, for example, entering marks and preparation of report cards. As argued above, understanding the concept of integration is nonexistent; it therefore becomes difficult to render pedagogical support to other teachers.

6.7 Conclusion

In conclusion of this chapter, the quantitative as well as the qualitative findings are presented in Sections 6.2 and 6.3 respectively. The qualitative findings are presented in Section 6.4. Findings from Pearson's correlation suggest that there was a strong relationship between support and collaboration by the principals and digital learning materials. There is a strong relationship between leadership and the vision of the principals as well as curriculum goals as perceived by the science teachers. There is also a strong relationship between the vision of the principal and collaboration and curriculum goals as perceived by the science teachers. These findings have been interpreted that both the principals and the science teachers are likely to agree on the statements made about those constructs. The regression analysis suggests that constructs that were found to be significant in the model were leadership of the principals, expertise as well as general use of ICT by the science teachers. The regression findings suggest that for every increase in the significant construct, the pedagogical use of ICT also increases. From the case studies, science teachers use ICT for administrative purposes. The science teachers have indicated that they use ICT for lesson preparation, to write documents, and to develop timetables. In the interviews, some science teachers indicated that their work was made easy with the introduction of ICT in their respective schools. These findings were validated by participants in the ICT use conference presented in Chapter 7.

CHAPTER 7

ICT USE CONFERENCE FINDINGS

This chapter presents the ICT use conference findings as obtained for purposes of deliberation, verification and legitimisation. Section 7.1 presents an introduction to the Chapter. Findings as negotiated during the ICT conference are presented in Section 7.2 before the conclusion in Section 7.3.

7.1 Introduction

This section presents findings on the ICT use conference findings, the aim of which was to '*legitimise*' the findings of this study. The conference design, instruments development, population and sample, and the analysis applied of the ICT use conference were presented in Chapter 4. As explained earlier, the ICT use conference invited representatives of key stakeholders to discuss the findings from the perspectives of 'do they recognise the findings as being indeed reflecting the context of the rural Namibian schools'?, and to discuss at the ICT use conference on the basis of two exercises what would be appropriate measures or actions to be taken by stakeholders such as the Ministry of Education and regional education authorities and/or at school level to address problems and issues that have been identified through this research.

The notion behind the ICT use conference methodology was to share information with stakeholders, again with the aim of legitimising the findings (Mulder, 1994). The documents shared with the stakeholders contained the main issues to be clarified during the conference, the description of the context of ICT implementation in rural areas, and the preliminary findings of this study as presented in Chapters five and six respectively. The presentation at the beginning of the conference covered the introduction to the study, aims and objectives, context, research questions, conceptual framework and preliminary findings. The presentation highlighted the dependent and independent variables so that when the participants performed exercise two, they would reflect on them. The exercises were presented before the preliminary findings for research questions one and two respectively. Exercise 1 comprised the questionnaire on preliminary findings, asking the participants to tick the most appropriate answer. Exercise 2 requested the participants to draw pictures illustrating the relationships that exist between the factors (*Appendix N*). Finally, the participants were given a chance to deliberate on how to improve ICT implementation in the rural schools. The deliberations were recorded in order to capture the consensus reached or the interactions in case of different opinions. Before the conference, the researcher developed rules to determine the final decisions. The decision was based on the mode of the highest frequency count for all statements per construct (see Section 4.4). The mode would determine the decision. The background information of the school principals, science teachers and ICT technicians are presented below.

The ICT use conference was attended by the representatives from the key stakeholders in ICT in Education in Namibia, such as the National ICT Coordinator who acted as a presenter for the outcomes of the exercises to verify the findings; the principals, science teachers and the ICT technicians from three schools, and the researcher who acted as the facilitator of the workshop and the presenter of the preliminary findings of this study, to verify and legitimise the findings. The principals, science teachers and the ICT technicians were drawn from schools in areas within at least a 100 kilometres of the conference venue which was held at UNAM Oshakati campus. These schools had scored high in the survey, indicating that they had ICT and that they had been implementing ICT for at least two years. The characteristics of the respondents are described in Table 7.1 below.

Table 7. 1: Characteristics of the school principals, science teachers and ICT technicians

	School P	School Q	School R
Principals			
Age	45	50	34
Training	Bed	BA, PGDE	BEd.
No of years as principal at that school	10	5	4
Science teachers			
Age	25	32	32
Training	BETD	BEd	Bed
No of years as teachers	5	3	7
ICT technician			
Age	30	25	42
Training	BETD	No formal training	Bed
No of years as ICT technician	7	3	10
Teaching subjects	Biology	Compute r studies	Computer studies

Table 7.1 above shows that the principals' age ranged between 34 and 50. Two had Bachelors of Education (Bed) degrees and one had a post graduate qualification in education, (PDGE), with more than four years of experience as principals of their respective schools. The science teachers' age ranged between 25 and 32, with two having a BEd and one a BETD teaching qualifications. The science teachers had more than three years of teaching experience. The ICT technicians' ages ranged between 25 and 42, with two having teaching qualifications, BETD and BEd and one being an 'unqualified teachers', that is, without a teaching qualification. The number of years of teaching ranged between three (for with the unqualified teacher) and seven and ten (for the other two teachers). Two of the ICT technicians taught Computer Studies whilst the third ICT technician taught Biology. In addition, the National ICT Coordinator had years of experience in that position and was a professional IT technician. This information is presented to provide a better insight into the findings of the ICT use conference.

This section presents findings from the ICT use conference. The results are presented in two parts. Section 7.2.1 presents findings on description of ICT implementation in science classroom and rural schools. Section 7.2.2 presents findings on affecting ICT implementation. The findings of the ICT use conference are presented in a descriptive mode. Finally, a summary of the negotiated findings are presented in Section 7.2.3.

7.2. Conference participants' perceptions' of ICT implementation in rural schools

This sub-section presents the legitimate findings for research question two on how ICT is being implemented in science classrooms. The participants were asked to reply to the statement about their own schools. An additional column was added to show the stance of the participants. However, where the participants differed on statements for their school, it is indicated in the scores as well as the discussions. Each statement is presented with a conclusion. The responses are reported in the tables below.

ICT infrastructure

The participants were asked to indicate if they agreed with the statements asking them about the extent of supply and maintenance of ICT infrastructure in rural schools.

Table 7. 2: ICT conference findings on ICT infrastructure

Statements	N	Strongly agree (n)	Agree (n)	Disagree (n)	Strongly disagree (n)	Conclusion for construct (n)
There is sufficient number of computers available.	10	0	2	5	3	**Disagree**
Computers at our schools are well maintained.	10	0	2	5	3	**Disagree**
My school has bought additional computers	10	0	1	6	3	**Disagree**
Total	**30**	**0**	**5**	**16**	**9**	

The table suggests that the participants disagreed that there were sufficient computers and that they were well maintained in all the junior secondary schools in the three educational regions.

Digital learning materials

The participants were asked to comment on whether the rural schools invested money in buying digital learning materials and whether the materials made available to them were relevant. In addition, the respondents were asked to indicate if they possessed skills that would enable them to use the said digital learning materials. The findings were as follows:

Table 7. 3: ICT conference findings on Digital learning materials

Statement	N	Very sufficient (n)	Rather sufficient (n)	Somewhat sufficient (n)	Not sufficient at all (n)	Conclusion on construct
Our school has invested into buying software for teaching	10	0	2	3	5	**Somewhat sufficient**
Statements	**N**	**Very relevant (n)**	**Rather relevant (n)**	**Somewhat relevant (n)**	**Not relevant at all (n)**	**Somewhat relevant**
The digital materials we have at our school are relevant for teaching science.	10	1	2	7	0	
Statement	**N**	**Strongly agree (n)**	**Agree (n)**	**Disagree (n)**	**Strongly disagree (n)**	**Disagree**
I possess skills that will enable me to use the digital learning material available at my school.	10	1	2	7	0	
Total	**30**	**2**	**6**	**17**	**5**	**0**

The results on digital learning materials suggest that some schools invested in buying software and that the software was somewhat relevant. Science teachers also disagreed that they possess some skills that would enable them to teach using the software.

Expertise

The participants were asked to rate the extent to which the teachers, principals and ICT technicians had relevant expertise and portray a positive attitude towards ICT use. The response was as follows:

Table 7. 4: ICT conference findings on Expertise

Statements	N	Very relevant (n)	Rather relevant (n)	Somewhat relevant (n)	Not relevant at all (n)	Decision on construct
I have relevant knowledge in ICT	10	2	0	8	0	**Somewhat relevant**
I have relevant skills in ICT to teach/assist colleagues.	10	2	4	4	0	**Rather relevant**
		Strongly agree (n)	**Agree (n)**	**Disagree (n)**	**Strongly disagree (n)**	
Science teachers at my school possess the right attitude to use ICT.	10	2	4	3	1	**Agree**
Total	**30**	**6**	**8**	**15**	**1**	

The responses on digital learning materials suggest that the knowledge of ICT of principals, science teachers and ICT technicians was somewhat relevant. The participants also suggested that they had rather relevant skills to integrate ICT or to assist other colleagues. The participants also agreed that the science teachers at their school possess the right attitude to ICT use.

Vision and leadership

The participants were asked to indicate whether their schools had a vision statement that reflected and encouraged ICT-related activities in the schools. The responses were as follows:

Table 7. 5: ICT conference findings on vision and leadership

Statements	N	Strongly agree (n)	Agree (n)	Disagree (n)	Strongly disagree (n)	Conclusion
Our school has a vision statement with regard to ICT.	10	2	3	5	0	**Agree**
Our school leadership is very active in all ICT related matters.	10	2	5	3	0	**Agree**
Statements	**N**	**Very much encouraging**	**Rather Encouraging**	**Somewhat encouraging**	**Not at all encouraging**	
Our school's vision encourages the use of ICT in class.	10	3	4	3	0	**Rather encouraging**
Our school's vision encourages teachers to use ICT.	10	3	5	2	0	**Rather encouraging**
Total	**40**	**10**	**17**	**13**	**0**	

The results on vision and leadership suggest that half of the schools had vision statements. The school leadership was also very active in all ICT-related matters, and the participants indicated that their schools' vision rather encouraged ICT use in class. Both scales expressed agreement on a 4-point scale and can be seen as similar. The survey had a small number of participants and the findings are used in an indicative way and not generalised to the population. The same reason is applicable to tables with a similar phenomenon.

Collaboration and support

The participants were asked to rate the statements describing the collaboration on ICT between schools and at circuit level and to rate the level of support made available to teachers. The responses were as follows:

Table 7. 6: ICT conference findings on Collaboration and support

Collaboration	Statements	N	Strongly agree	Agree	Disagree	Strongly disagree	Decision on construct
	Our school collaborates with other schools on ICT related matters	10	0	4	6	0	**Disagree**
	I collaborate with other teachers in my circuit on ICT related matters	10	0	4	6	0	**Disagree**
	I belong to a teachers' online forum.	10	0	0	6	4	**Disagree**
Total		**30**	**0**	**8**	**18**	**4**	

Support	Statements	N	Very much	A little	Somewhat	Not at all	Decision
	I receive/render necessary technical support on time.	10	0	2	6	2	**Somewhat**
	I receive/render the necessary pedagogical support on time.	10	0	3	5	2	**Somewhat**
Total		**20**	**0**	**5**	**11**	**4**	

The results with regard to collaboration suggest that there was none between schools within the same circuit or online forum for teachers on ICT-related matters. The technical and pedagogical support that the science teachers received was somewhat sufficient.

Professional development

The participants were asked to rate the extent to which professional development was offered with regard to skills acquisition and also on integration of ICT. The responses were as follows:

Table 7. 7: ICT conference findings on professional development

Statements	N	Strongly agree (n)	Agree (n)	Disagree (n)	Strongly disagree (n)	Conclusion on construct
I have been trained in ICT.	10	0	7	0	3	**Disagree**
I have been trained in ICT integration.	10	0	2	5	0	**Disagree**

Statements	N	Strongly agree (n)	Agree (n)	Disagree (n)	Strongly disagree (n)	Conclusion on construct
The training I received was relevant for teaching science.	10	0	2	4	4	**Disagree**
Total	**30**	**0**	**11**	**9**	**10**	

The respondents disagree that professional development was provided, particularly with regard to integration and also the relevance of ICT.

7.3 Conference participants' views about factors affecting ICT implementation

This section presents the negotiated findings on factors affecting ICT implementation in rural schools. The negotiated findings are presented in two parts: 1) list of factors in order of importance, the how factors link to each others, and 2) the suggestions.

The participants were asked to rate the order of importance of the constructs illustrated in the conceptual framework (Chapter 3) of this study. The respondents were reminded to think of the factors they thought would be dependent and independent and link these accordingly. Space was also provided in the questionnaire in case the participants had more factors that did not appear in the list provided. The results were as follows:

Table 7. 8: Findings on factors affecting ICT implementation

Factors	N	Very important	Rather important	Somewhat important	Not important	Conclusion
Vision and leadership	10	10	0	0	0	**Very important**
Collaboration	10	5	5	0	0	**Rather important**
Pedagogical Support	10	8	2	0	0	**Very important**
Technical support	10	8	2	0	0	**Very important**
ICT infrastructure	10	10	0	0	0	**Very important**
Professional development	10	10	0	0	0	**Very important**
Digital learning materials	10	8	2	0	0	**Very important**
Knowledge, attitude and skills	10	8	2	0	0	**Very important**
Pedagogical use of ICT	10	5	5	0	0	**Rather important**
ICT use in general	10	10	0	0	0	**Very important**
Total	**100**	**82**	**18**	**0**	**0**	

The results in the table above suggest that most of the factors listed in the conceptual framework of this study were rated by the participants as very important. However, half expressed that collaboration and pedagogical use of ICT were rather important. The participants deliberate on the importance of the two constructs based on the effort and the acquisition of the basic needs for the schools. Some schools indicated that they were very much challenged by the sustainability of pedagogical use of ICT, given that they had less infrastructure, less time to finish the syllabus and few skilled science teachers. With regard to collaboration, half the participants said that collaboration was also rather important for science teachers to share knowledge and skills on ICT use, but that they would have liked more ICT training to be conducted so that more science teachers would be skilled before collaborative activities were taken on by the Ministry of Education. Overall, the finding suggests that the factors are very important. The respondents did not come up with any new factors.

Linking of factors

After the participants listed the factors accordingly, they were asked to link them in a way they saw as affect ICT implementation. In this exercise, two groups were formed each consisting of five participants. Group 1 consisted of one Principal, one ICT technician, the National ICT Coordinator and two science teachers. Group 2 consisted of two principals, two ICT technicians and one science teacher. The groups provided different answers as presented below:

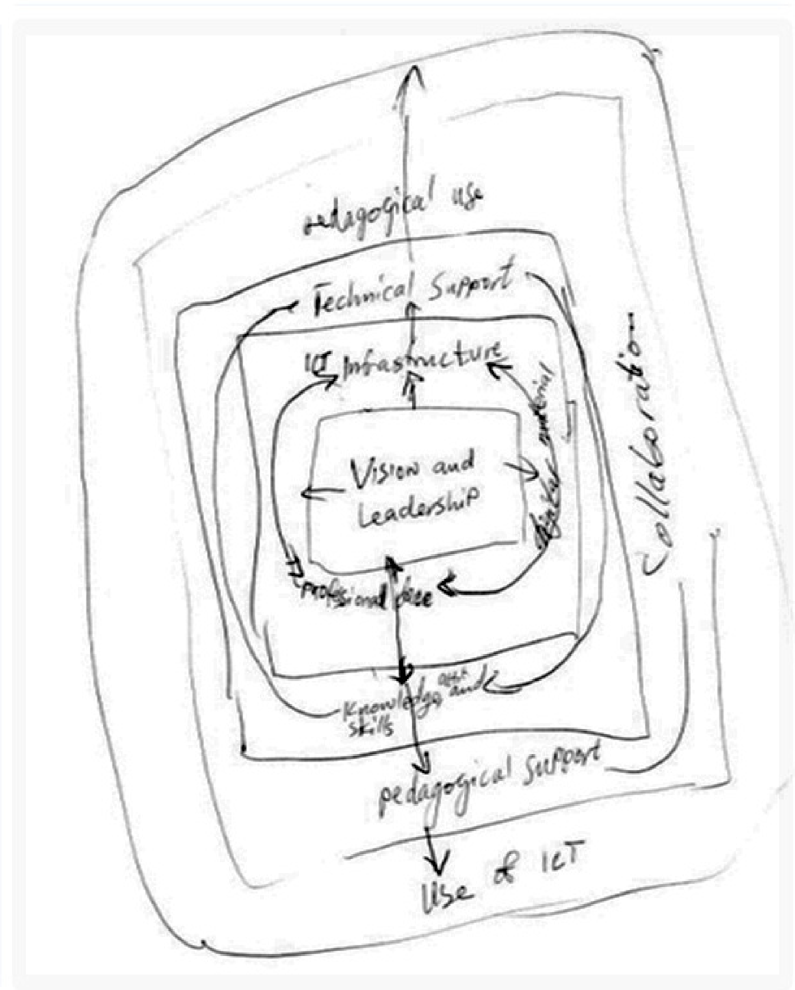


Figure 7. 1: Link of factors by group 1

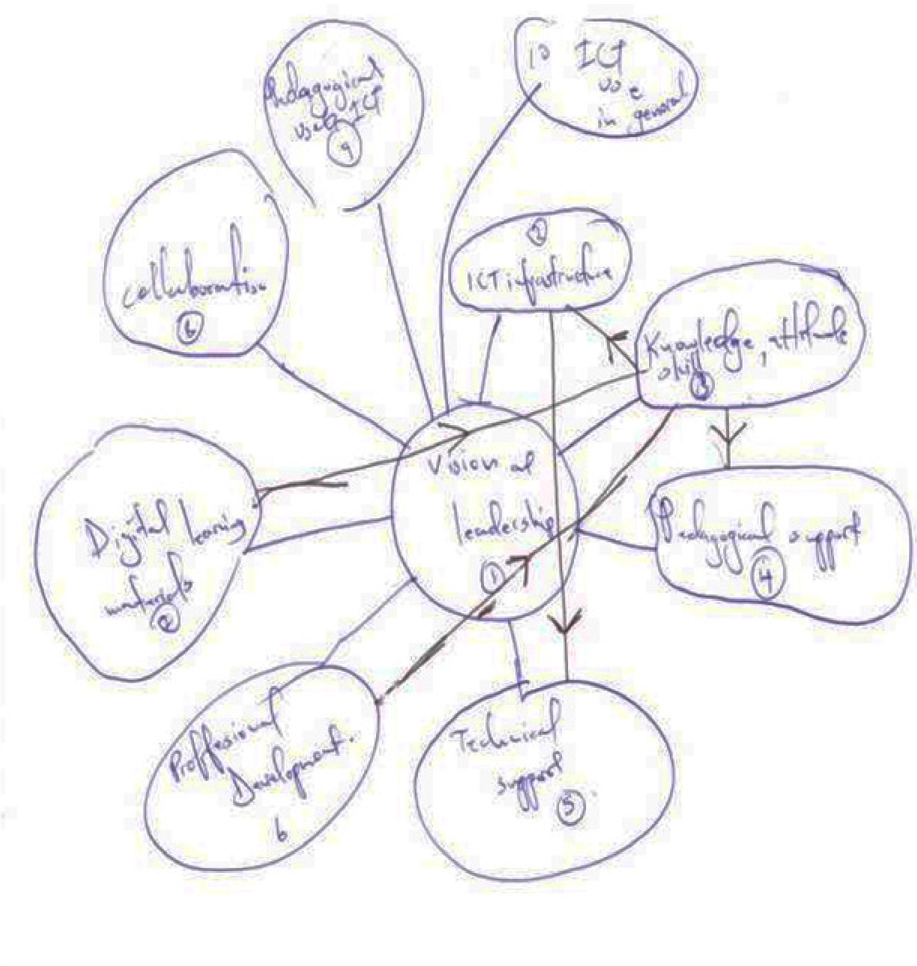


Figure 7. 2: Linking of factors by Group 2

Both figures 1 and 2 (above) show that the vision and leadership is seen as core to the implementation of ICT and may influence other actors positively or negatively. These figures suggest that all other factors are dependent on the vision and leadership of the school. Group 2 numbered the factors in terms of importance and how they linked to each other.

Suggestions from the participants

As the final activity of the curriculum conference, the participants were asked to provide suggestions they think should be considered in the effort to improve the implementation of ICT in rural schools. The suggestions were provided per construct as follows:

Leadership

When asked to make suggestions about the vision and leadership, the participants made the following comments:

> *'The leadership should remain strong. The principals are eager to have the ICDL Computer programme introduced to their schools. The leadership would like to have their learners and teachers become ICT literate by 2030. The leadership must therefore encourage the teachers and learners to use ICT' (Principal R, 02 July 2010).*

> *'On a national level, I think the whole issue of ICT should be reviewed. I find it to be very understaffed at national level as a result, the regions are becoming increasingly frustrated because they feel that there is no constant and continued flow of information… so improved relation between the head office and regional offices is needed' (ICT National Coordinator, 02 July 2010).*

> *'Are schools at liberty to develop their own ICT policy that will guide their operations? Should the schools have guidelines, they will be able to generate their own income for as long as it is properly managed' (ICT National Coordinator, 02 July 2010).*

This statement raised an argument as Principal 'C' does not know whether it is allowed to generate income for the school that will be used towards ICT activities. Principal C comments furiously:

> *'I am not so sure if schools are allowed to generate their own income by letting the community members use their facilities...sometimes we are being told that it is not allowed ...things are just not clear for us…' (Principal R, 02 July 2010).*

In an attempt to reach a consensus, Principal 'A' comments:

'Schools can have internal policies and with that, one can be protected...' (Principal, P, 02 July 2010).

From the data, it appears that the participants are of the opinion that the school leadership is responsible for taking the lead in the implementation of ICT. The conference participating schools have shown willingness to take part in the ICT project and the school leadership encourages teachers and learners to use ICT effectively. However, there were a number of ambiguities within the National ICT policy as well as other policies that may affect the implementation of ICT in schools. The participants referred to ambiguities such as inconsistency within the different education-related policies with regard to generating income for the school, and the mandate of the school leadership. The ICT National Coordinator is therefore calling for a review of the National ICT policy.

Collaboration

The participants also commented on the issue of collaboration within and between schools circuit as well as the region in general. The participants had the following comments:

'The fact that collaboration is not there, is due to the fact not all schools have the ICT infrastructure. Let us say, in a circuit of 30 schools for example, and only one school has computers. With whom are you going to collaborate? However, principals must do their level best to collaborate with other schools regardless of their schools being in the same circuit or same region so that the flow of skills can be increased from one school to the other' (Principal, R, 02 July 2010).

'Schools must find sister schools which are well established and link up, that is, schools with well established ICT and partner with them. There are still schools that do not have guidelines on how to use computers...but with a partner school, guidelines could be developed

on how to come up with guidelines, how to best use computers labs, and how to best share the limited resources available. Say for example, the other party comes to another school on a Tuesday afternoon to show teachers how certain activities are performed. It is practical and it does not cost you money...' (ICT National Coordinator, 02 July 2010).

In addition, Technician Q stated:

'There is need to enhance ICT use within our school. Very few teachers possess knowledge and skills in ICT….they need to be encouraged to transfer skills to more teachers' (ICT technician Q, 02 July 2010).

From the data, two suggestions have been made, namely to foster strong links within and between schools in the same circuit, intra-regional and inter-regional collaboration in order to share resources and ensure skills transfer from one school to the next.

Pedagogical support

In terms of pedagogical support, one suggestion was made.

'For effective use of ICT in teaching, why can't we have advisory teachers for ICT at the regional level?' (Science teacher Q, 02 July 2010).

It appears that the participants are not exposed to advanced ICT skills and knowledge in order for them to make demands that are reasonable.

Technical support

In terms of technical support, the participants made remarks such as:

'It will not work with only one technician per region. I think technicians must be appointed to each and every school so that technical support is provided on time should any faults occur...it is not good to hear that the technician is somewhere else every time you need him. It will delay the use of ICT' Teacher A, 02 July 2010).

> *'If appointing technicians per school is too much...Maybe technicians should be appointed per circuit'* (Principal R, 02 July 2010).

> *'Finance will always be an issue. We can't even appoint teachers at all our schools...so appointing technicians may not be possible but it will be a matter of training the ICT focal person at each school and that should be rolled out from the head office level. Thus, maybe increasing capacity at circuit level...'* (ICT National Coordinator, 02 July 2010).

> *'In terms of technical support, I think the government should look into recruiting volunteers from other countries in order for them to come assist...' (*Principal Q, 02 July 2010).

The participants suggest that ICT technicians be appointed at circuit level to ensure that the schools receive professional service on time. Appointment of technicians may take a long time before being considered since the Ministry of Education is struggling even to appoint teachers. Another suggestion to appoint volunteers from other countries to render technical support might also work.

Professional development

The participants made suggestions on improving professional development as follows:

> *'I think teachers should be trained at colleges because at schools, teachers hardly have time'* (Principal P, 02 July 2010).

> *'The colleges must have a computer course that is compulsory for all...but also the government must make sure that it supplies schools with infrastructure'* (Science teacher P, 02 July 2010*).*

> *'Right now at UNAM, computer is compulsory but it is not sufficient. It can also not be sufficient because [as a student] you have other subjects but then more training on integration of ICT needs to be taught'* (Science teacher R, 02 July 201).

The conference recommended that both principals and teachers be trained in ICT. The teachers must be trained at the teacher training institutions to ensure that upon appointment, they have the necessary skills to perform duties using ICT. In addition, the principals must also be trained in ICT to ensure effective supervision and guidance with regard to ICT implementation in schools.

Expertise

Suggestions with respect to knowledge, attitude and skills, the comments were as follows:

> *'You find that at times the teachers had knowledge in ICT but because he or she was placed at a school without ICT, she forgets'* (Science teacher P, 02 July 2010).

> *'The school leadership should encourage the teachers' attitude to change in a more positive way...to integrate ICT in their daily lessons...and to use internet more'* (Principal R, 02 July 2010).

The participants did not have concrete suggestions about knowledge, attitude and skills, rather, the comments were more general towards encouraging ICT use and subsequently changing the attitude of the teachers. However, the level of expertise amongst the science teachers may increase with the increase in professional development. The outcome of such training and the provision of ICT to schools may influence the science teachers' attitude more positively.

Digital learning materials

The participants' suggestions on digital learning materials were as follows:

> *'We need money to buy the materials' (*Science teacher P, 02 July 2010).

> *'We are not aware that Namcol is training teachers to develop software for use in teaching subjects'* (Principal R, 02 July 2010).

> *'It is important that the teachers are supported with educational software that align to the curriculum goals....and more so, the curriculum should be clear on how certain topics are to be taught using ICT'* (Science teacher Q, 02 July 2010).

From the data, the schools must be given more money to buy their own software, though the types and use were not specified. It may be interpreted from this that the knowledge about software is limited and they do not know what is available in the market. In addition, the participants were not informed about the development being pursued about content development courses at Namcol. The acquisition of digital learning software must be in line with science curriculum goals.

ICT infrastructure

With regard to ICT infrastructure, the participants suggested that the principals must make sure that the schools were equipped with ICT. In order to do so, the principals must be trained on a course that raises awareness about the importance and use of ICT. For example:

> '*Principals in rural areas have been trained in those years and did their work without computers and they do not even care whether the schools have computers or not. Thus, principals need to be made aware of the importance of ICT and how to get their staff use ICT'* (Principal P, 02 July 2010).

Processes on how to acquire ICT were not discussed as it is taken for granted that the government should provide ICT. There was no plan to replace the obsolete computers.

7.4 Summary of the negotiated findings for the study

This section presents the summary of the negotiated findings sought from the ICT use conference. The ICT use conference was aimed at legitimising the findings, phrase conclusions and suggest recommendations. The findings from the ICT use conference are summarised per construct below:

1. Schools have vision statements and the school leadership is active in ICT-related matters. Through the vision, science teachers are encouraged to use ICT. It is envisioned that schools should develop their own ICT policy to guide them on ICT-related matters for the school. Some participants claimed that they did not know what was expected from them and also how to go about raising funds in order to sustain and maintain the ICT. It is recommended that the National ICT Policy be reviewed.

2. Collaboration between teachers in the same school or with other school in the same circuit or region is lacking as is collaboration between schools and the communities in term of ICT support. It is recommended that the notion of establishing sister schools be introduced thus, schools with more or better ICT resources would assist those without. Also, collaboration within and between schools and communities should be encouraged by the school leadership.

3. There is insufficient pedagogical or technical support being offered to the science teachers who are rather encouraged to use ICT. In addition, it was observed that the National ICT Office was understaffed and there was lack of flow of information from head office to rural schools. It is recommended that advisory teachers and ICT technicians be appointed at regional level in order to ensure pedagogical and technical support respectively in rural schools.

4. There was lack of professional development in rural schools. Principals, science teachers as well as ICT technicians had not been trained in basic computer use or pedagogical use of ICT. It is recommended that they attend extensive training in basic computers and also in pedagogical use of ICT. Compulsory ICT training should be done during pre-service so that teachers become skilled before resuming teaching duties.

5. With regard to expertise, the participants indicated that the knowledge they possess is somewhat relevant and they also have rather relevant ICT skills. As a result, the science teachers from the participating schools, use ICT, they have indicated that they have a positive attitude towards ICT. However, skilled science teachers may be placed to work in schools without ICT, which may result in the science teachers forgetting most skills. It is therefore recommended that in order to increase ICT use and transfer of skills, ICT skilled science teachers be placed in schools with the necessary infrastructure.

6. Digital learning materials are somewhat not available. A few schools buy digital learning materials and they claimed that the software is relevant. However, science teachers and ICT technicians had not been trained on how the software operates. It is recommended that rural schools be supplied with relevant software that is aligned to science curriculum goals.

7. There is a lack of ICT infrastructure in schools. The government has provided the basic ICT to rural schools irrespective of the number of learners and teachers in those schools. The criteria for ICT deployment are not consistent with all schools. Some schools have acquired more ICT

depending on the availability of funds in their school development fund. It is recommended that the principals attend an awareness campaign on the importance of ICT in schools.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

This chapter presents a summary of the research project and of its key findings, as well as reflecting on methodology and conceptual framework and making recommendations and drawing conclusions. The findings, recommendations and conclusions drawn from this study provide strategies to improve and implement ICT in rural junior secondary schools, particularly in the science classroom, and the overall education system in Namibia. The results provide a general overview of translating policy into practice in the rural schools in developing countries, but the findings and conclusions are only applicable to the population of this study. Further research questions are also proposed.

8.1 Summary of the research

This thesis has evaluated the implementation of Namibia's Policy on ICT in rural junior secondary schools, particularly in science classrooms. It is argued that new technologies require teachers to include new pedagogical approaches that apply innovative ways of using ICT. Some authors have noted little understanding of the way in which ICT is used in schools and classroom around the world (Ainley et al., 2008; Boateng, 2007). However, it is important for the national policy to state what ICT should be used for in school and at classroom level. To date, no study has been conducted in Namibia to evaluate how ICTs have been used by the teachers since the introduction of ICT Policy (2005) in the country's schools. What schools are doing with ICT in accordance with the policy requirements have not been investigated (Matengu, 2006). It is in this light that the thesis was conducted to explore ways ICT is being implemented in rural schools and to identify factors that affect the implementation process, in particular how science teachers integrate ICT in the science classrooms and contribute to the knowledge of it in rural schools in developing countries.

The main research question was as follows:

- How and to what extent has ICT been implemented in Namibian rural junior secondary schools?

The sub-research questions were:

- *How are ICT being implemented in the science classrooms?*
- *What factors affect ICT implementation in the rural schools?*

Findings for these research questions were presented in Chapters 5 and 6 respectively.

The study has used a mixed methods approach (as argued in Chapter four): a baseline survey to describe the status of ICT and to explore factors and a case study approach (interviews and classroom observation), to deepen the understanding of factors that affect ICT implementation in junior secondary schools in Namibia. The survey consisted of three questionnaires for principals, science teachers and ICT coordinators, respectively. A total of 136 out of 163 schools were drawn from the population of secondary schools in the Northern educational regions. Data was analysed using the SPSS to explore and identify predicting factors that affect ICT implementation. Interviews were conducted with nine interviewees from three purposively sampled schools (three principals, three science teachers, and three ICT coordinators) Data was analysed manually. Further, an ICT use conference was conducted with the following participants: the National ICT Coordinator and the principals, science teachers and ICT coordinators from three purposively selected schools, viz schools that appeared to use ICT relatively intensively, based on the survey findings, and not included in the case studies. Data was collected using self-designed questionnaires and focus group discussions in the ICT use conference, and was analysed using frequency counts to determine the findings for purposes of verification of the preliminary findings.

The findings of this study should be placed in the perspective of supporting the Four-in-

Balance Model (2002) (Figure 3.2). This model was useful in advancing the theoretical understanding and has been used as the conceptual framework for analysing ICT use in rural schools (Sections 5.3, 5.4 and 5.5 and Sections 6.4, 6.5 and 6.6 respectively). The model is also used to identify the variables that emerged from a review of the literature (Chapter 3) as possibly affecting pedagogical use of ICT in rural schools. As illustrated in the previous chapters, it has been tested for consistency with data collected and suitability for answering the research questions. The findings illustrate that the model and other factors derived from relevant research and models fit the data on implementation of ICT in rural science classrooms.

8.2 Summary of the research findings

This section presents the key research findings that were established from the previous chapters. They are presented in line with the research questions with literature findings also discussed to enhance the quality of the discussion. The research findings of this study are summarised according to each research question in the following sections:

8.2.1 Pedagogical use of ICT in science classrooms

In general the use of ICT by science teachers is in Phase 1 of the National ICT Implementation Plan for ICT in Education (2006) (see Chapter 2). Phase 1 requires the deployment of ICT to educational institution, development of curriculum and content, training of teachers and learners in ICT skills and the development of a sustainable support mechanism. According to the National ICT Policy, it was anticipated that by the year 2009 all activities in Phase 1 of the ICT implementation Programme (2006) would have been complete. The findings of this study in comparison to the statements in the policy are presented. For a better understanding of scores as low, medium and high, the computation has been shown in Appendix O to explain the level of ICT implementation

ICT use

The use of ICT in Namibian rural schools is in its initial stage of implementation. The Namibian ICT in Education Implementation Plan Guide (2006) states developmental levels with targets for implementation. Five levels are outlined from level 1, describing schools and institutions with very basic ICT usage to level 5 being the schools and institutions at exceptionally advanced stages of ICT usage. The levels ensure access and usage of ICT. At level 1 it is expected that the school would have one room with ICTs, audiovisual facilities, at least one to two teachers with intermediate level ICT Literary Certificate, and learners who are introduced to ICT through one class period per month in order to meet the requirements of Level 1. At this level the Internet is not a requirement.

This study found that the rural schools only partially met the requirements of Level 1, as none of the science teachers had indicated that they possessed the Intermediate Level ICT Literacy Certificate. However, science teachers in Namibia use computers almost every day for lesson preparation, study notes, lesson activities and for assessment. On average, science teachers spent between 2 to 6 hours on ICT use per week (Figure 5.3) on ICT.

From the literature, Kennisnet (2008) found that secondary school teachers in The Netherlands use ICT on average 5 hours a week, whilst the managers use ICT about 13-18 hours a week. In Finland, science teachers use ICT only once a week, amounting to 28% of the teaching time during a particular period of the year, this being due to lack of time, too few digital learning materials, and a lack of ICT resources after school (Kankaanranta, 2009). Finnish teachers have developed a negative attitude towards ICT use at school despite the rapid increase of access to ICT in all schools, and they do not make use of its full potential. Generally, in England, science teachers use ICT for exploring simulations of scientific phenomena, modelling scientific process, capturing and analysing data automatically and being able to access and communicate scientific information (Webb, 2008).

Pedagogical use of ICT

Pedagogical use of ICT in Namibian rural schools is in its initial stage. Policy states that ICT integration for educators addresses the use of ICT across all subject areas, as ways in which ICT can be utilised as pedagogical tools. The science teachers are expected to use ICT in their lessons in various subjects to enhance learning opportunities beyond what is possible with currently available resources. As discussed above, the use of ICT has not yet reached an advanced stage in which one would expect rural science teachers to perform above Level 1 of the developmental stage.

The findings of this study show that science teachers performed the most basic tasks when teaching using ICT (see Table 5.4). For example, during observation they taught scientific themes in which they asked the learners to explore Encarta and developed notes using an overhead projector. No advance skills were evident during observations. In addition, a few science teachers indicated that their personal computers were connected to the Internet and that they used them for teaching-related activities (Figure 5.4).

The Finnish science teachers lacked pedagogical skills, which resulted in their developing a negative attitude towards ICT use (Kankaanranta, 2009).

Professional development

At present, professional development courses in Namibia are inadequate to prepare science teachers for pedagogical use of ICT. The aspect of professional development in the National ICT Policy for Education has been omitted and made synonymous with training. Under the section ‘schools with secondary grades’, it was only mentioned that by the year 2009, 5,500 teachers would have been trained in at least the Foundation Level ICT Literacy Certificate and completed the ICT Integration for Educators module. The policy did not mention how the pre-service teachers would be trained. The involvement of the University of Namibia in the teachers’ training programme with regard to ICT is non-existing.

This study found through document analysis (see Chapter 2) that the Integrated Media in Technology Education (IMTE) course offered to pre-service teacher trainees was only revised in 2006 to include ICT, and a few science teachers have undertaken this course at the Colleges of Education. The professional development in ICT follows the ICDL Programme or ICT Literacy programmes with no strategies to integrate ICT in the science lessons. No professional development courses were made available for principals and ICT technicians in the Namibian rural schools.

Literature relates how the Danish professional development programme started with a pedagogical IT driver's license in 1994 and gradually integrated ICT in the main stream programme of the in-service teacher training programme. Subject-specific courses were developed as follow-ups for ICT licensed teachers (Larson, 2009). Chile has invested in professional development to train teachers in ICT use (Sánchez & Salinas, 2008) whereby the Ministry of Education had partnered 24 universities to provide technical and pedagogical support to each school in the country **(**Hinostroza, Hepp, Laval, 2000). Also, Trinidad and Tobago University has developed a model on professional development where teachers receive incentives for having completed a course in ICT (Gaible, 2008). Universities and other institutions are working to develop models for ICT integration into specific curriculum subject matters such as science and mathematics. The models include technology, teaching methodology, learning objectives, teaching resources and tools for student learning assessment (Sánchez & Salinas, 2008)**.**

ICT infrastructure

ICT infrastructure in the Namibian rural schools is poor (Table 5.4) in terms of availability, decision making about acquisition, and maintenance. The Namibian government has provided the minimum basic ICT to rural schools. Each school under the TechNa project (see Chapter 1), is to have the basic necessary ICT infrastructure.

This study found that the Namibian government has provided 20 computers to each participating school, but how these computers were maintained and sustained was not *very clear. Obsolete computers from the SchoolNet project were stored in one corner of the computer laboratories or classrooms, taking up space for more equipment (Section 6.5). During observation in School C (Section 5.4) the electricity went off three times within a period of 45 minutes. The criteria for deploying computers and Internet connectivity to rural schools were not consistent. Some schools received computers without the Internet and others received both. As a result, some schools had acquired Internet devices for which the schools paid N$ 300-500.00 per month (Tables 6. 21, 6.22).*

Some authors in other developing countries, such as Macambique (Cossa & Cronje); Uganda, (Kenny, 2001; 2002); and Chile (Hinostroza, Hepp & Cox, 2009; Hinostroza, Labbe & Claro, 2005), noted with concern that the ICT infrastructural deployment was limited and not provided to all educational institutions in the amounts needed. However, in South Africa, there were cases of low density of Internet connectivity (Howie, in press), and high costs of ICT provision in comparison to the costs of other equipment. Thus, provision of infrastructure is in competition with the provision of other basic needs such as textbooks, basic furniture, teacher training, and nutritional supplements and more (Brandt et al. 2008; Cawthera, 2002). A study conducted in Europe including many countries, concluded that schools with good ICT resources achieve better results than those that are poorly resourced (Balanskat, Blamire & Kefala, 2006).

Vision on ICT in education

Rural schools have a rudimentary and implicit, rather than explicit vision on ICT in education. *This study found that the Namibian schools participating in the case studies have vision statements written on the wall at the entrance of the schools but that these do not include a phrase on ICT. However, the data from the larger sample of this study showed that the vision as perceived by the science teachers was high (Table 5.4) and forms basis of the implementation of ICT (Figures 8.1, 8.2).*

The vision of the National ICT Policy for Education should reflect any or all of the three paradigms: technological literacy, which puts emphasis on computer or information literacy as a subject; knowledge deepening, which emphasises on improving effectiveness of learning in different subjects by using ICT; and knowledge creation, which emphasises ICT as an agent of curriculum and pedagogical change to foster students' development of 21st century skills (UNESCO, 2008a). In addition, the policies need to state developmental strategy that articulates the vision on how the goals are to be achieved (Cecchini & Scott, 2003; Kozma, 2008; Law, 2009), requiring the introduction of school-level policy to engage the school leadership more in an effort to strive for quality in schools.

Leadership

Leadership at school level is medium (Table 5.8). In accordance with the National ICT Policy for Education requirements, the principal is expected to manage finance, human, and physical resources in an efficient and effective manner.

In this study, principals indicated that leadership was the basis on which all other constructs were built (Figures 8.1, 8.2). Principals were not exposed to any training courses to guide them on decision-making regarding ICT-related issues, but rather they continued encouraging science teachers to use ICT in their lessons.

In Namibia, Katulo (2010) found that principals need transformational leadership skills in order to ensure ICT integration in schools located in the Caprivi region. In Mozambique, the principals of schools were trained to allow them to understand and support the project activities (Cossa & Cronje, 2004). Contrary to the idea of training, principals in Finland have developed a negative attitude towards ICT use at school, despite the rapid increase to ICT access in all schools (Kankaanranta, 2009).

Collaboration

The level of collaboration and support was high on the surface value and low in practical terms. The National Policy of ICT states that the best option to develop collaboration and support systems is to establish a National Education Technology Service and Support Centre (NETSS). This centre would provide maintenance and technical support to schools and also acts as a distribution hub for ICT in terms of hardware.

This study found that the element of collaboration between science teachers at the same school or between schools is missing. The principals however indicated that they encourage teachers to collaborate by sharing skills and resources within the same school (see Section 5.4). From observation, an administrator was at School B to make copies for schools within the surrounding area that did not have ICT facilities. There is lack of teachers' networks or organizations with regard to teaching and learning activities. In addition, the schools have indicated that they do not allow community members to use their ICT facilities (see Section 5.4).

From the literature, the involvement of teacher forums for purposes of collaboration appeared to be necessary for sharing teaching materials and experiences (Delphi project, 2004). In addition, the involvement of the local community in ICT implementation is a crucial element in the ICT use in rural schools and not necessarily considered in the developed world. For parents to allow their children to learn what computers are and to work with them after school, for example, the parents must have a fair understanding of computers and so may contribute to the investment in computers. An important finding from research in Mozambique and South Africa is that ICT projects need support if they are to become sustainable or else they are likely to fail (Cossa & Cronje, 2006; Thomas, 2006).

Support

Pedagogical as well as technical support towards science teachers is also low (see Table 6.24). The Ministry of Education in Namibia has established a NETSS Centre to provide support services to the schools partly via telephone and by employing one ICT technician per educational region.

In this study, the science teachers have indicated that the kind of support the teachers receive from the principals is administrative. The principals know very little about pedagogical and/or technical aspects of ICT use to guide or support the science teachers accordingly. Technically, the science teachers also receive support from ICT technicians, who have no professional technical skills.

The quality of technical support might be compromised and the telephonic instructions through the call centre at NETSS seem not to be effective. In order to receive quality technical service, some schools paid out of the school development fund. From the literature, Boateng (2007) found that in Ghana, although computers were available at the school teachers were not using them. This was attributed to lack of support from the local communities. Bringing technology into the schools systems in developing countries was unsuccessful due to lack of planning and support to secure the support of key participants (Tiene, 2002).

Expertise

Science teachers' expertise in pedagogical use of ICT is in its infancy, although statistically the findings show that it was medium (see Table 5.4). The National ICT Policy for Education states that the ICT Literacy Certification is designed to serve as the basis for computer literacy standard and curricula in the country.

This study found that the knowledge that the science teachers had about ICT was acquired informally and over a long period of time, sometimes as far back as typing lessons in high school (see Section 5.4)). As observed, the innovative science teachers used basic ICT in their lessons. Platforms to learn about the newest development were not made available in rural schools.

Katulo (2010) revealed that there was a lack of personnel to cascade training in the Caprivi region, Namibia. Anderson and Plomp 2009 revealed gaps in countries that took part in the SITES2006 study. Most of the education systems that took part in the study indicated that they did not have specific policies on ICT requirements for teachers, with approximately 50% not having formal requirements for key types of teacher development, nor having a system-wide programme geared towards stimulating new pedagogies.

Attitude

Findings of this study suggest that the attitude of the science teachers towards pedagogical use of ICT was negative. Contrary to this finding, science teachers who participated in the case studies portrayed the right attitude to implement ICT. These science teachers prepared their lesson plans using ICT and had managed to let their school acquire more software for timetabling, mathematical software and many more uses to ensure effectiveness in their work. From the literature, a study in Turkey revealed that science teachers had a positive attitude towards ICT, although the results did not differ regarding gender, only age, ownership of computers at home and computer experience (Cavas et.al., 2009).

Digital learning materials

Digital learning materials were inadequate in number and also in quality (see Table 5.4). The National ICT Policy for Education Implementation Plan states that a number of content packages are available in schools, which include *DireqLearn, Learn Things, Learn Online, Encarta* and local content developed by Namibians.

This study found only one (Encarta) out of the five content packages available in rural schools. Depending on the money available in the school fund and need, some schools bought software for timetabling and preparing report cards. The acquisition of educational software was not matched to subject specific curriculum goals. No science teachers or the ICT technicians were trained in using pre-installed software. The *science teachers indicated that Microsoft Word was the mostly used software for lesson preparation and report writing by the principals, teachers and learners. Generally, there was lack of knowledge about the types of software science teachers may need in their teaching.* The costs of development of digital learning materials are great and effective demand is not likely to be large while those with purchasing power are already served by good conventional schools (Dede, 2000; MacFarlane & Sakellariou, 2002; Wagner, 2004). In order to ensure access to all schools, many governments have taken it upon themselves to take on the task of e-content distribution, either through a portal or any Learning Management Systems. The development of these materials and their quality is a concern (Cawthera, 2002; Cecchini & Scott, 2003).

In summary, the findings showed that pedagogical use of ICT, technical support, attitude of science teachers and ICT infrastructure were low. Science curriculum goals, collaboration, professional development, digital learning material, expertise were medium. Leadership and vision were high.

8.2.2 Factors affecting ICT implementation in rural schools:

This section presents findings on research question 3, what factors affect ICT implementation in rural schools. Findings on factor analysis are presented. Exploratory correlation analysis as well as regression findings are summarised.

The factor analyses revealed the following factors per construct:

Table 8.1: Summary of factor analyses per construct

Construct	Factors yielded:
Vision on ICT in education	Learner preparation for the ICT world Learner assessment on curriculum content
Leadership on implementing ICT	Teacher mentoring Innovations Creating schedule for collaboration and technical support
Use of ICT in school	Use in school subjects ICT integration in a school subject ICT use of applications ICT integration and challenges.
Digital learning material	Software availability Digital resources Software application Science projects Instructional learning Investigation of scientific principles Data analysis
Collaboration	Collaborative activities Learner mentoring
Science curriculum goals	Learner skills preparation Technological challenges
Pedagogical use of ICT	Use of ICT for assessment Collaborative activities Classroom management Giving feedback to learners Assessment ICT use for collaboration

The exploratory correlation analysis revealed that the leadership of principals had a strong positive relationship between curriculum goals and the vision of the principal respectively. The vision of the principal had a strong relationship with the science teachers' views on collaboration and also with science curriculum goals. ICT use and the vision of the principals were strongly correlated. Pedagogical support and vision of the principals were strongly correlated. Science teachers' attitude, expertise and professional development were strongly correlated. This means that principals and the science teachers were likely to agree on matter regarding the identified relationships.

Given the results, more relationships have been identified. For example, the inputs from the science teachers' characteristics, the location, and the demands by the National ICT Policy, have been a direct effect on school quality. This suggests that while there could be relationships established through school quality, the science teachers' characteristics could be very influential, given that only highly motivated science teachers would teach using ICT in the adverse exceptional circumstances. In turn, the school quality has a relationship with the leadership style adopted by the school leadership. Thus, the data on the type of leadership applied in the rural school could generate more relationships between factors. This challenging situation may only be experienced in the developing world.

The regression analysis showed that the following constructs were retained in the regression model, with Pedagogical use of ICT as a dependent variable. The independent constructs of interest were professional development, vision, obstacles, digital learning materials, support, collaboration, expertise, general use, leadership and ICT infrastructure, curriculum goals and attitude as perceived by the science teachers. In addition, expertise, vision, effort, leadership, collaboration, ICT infrastructure, pedagogical support and obstacles as perceived by the principals were included. The model of factors affecting ICT implementation in rural schools that include all these constructs can explain 85% of the variance in the model (see Section 6.5.2). The model parameters indicate that the only constructs found to be significant in the model were leadership of the principals, expertise of the science teachers as well as general use of ICT by science teachers (Section 6.6). As a result, there is an increase in pedagogical use of ICT about 0.353 for every unit increase in the leadership. The pedagogical use of ICT increases by 0.267 and 0.877 per unit increase in both the expertise as well as in general use respectively. This finding suggests that the regression model conforms to a higher degree (85%) of the Kennisnet model (2009).

In conclusion, the results seem to be robust and have to some extent validated what other researchers have reported from countries in the developing world, such as Ghana (Boateng, 2007), in South Africa (Howie et al., 2005), in Mozambique (Cossa, 2006), in

Sudan (Ali, 2010) and in Chile; as well as the developed world, such as in Finland (Kankaarata (2009), and Lithuania (Markauskaite, 2009). This study revealed that ICT implementation in Namibia is still in its initial stage, where at times ICT has to compete with the acquisition of the most basic need in rural schools. In cases where that is a problem, ICT becomes secondary. Professional development and expertise are geared towards acquiring the most basic ICT skills. The Namibian government provided schools with the most basic digital learning materials, which may not be aligned to the curriculum goals. Schools with more financial resources acquire more digital learning materials to enhance effective teaching and administration activities. There was minimal collaboration amongst teachers of the same school but it does not go beyond. No support is evident, be it technical or pedagogical, for the science teachers. The relationships between factors were determined and the significant constructs in the model were identified as leadership by principal, general use of ICT and expertise of the science teachers.

8.3 Reflections

This section presents some issues arising from the study and possibly some lessons that can be learnt: firstly, methodological issues addressing the extent to which the approach influenced the findings of this study; secondly, a reflection on the analyses and the conceptual framework applied in this study.

8.3.1 Methodology

This subsection presents reflections on baseline survey, in-depth case studies and ICT conference accordingly:

Baseline survey

Three main reflections are discussed, namely research conducted in the developing world, sampling and ICT coordinator. There is a deficit of research conducted in ICT implementation in the developing world, making it difficult to identify the most important variables to be considered in rural schools. The sample for the survey was considered sufficient in order to yield significant statistical conclusions about how ICT is being implemented in Namibian rural schools. Most schools in the Namibian rural areas are similar in nature and therefore conclusions could apply to other rural schools not included in the sample. Most schools lacked ICT technicians, which affected this study in terms of collecting some important data from most schools.

In-depth case studies

The sample used in the case studies was small and therefore not intended to represent all rural schools in Namibia. The schools were chosen based on them being case-success stories, using ICT extensively. More schools could have participated, but due to a natural disaster that occurred during the data collection period this was not possible. Data collected from the case studies was used to deepen the understanding of what was happening in rural schools with regard to ICT implementation.

ICT use conference

This method was particularly a challenge due to it being the first time it was being applied in the Southern African region. The questionnaires were designed to include statements that would lead to finalising the findings. It is important that a four-point Likert scale be considered to avoid bias responses.

In addition, the following should be considered during the analyses:

After conducting the baseline survey, it was discovered that the categorical responses used in the questionnaires did not match the analysis. The categorical responses were revised and narrowed to reflect the indices that would enable the schools to score in the range of minimum and maximum values in order to determine the extent of implementation of the National ICT Policy. The research should build the indices already into the responses when designing the questionnaires.

In order to run a regression analysis, data was reduced to include only schools that had both the principals and the science teachers responding to the questionnaires. The aim was to match the principals' responses to those of the science teachers. Where the school had two science teachers responding to the questionnaire, an average response was calculated. The ICT technicians' data was excluded in the exploratory factor analysis because of the low number of responses. However, during the pilot study, all questionnaires, including those of ICT technicians were returned and it was anticipated that the ICT technicians would respond to the survey in large numbers. In hindsight, the researcher perhaps should have adopted a more rigorous approach, such as explaining the portfolio of the ICT at workshops and meetings where the target group meets occasionally.

A number of relationships could not be determined using Pearson's correlations, due to either the quality of the data or the fact that the respondents could not identify some of the variables under the constructs. This does not necessary mean that the relationship does not exit, but could be attributed to this study having adapted the SITES instruments used internationally, and that are flexible for adoption and adaptation in the participating countries. This study experienced difficulty in using some of the ICT terminologies that may pose challenges to the respondents. These terminologies were adapted from the variables. More research needs to be conducted in order to develop more appropriate variables for Namibia.

Despite the limitation highlighted above, the data collected for this study was mined extensively to enhance the quality of this research design and generate findings for the extent to which ICT is being implemented, as well as identifying factors that affect ICT implementation in rural school. This study yielded some interesting findings that will be reflected upon in the conceptual framework below.

The limitation in the dataset may not necessarily be the weakness in the conceptual framework, but it is limited to rural areas in the developing country when attempting to explain ICT Policy implementation. The variance in the data could also be a result of the respondents' limited knowledge on ICT-related activities, but that could improve with ICT development in rural schools. This may explain much of the variance in the developing countries in contrast to the developing world, where the resources and teaching experiences may be different.

8.3.2 Conceptual framework

The conceptual framework of this study was influenced by the Kennisnet model (2009), which was placed within the Howie model (2002) in order to demonstrate the systems level (see Chapter 3). A few options have been added to the Kennisnet model (2009) as well as the Howie model (2002) to illustrate the situation of ICT implementation in Namibia and possibly other developing countries. This study should not be interpreted as a test for the Kennisnet model as presented in Chapter 3. Based on the results and reflection on the initial conceptual model, this study yielded some interesting conclusions that required modification of the initial conceptual framework for this study.

The original model of the Kennisnet (2009) had the leadership directly influencing the four constructs at school level: vision; expertise and attitude; ICT infrastructure; and digital learning materials. In addition, the Kennisnet model (2009) suggests that collaboration and support have an influence on the same four constructs. Findings from this study suggest that at school level, 'science curriculum goals' also influence the four constructs (see Figure 9.1). This in turn influences the general use of ICT and, consequently, the pedagogical us of ICT. The attitude of the science teachers may also influence the pedagogical use of ICT.

The Howie Model (2002) has been adapted for this study to provide the structure within which the Four-in-Balance Model was placed for purposes of distinguishing the systems level from the school level. Some parts of the Howie Model (2002) have been changed to suit the conceptual framework of this study. The three levels have been adopted from how they appeared in the Howie Model (2002) (see Figure 3.3). These are input, process and output and the elements thereof have been adapted as follows:

Input

In the input level, describing the National Policy issues,the economic, physical and human resources influenced the quality of the schools in the Howie model (2002). In this study, those variables have been replaced by the provision of ICT to schools, professional development and the vision of the Nation a ICT Policy for Education resulting in the quality of the school (see Figure 9.1 below).

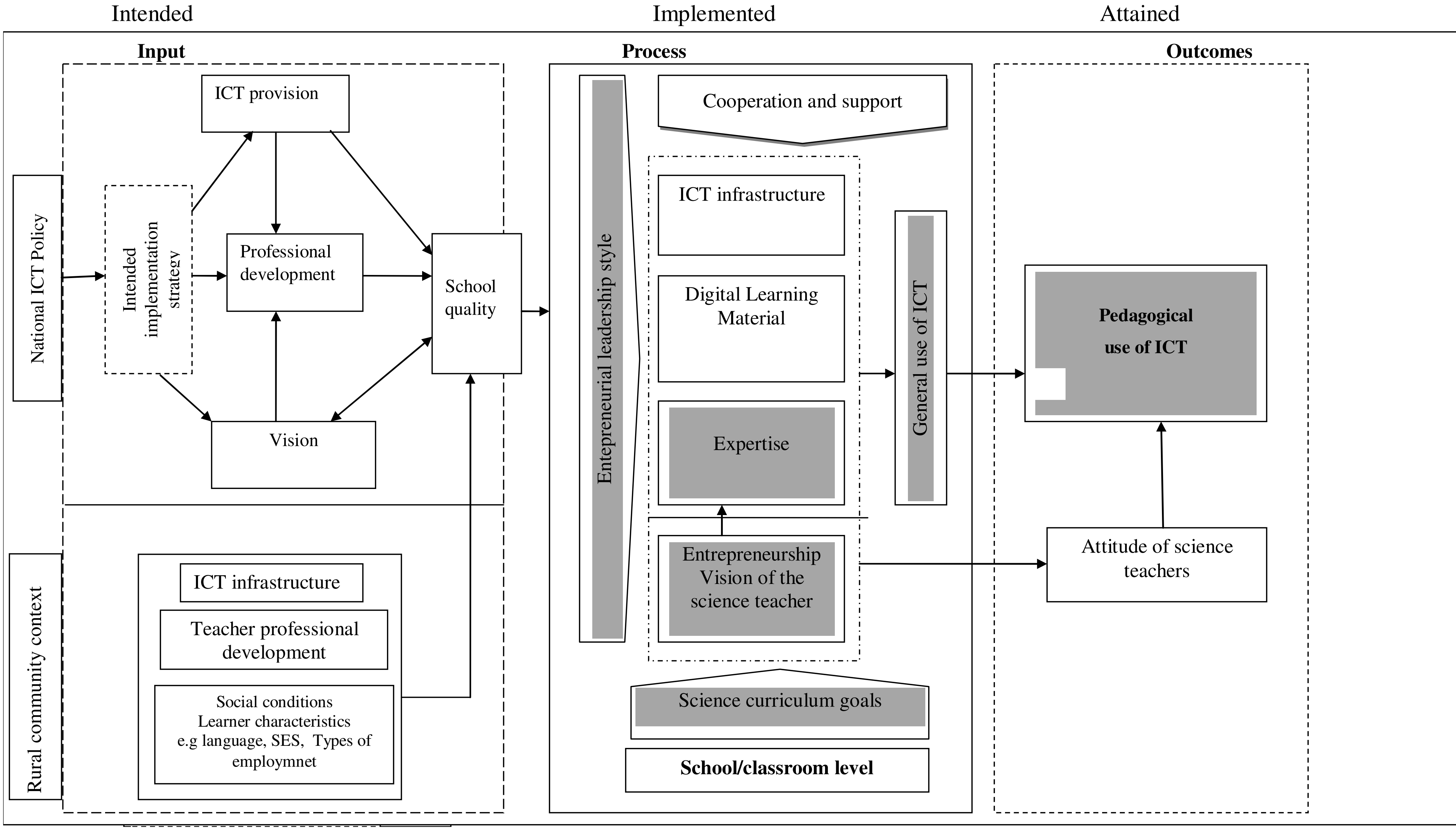
Process

In the process level, the adapted Kennisnet model (2002) was placed with additions to the number of constructs. In line with the findings of the regression analysis, entrepreneurial leadership style, expertise and the general use of ICT have been added. Entrepreneurial leadership style refers to principals who are very skilful 'partnership builders' in an effort to source the necessary ICT resources for the school (Yee, 2000). In addition, the case studies suggested the constructs on entrepreneurial vision of the science teachers and the science curriculum goals.

Outcome

To the Howie model (2002), the construct on attitude construct has been retained to show the effect of science teachers' attitude to pedagogical use of ICT. The outcome of this study suggests that in order to increase ICT use in rural schools, the science teachers need to be motivated constantly. This is not thought through in the Kennisnet model (2009) as teachers in the developed world have good infrastructure, digital learning materials, knowledge and skills in ICT. However, the attitude of teachers is said to be moderate but yet the implementation of ICT is advanced compared to Namibia or some other developing countries such as Sudan and South Africa. Science teachers in rural areas tolerate many unrealistic demands from the Ministry of Education when they have insufficient infrastructure, no digital learning materials, no knowledge and skills in ICT, and almost no support. However, some science teachers were committed to ICT use and therefore they need encouragement from the school leadership to continue using ICT in their teaching.

Figure 8.1 Factors affecting ICT policy



8.4 Conclusions and Recommendations regarding ICT implementation in rural areas

This section presents the main conclusions of the study based on the findings presented in Chapter 6 to 8 and in Section 8.2. These are informed by the conceptual framework for the study. Key recommendations are made for Namibia and other developing countries if applicable. In addition, the study suggests future research directions. The main conclusions of this study are:

1. **The Namibian rural schools implement ICT at a low level of Phase 1 of the Implementation Programme**.

ICT implementation is not yet widespread and where it is being implemented it is not yet fully utilised. The data shows that ICT use is in the medium category (Table 6. 8). The medium category entails basic use of ICT for pedagogical and administrative use. However, findings from case studies suggest that ICT use in rural schools is low (Section 6.6). It can therefore be concluded that ICT implementation in rural schools is not yet widespread or effective nationally. The science teachers make very little use of ICT if at all in most schools. ICT is used mainly for basic administrative duties such as report writing by the principals (Table 6.2) and lesson preparation by science teachers (Section 5.4). This finding could be attributed to many principals and science teachers lacking the necessary skills and knowledge to use ICT in an advanced way. In addition, schools have still not yet acquired the basic needs such as chairs, desks, running water and storage facilities for the schools (Table 6.7), making it difficult to move up to the next phase of implementation. The obstacles to ICT use that were identified were: *lack of knowledge to identify the appropriate equipment*; *learners' lack of skills* and *lack of confidence and time* to teach using ICT by science teachers (*see Appendix F*, item 24). Obstacles were found to be a significant predictor of pedagogical use of ICT. This finding is evidenced in Matengu (2006) that ICT use in some parts of Namibia was low but as a consequence claimed that the need for ICT use in schools appeared at national and regional levels of educational leadership but did not exist in schools. This was typical of developing countries such as Chile (Hinostroza, Hepp & Cox, 2009), the Philippines (Ogena & Browner, 2009) and Trinidad and Tobago (Gaible, 2008) before 2005 and 2006 respectively. These countries have been identified internationally as examples of good practice for ICT. Namibia has the potential to advance its level of ICT implementation.

Recommendation: *There is need to revise the National ICT in Education Implementation Plan (2006), to make it more realistic in terms of what if achievable in a particular period. As the Implementation Plan is now, it is very ambitious. Many activities should have been completed already by 2009, but this has not been the case. The review should consider fewer goals, extended timelines, and an increase in the number of personnel as well as professional development programmes. In addition, schools must be encouraged to develop explicit ICT policy goals and specific implementation plans for the specific school year.*

There is a need to develop a strategy on increased ICT use in rural schools. The strategy must identify the appropriate equipment, attempt to enhance learners' ICT skills by increasing the number of ICT lessons, and in addition to general teachers training in using ICT pedagogically instil confidence in the science teachers with regard to ICT use.

Further research: *There is a need to investigate the perceptions' of principals, science teachers and ICT technicians towards ICT implementation in rural schools more broadly.*

Research is needed in other educational regions to complete the view of ICT implementation in Namibian schools. More research is needed to compare Namibia to other African and other developing states concerning the national ICT policies, problems, challenges and issues experienced by local schools in comparison to the ICT implementation strategies. The comparative studies are needed for countries to learn from each other, both in policy and in the implementation strategies.

In addition, this thesis calls for comparative studies between Namibia, Chile and Trinidad and Tobago and/or the Philippines in search of good practices for rural areas.

2. Rural schools have a rudimentary and implicit vision of ICT.

The data shows that the vision of rural schools is medium (Table 6.8). The vision is limited and rudimentary. The school leadership lacks the basic knowledge that will enable them to advise and make informed decisions about ICT. Currently, the vision is geared towards: *preparing learners for the ICT world* and is also perceived as a tool to *assessing learner's content knowledge* (Section 6.4). The vision of the principal is strongly related to the science teachers' views on collaboration, pedagogical support and ICT use. Thus, this finding suggests that where there are strong leadership qualities, there are likely to be strong views on collaboration, pedagogical support and ICT use and vice versa. The ICT use conference findings show that the vision of the principals is very important in the planning of ICT implementation (Figures 7.1 and 7.2). This finding is supported by Anderson and Plomp (2009) and Katulo (2010) who found that leadership at school level makes a great difference in terms of pedagogical improvements in teaching.

Recommendation: There is a need to educate principals and other staff, including all teachers about ICT. The course or awareness campaign should cover the importance of ICT in general and in education.

Further research: *There is need for research on the role of principals in implementing ICT policy at the school level.*

3. There is lack of necessary infrastructure to enable ICT implementation in rural schools.

The data suggests that ICT infrastructure is medium (Table 6.8). The infrastructure provided to schools is basic and limited to computers and a printer. Schools receive 20 computers from the Government of Namibia, irrespective of the total number of learners. This number of computers is perceived by the principals, science teachers and ICT technicians as insufficient, from the case studies (Section 5.4 and Section 6.6) and from the ICT use conference participants (Table 7.2). A few schools sourced additional computers and Internet connectivity and digital learning materials on their own. The schools that acquired additional infrastructure were those that showed entrepreneurial leadership style. However, the digital learning materials were said to be somewhat relevant (Table 7.3) but not aligned to the science curriculum goals. In addition, there is a correlation between ICT infrastructure, leadership and support (Table 6.27). However, ICT infrastructure was not a predictor for ICT pedagogical use, but yet it is a necessary condition for use. However, it is not the number of computers that will ensure effective use but the quality of use. For example, Chile deployed ten computers to schools, which is less than the number received by rural schools in Namibia, but the quality of support in Chile contributed to the effective use of computers (Hinostroza, Hepp & Cox, 2009). Since the adoption of the National ICT Policy (2006), this is the first study that provides a comprehensive view of ICT implementation, including the infrastructure provided to rural schools. From the international literature, Anderson and Plomp (2009) found through the SITES 2006 that in all participating countries except South Africa, most highly developed countries, had almost 100% of schools with computer and Internet access for pedagogical use.

Recommendations: *A 'needs assessment plan' for rural schools with regard to ICT must be developed. Future plans should consider a systematic approach with regard to ICT infrastructure and ICT implementation. Also, planning must consider appropriate storage space, and development of deployment and the maintenance plan in order to avoid provision of computers to schools that lack the basic needs such as desks and chairs.*

The teachers currently acting as ICT technicians should be trained so that they will acquire troubleshooting skills that will enable them to repair and maintain the computers in the absence of available technicians.

Also, there is need to strengthen the link between the school's overall educational approach and its use of digital learning material. Not only should teachers use digital learning materials for small-scale projects but when purchasing them their relevance should be considered and the use should be extended to include conceptual approaches.

Further research: *An investigation is needed into the quality of the locally produced e-content and its relevance to the Namibian context. This effort is commendable but the level of knowledge of the teachers producing should be on par with the latest technology worldwide and/or internationally.*

4. There are an inadequate number of science teachers trained in pedagogical use of ICT.

Generally, pedagogical use of ICT shows that it is in the medium category (Table 5. 4). A few science teachers' who were observed using ICT for pedagogical purposes, demonstrated very basic skills. This suggests that teachers have been trained. The medium category is attributed to the fact that training in ICDL was carried out. The data shows that country-wide only 408 teachers started the training and out of these 352 obtained ICDL certificates between 2007 and 2009 (Section 2.4.2). Perhaps, as a result, only about half (47%) of the science teachers in the three educational regions of interest had allocated between two and four hours a week to ICT use (Table 5.3). There is no evidence that training in pedagogical use of ICT was conducted. Instead, only training in computer literacy was conducted. Six different factors emerged as important towards support of pedagogical use of ICT, namely: *use of ICT for assessment*, *collaborative activities*, *classroom management*, *giving feedback to learners*, *assessment*, and *ICT use for collaboration* (*see Appendix F*, item 16, 17, and 18).

A small percentage of science teachers benefited from the Integrated Media and Technology Education (IMTE) course offered in the BETD pre-service professional development after 2006 when the curriculum was reviewed to include ICT (Iipinge, 2010). On the one hand, Matengu (2006) found that there was no school capacity to deal with ICT integration. On the other hand, Kapenda (2009) suggests that ICT use be enhanced in the teaching of science. Other studies have provided evidence that there is a lack of understanding about what ICT integration in the subject areas means (Boateng, 2007, Sutherland & Sutch, 2009).

Recommendations: *There is need to develop extensive teaching and teacher training programmes that cover content on ICT integration, considering the classrooms sizes and insufficient resources made available to schools by the Namibian Government. In addition, the principals need to be trained in ICT courses that cover basic ICT as well as entrepreneurial skills defined as the innovativeness and capability to source more ICT infrastructure for the purpose of increasing access and enhancing teaching efficiency.*

In addition, policy-makers need to follow this debate about emerging pedagogical paradigms that focus on ICT knowledge application skills, self-management skills, thinking skills and creativity so that the teachers comply with the required skills of the 21st century. The review of the science curriculum should be conducted accordingly and more aligned to the National ICT Policy. The policy-makers should come up with clearer defined tasks that science teachers should understand and be able to practice.

***Further research**: There is need to investigate the teaching strategies using ICT that rural science teachers employ in their classrooms, given large class sizes and limited resources.*

There is need to investigate gender and age issues in relation to ICT use in the rural science classrooms. This information may help to attune teacher training to the needs and characteristics of the target group, but also implementation strategies may take into account differences on these variables.

5. There is a lack of support for science teachers, both pedagogical and technical.

The data suggests that support towards science teachers is low (see Table 5.4). There is very little evidence of pedagogical or technical support of science teachers. The case studies show that science teachers received very limited support from other experienced science teachers (Section 5.4). There is only one ICT technician per educational region, making it difficult for him/her to reach all schools on time. As a result, some teachers with knowledge about trouble-shooting have volunteered to act in this position. A number of obsolete computers obtained through the School Net project were dumped in one corner of the computer laboratory of at least two of the participating schools (Section 6.6). Two factors emerged as important for support, namely: *pedagogical support towards students* and *pedagogical support towards teachers and administrative staff* (*see Appendix E*, item 23 and 24). Technical support for science teachers strongly relates to ICT infrastructure (Table 6.27). Thus, technical support was applicable in schools where ICT infrastructure was also available and vice versa.

This finding is consistent with SITES M1 that there is lack of computer literacy amongst teachers and lack of training amongst the computer integration into different learning areas. Also, this finding was confirmed in Namibia by Matengu (2006), stating that there is a need for both technical staff and pedagogical support with increased training and personalized access to enhance ICT use in teaching.

Recommendation: *There is a need for a strategy to be put in place that will coordinate pedagogical and technical support initiatives for rural schools.*

Also, there is need to develop support strategies that will consider support centres for science teachers at regional level.

In addition, there is needed to appoint more ICT technicians that will attend to technical problems within a reasonable time. Science teachers need to establish a collaboration forum where they can share resources and experiences.

Further research: *Research should be done to develop optimal scenarios for pedagogical and technical support to science teachers.*

6. Where a high level of ICT use for pedagogical purposes was found generally within schools, an entrepreneurial leadership style was present.

Case studies (Section 5.4) data suggests that schools with higher level of ICT use have science teachers with expertise resulting in entrepreneurial vision and consequently entrepreneurial school leadership (Section 6.6). In Namibia, there is a lack of studies on ICT implementation by principals. However, Yee (2000) emphasises training of principals, including skills in entrepreneurial skills development. In the majority of schools in the Potchefstroom district in South Africa, Mentz and Mentz (2003) found that where computers were used for teaching, principals were of the opinion that they were used effectively for pedagogical purposes.

Recommendations:

Principals also need to be trained in basic computing courses, content development and pedagogical use of ICT in order for them to provide the necessary support. Training should be provided by certified trainers. The courses should be appropriate and should meet the needs of the schools.

This study suggests that principals be exposed to entrepreneurial development approaches in order to encourage widespread and more intensive use of ICT in education. The training must cover alternative ways of raising school funds in order to keep up with these technological challenges. In addition, the school leadership should undergo ICT skills development courses to enable them to make informed decisions about ICT-related matters.

Further research: *There is need to investigate the types of entrepreneurial leadership styles that exist within the different school leadership and try to identify the most appropriate for enhancing ICT-related activities in the rural schools.*

7. Where a high level of ICT use for pedagogical purposes was found within specific classrooms, an entrepreneurial vision of the science teachers was present.

Data from the case studies suggest that higher level of ICT use for pedagogical purposes was mostly attributed to the entrepreneurial vision of the science teachers. From observations, science teachers expressed willingness in ICT use despite the difficult situations in which the lessons are conducted. For example, during a classroom observation in a case study school, the electricity went off three times within a period of 45 minutes. In addition, two learners were observed sharing a chair as they worked on one computer. Despite these difficult conditions, the science teachers in the case studies portrayed willingness and enthusiasm to teach using ICT. These were the same teachers that influenced the vision of the school leadership in terms of increasing access to ICT use as well as buying more computers and subscribing to Internet services (Sections 5.3 and 5.6). Hamunyela (2009) observed a lack of electricity and modern equipment in rural Namibia (2008). Brandt et al. (2006) report on a survey undertaken by the Education Policy Unit of the University of the Western Cape and the International Development Research Centre which found that South Africa has an alarmingly low teledensity in some rural areas, sometimes less than 5% in certain rural areas.

Recommendation: Science teachers with entrepreneurial ideas and attitudes that influence their vision need to be supported and encouraged continuously in order to them to enhance ICT use for pedagogical purposes.

Further research: There is need to further investigate the motivating factors that enable continuous use of ICT for pedagogical purposes despite the difficult rural environment the science teachers are working under.

There is also need to investigate the optimal scenarios that exist within the entrepreneurial vision of the science teachers.

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APPENDIX A

PERMISSION TO CONDUCT RESEARCH

17th November 2008

The Project Manager
Tech //Na
Ministry of Education

Dear Mr. Van Wyk,

Application for permission to conduct research on ICT in the public schools

I hereby apply for permission to conduct research in public schools as part of a PhD study I am conducting at University of Pretoria.

I am conducting a study on the Evaluation of **ICT Policy implementation in Namibian rural junior secondary schools**. The need for the study is coupled with efforts of Vision 2030 to build an information society and knowledge-based economy in Namibia. The focus of the study is on rural areas, drawing its attention to the three educational regions namely: Ohangwena, Oshana and Oshikoto. The Omusati region has been left out because to date no teachers have been trained on ICT.

The study will employ a mixed method approach of which Phase 1 will be a survey after which Phase 2 comprises a case study approach. In Phase 2, science teachers, advisory teachers, curriculum developers and the ICT Project Manager would be interviewed, and observed periodically. The University of Pretoria requires that the participants of this study be protected in terms of keeping their identity anonymous and the information be kept confidential.

The Ministry of Education will benefit from the study in the following ways: 1) ascertain the extent to which the ICT Policy for Education has been implemented successfully; and 2) identify and understand the factors affecting the implementation process; 3) inform policy makers to make informed decisions.

Upon completion of this study, a copy of the report will be made available to the Ministry of Education offices and other government agencies.

I count on your support.

Yours in Technology Education,

____

Elizabeth N. Ngololo
Tel: 0811229022

Cc:	Mr. L. Kafidi	Director, Oshikoto Region
	Ms. D. Shinyemba	Director, Oshana Region
	Mr. J. Udjombala	Director, Ohangwena Region

APPENDIX B

PERMISSION TO CONDUCT RESEARCH

REPUBLIC OF NAMIBIA

MINISTRY OF EDUCATION

OFFICE OF THE PERMANENT SECRETARY

Tel: (061) 293 3125
Fax: (061) 293 3139
Enquiries: Mr. J van Wyk jvanwyk@mec.gov.na
2008

Private Bag 13186
WINDHOEK
21 November

Ms. Elizabeth Ngololo
University of Namibia

Dear Ms. Ngololo

Re: **Permission to conduct research in schools based in Ohangwena, Oshana and Oshikoto educational regions**

1. Your letter dated 15th November has reference.
2. Permission is hereby granted to you to conduct such research in schools of the three educational regions on condition that normal school programmes will not be disrupted. Before visiting schools, you should contact the respective Regional Director and if possible present the scope of your research.
3. You should also approach the EMIS division should you need additional statistics and data. The Division ICT will also be able to assist you when any data you may require.
4. Kindly be informed that you will be required to deposit one copy of your thesis to the respective educational region and the Ministry of Education ICT Division.
5. I would like to wish you success with your doctoral studies and look forward to the findings and recommendations of your research.

Sincerely yours in Education

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APPENDIX C

ETHICAL CLEARANCE CERTIFICATE

UNIVERSITY OF PRETORIA

FACULTY OF EDUCATION

RESEARCH ETHICS COMMITTEE

CLEARANCE CERTIFICATE	**CLEARANCE NUMBER :** CS09/05/01
DEGREE AND PROJECT	PhD: Computer Integrated Education An evaluation of the implementation of the ICT Policy for Education in rural Namibian schools
INVESTIGATOR(S)	**Elizabeth Ndeukumwa Ngololo**
DEPARTMENT	Department of Science Mathematics and Technology Education
DATE CONSIDERED	15 September 2010
DECISION OF THE COMMITTEE	APPROVED

Please note:

For Masters applications, ethical clearance is valid for 2 years

For PhD applications, ethical clearnace is valid for 3 years.

CHAIRPERSON OF ETHICS COMMITTEE	Prof L Ebersohn
DATE	15 September 2010
CC	Prof S Howie Ms Jeannie Beukes

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This ethical clearance certificate is issued subject to the following conditions:

1. A signed personal declaration of responsibility
2. If the research question changes significantly so as to alter the nature of the study, a new application for ethical clearance must be submitted
3. It remains the students' responsibility to ensure that all the necessary forms for informed consent are kept for future queries.

Please quote the clearance number in all enquiries.

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APPENDIX D

LETTER TO PARTICIPANTS

02 February 2009

Dear Participant

You are invited to participate in a study project aimed at evaluating the implementation of ICT Policy for Education in Namibian rural junior secondary schools. The purpose of this survey is to assess teaching practices and how Information and Communication Technologies (ICT) support these in rural junior secondary schools. The focus of the study is on how teachers organize their teaching and learning, the ICT facilities they have available at school, how they use ICT for teaching and learning, and the obstacles or difficulties they experience in relation to these technologies. This information will give better insight into the current state of pedagogical approaches and of how technologies support them. It will also allow educational practitioners and policy-makers to gain a better understanding of areas needing intervention and additional support. This study is being conducted under the auspices of the Centre for Evaluation and Assessment, University of Pretoria.

I am asking for your help in order to determine the current state of pedagogical approaches to and the use of ICT. Please try to answer each question as accurately as you can.

Your participation in this research project is voluntary and confidential. At no time will the name of any school or individual be identified. While results will be made available by school, you are guaranteed that neither your school nor your name will be identified in any report of the results of the study. Participation in this phase does not obligate you to participate in the follow up individual, however, should you decide to participate in follow-up interviews, your participation remain voluntary and you may withdraw at any time.

When in doubt about any aspect of the questionnaire, or if you would like more information about it or the study, you can reach Elizabeth NdeukumwaNgololo by phone at the following numbers: 0811229022.

If you would like to receive a copy of the results of the research study, please list a postal address where I can send the results: ____________________

____

____

Participant's signature ____________________ Date: ____________

Researcher's signature ____________________ Date: ____________

Yours sincerely,

Elizabeth Ndeukumwa Ngololo

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APPENDIX: E QUESTIONNAIRE FOR PRINCIPALS

School Code	Name of the school

This questionnaire comprises the following parts:

Part A:	Demographics
Part B:	Vision of your school
Part C:	Leadership and ICT in your school
Part D:	Cooperation and support
Part E:	ICT infrastructure
Part F:	Use of ICT in your school
Part G:	Expertise
Part H:	Pedagogical Support for teachers using ICT
Part I	Obstacles

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Introduction

The questionnaire is part of a doctoral study project which aims at investigating how and to what extent the Namibian policy on ICT in education has been implemented in rural areas since its establishment in 2005. The questionnaire is designed and administered only for graduation purposes. You and your school have been chosen to participate in this project in assessing teaching practices and how Information and Communication Technologies (ICT) support your school, the obstacles or difficulties you experience in relation to these technologies and how to improve ICT use.

Why is this information important?

This information will give better insight into the current state of pedagogical approaches utilized in schools and how technologies support them. It will also allow educational practitioners and policy-makers to gain a better understanding of areas needing intervention and additional support.

Confidentiality

All information is treated as confidential. At no time will the name of your school or your name be mentioned in the study. The school will receive feedback but no one will know what you have answered, only the overall results will show.

About this Questionnaire

This questionnaire asks for information from schools about education and policy matters related to pedagogical

practices and computers. If you do not have the information to answer particular questions, please consult other persons in the school. When the question is about ICT and/or ICT use, this will be explicitly stated. This questionnaire will take approximately 30 minutes to complete.

The words computers and ICT (Information and Communication Technologies) are used interchangeably in this questionnaire.

Please note that some questions refer to the entire school, while other questions refer to Grade 8 to 10 only.

Please note that some questions asking for educational policies and activities in general, while other questions explicitly focus on the use of ICT.

Guidelines for answering the questions are typed in *italics*. Most questions can be answered by marking the one most appropriate answer.

Please use a writing pen or ballpoint to write your answers.

When you have completed this questionnaire, please return to the Inspectors office by 22nd January 2010.

Further information

When in doubt about any aspect of the questionnaire, or if you would like more information about it or the study, you can reach me by phone at the following numbers: 0811229022.

Thank you very much for your cooperation!

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Part A: Demographics

1. Including this school year, how many years have you been:

Please mark only one choice in each row.

		Less than 3 years	3-5 years	6-10 years	11-20 years	21 years or more
A	Principal of any school (including years as principal in this school)	☐	☐	☐	☐	☐
B	Principal of this school....................	☐	☐	☐	☐	☐
C	Working in any professional capacity at this school (including years as teacher, head of department, and principal)	☐	☐	☐	☐	☐

2. What is your age?

☐ 30 years or less

☐ 31-35 years

☐ 36–45 years

☐ 46-55 years

☐ More than 55 years

3. Please indicate whether you are:

☐ Female

☐ Male

4. What is the total number of boys and girls in the entire school?

Please write a whole number. Write 0 (zero), if none.

☐☐☐☐ Total number of girls ☐☐☐☐ Total number of boys

5. How many people live in the village where your school is located?

Please mark only one choice.

☐ 3,000 people or fewer

☐ 3,001 to 15,000 people

6. Approximately what percentage of students are absent from your school on a typical school day?

Please mark only one choice.

☐ Less than 5%

☐ 5–10%

☐ 11–20%

☐ More than 20%

7. Has your school been involved in any of the following activities during the past few years?

Please mark only one choice in each row.

		0	1
A	Making changes to pedagogical practices	☐	☐
B	Adopting new assessment practices	☐	☐
C	Connecting to the Internet	☐	☐
D	Adapting buildings to suit the school's pedagogical approaches	☐	☐
E	Setting up computers in classrooms	☐	☐
F	Installing computer laboratories	☐	☐
G	Installing electricity	☐	☐
H	Installing running water..	☐	☐
I	Installing flushing toilets..	☐	☐
J	Setting up a science laboratory..	☐	☐
K	Setting up a school library...	☐	☐
L	Setting up a storeroom	☐	☐
M	Acquiring a telephone line..	☐	☐
N	Acquiring a fax machine..	☐	☐
O	Acquiring a photo copier..	☐	☐
P	Acquiring sufficient desks...	☐	☐
Q	Acquiring sufficient chairs..	☐	☐

_____ 17

0=no
1=yes

Part B: Vision of your school

This section asks you to answer questions about vision and ICT in your school.

8 . To what extent do you agree or disagree that the school leadership (you and/orother school leaders) encourages the following activities to take place in Grade 8 to 10?

Please mark only one choice in each row.

		0	0	1	1
A	To cover the prescribed curriculum content	☐	☐	☐	☐
B	To improve students' performance on assessments/examinations	☐	☐	☐	☐
C	To individualize student learning experiences in order to address different learning needs	☐	☐	☐	☐
D	To increase learning motivation and make learning more interesting	☐	☐	☐	☐
E	To foster students' ability and readiness to set own learning goals and to plan, monitor and evaluate own progress	☐	☐	☐	☐
F	To foster collaborative and organizational skills when working in teams	☐	☐	☐	☐
G	To provide activities which incorporate real-world examples/settings/applications for student learning	☐	☐	☐	☐
H	To provide opportunities for students to learn from experts and peers from other schools/organizations/countries	☐	☐	☐	☐
I	To foster communication skills in face-to-face and/or on-line situations	☐	☐	☐	☐
J	To prepare students for responsible Internet behavior (e.g., not to commit mail-bombing, such as spam, etc.) and/or to cope with cybercrime (e.g., Internet fraud, illegal access to secure information, etc	☐	☐	☐	☐

Strongly disagree=0

Disagree=0

Strongly agree=1

Agree=1

20

Part C: School leadership and ICT in your school

9. After the adoption of the national ICT Policy, has the school leadership (you and/or school board) taken any of the following actions during the past few years?

Please mark only one choice in each row.

		0	1
A	Re-allocating workload to allow for collaborative planning for innovations in the classrooms	☐	☐
B	Re-allocating workload to allow for the provision of technical support for innovations	☐	☐
C	Organizing workshops to demonstrate the use of ICT-supported teaching and learning	☐	☐
D	Meeting with teachers to review their pedagogical approach	☐	☐
E	Monitoring and evaluating the implementation of pedagogical changes	☐	☐
F	Establishing new teacher teams to coordinate the implementation of innovations in teachers' teaching and learning	☐	☐
G	Changing class schedules to facilitate the implementation of innovations	☐	☐
H	Implementing incentive schemes to encourage teachers to integrate ICT in their lessons	☐	☐
I	Encouraging teachers collaborate with external experts to improve their teaching and learning practices	☐	☐
J	Featuring new instructional methods in the school newspaper and/or other media (e.g., the school website)	☐	☐
K	Involving parents in ICT related activities	☐	☐

______
11

No=0

Yes=1

10. During this school year, how often did the school leadership (you and/or school board) undertake each of the following?

Please mark only one choice in each row.

		0	1	1	2
A	Organize activities to develop a common vision of what is meant by quality education	☐	☐	☐	☐
B	Inform teachers about pedagogical changes taking place in the school	☐	☐	☐	☐
C	Inform teachers about educational developments outside the school	☐	☐	☐	☐
D	Consult teachers about desired pedagogical changes	☐	☐	☐	☐
E	Discuss with teachers what they want to achieve through their lessons	☐	☐	☐	☐
F	Motivate teachers to critically assess their own educational practices	☐	☐	☐	☐
G	Encourage teachers to assess their educational practices in the context of your school's goals .	☐	☐	☐	☐
H	Discuss with parents/guardians/caretakers what pedagogical changes are taking place in our school	☐	☐	☐	☐
I	Discuss with students the teaching and learning in our school	☐	☐	☐	☐

Not at all= 0

A few times= 1

Monthly= 1

Weekly=2

____ 27

Part D: Collaboration and support

11. To what extent do you agree or disagree that the school leadership (you and/or school board) encourages the following activities to take place in Grade 8 to 10?

Please mark only one choice in each row.

		0	0	1	1
A	Teachers co-teach with their colleagues	☐	☐	☐	☐
B	Teachers collaborate with teachers from other schools..	☐	☐	☐	☐
C	Teachers discuss the problems that they experience at work with their colleagues	☐	☐	☐	☐
D	Teachers collaborate with teachers from other countries	☐	☐	☐	☐

4

12. To what extent do you agree or disagree that the school leadership (you and/or school board) encourages teachers to use each of the following types of assessment at Grade 8 to 10 ?

Please mark only one choice in each row.

		0	0	1	1
A	Written test/examination	☐	☐	☐	☐
B	Written task/exercise....................................	☐	☐	☐	☐
C	Individual oral presentation	☐	☐	☐	☐
D	Group presentation (oral/written)....................	☐	☐	☐	☐
E	Project report and/or (multimedia) product	☐	☐	☐	☐
F	Students' peer evaluations	☐	☐	☐	☐
G	Portfolio/learning log	☐	☐	☐	☐
H	Group assessment scores for collaborative tasks	☐	☐	☐	☐

8

Strongly disagree=0

Disagree=0

Strongly agree=1

Agree=1

Part E: ICT infrastructure

13. Who at your school has the primary responsibility for making decisions about each of the following?

Please mark only one choice in each row.

		2	2	1	1	0
A	Purchasing ICT equipment	☐	☐	☐	☐	☐
B	Determining which pedagogical approaches will be used	☐	☐	☐	☐	☐
C	Choosing whether ICT is used	☐	☐	☐	☐	☐
D	Using mobiles and/or handheld devices for instructional purposes	☐	☐	☐	☐	☐

Not applicable= 0

Subject department/teacher =1

School leadership/schoolboard=2

____
12

14. Are the following actions taken in your school?

Please mark only one choice in each row.

		0	1
A	Setting up security measures to prevent unauthorized system access or entry	☐	☐
B	Restricting the number of hours students are allowed to use the computer	☐	☐
C	Allowing students to access school computers outside school hours	☐	☐
D	Allowing students to access computers outside class hours (but during school hours)	☐	☐
E	Honouring of intellectual property rights (e.g., software copyrights)	☐	☐
F	Prohibiting access to adult-only material (e.g., pornography, violence)	☐	☐
G	Restricting the playing of games on school computers	☐	☐
H	Specifying the compulsory computer-related knowledge and skills that students need	☐	☐
I	Giving the local community (parents and/or others) access to school computers and/or the Internet	☐	☐
J	Complementing printed lesson materials with digital resources for teaching and learning	☐	☐

____ / 10

Part F: Use of ICT in your school

This section asks you to answer questions about pedagogy and ICT in your school.

15. For each of the following, how important is the use of ICT at Grade 8 to 10 in your school?

Please mark only one choice in each row.

		0	1	1	2
A	To prepare students for the world of work	☐	☐	☐	☐
B	To improve students' performance on assessments/examinations	☐	☐	☐	☐
C	To promote active learning strategies	☐	☐	☐	☐
D	To individualize student learning experiences in order to address different learning needs	☐	☐	☐	☐
E	To foster collaborative and organizational skills when working in teams	☐	☐	☐	☐
F	To develop students' independence and responsibility for their own learning	☐	☐	☐	☐
G	To do exercises to practice skills and procedures	☐	☐	☐	☐
H	To increase learning motivation and make learning more interesting	☐	☐	☐	☐
I	To satisfy parents' and the community 's expectations	☐	☐	☐	☐
J	To act as a catalyst in changing the pedagogical approaches of teachers	☐	☐	☐	☐

Not at all=0

A little= 1

Somewhat=1

A lot= 2

____
30

16. To what extent do you agree or disagree that the school leadership (you and/or other school leaders) encourages teachers at Grade 8 to 10 to use ICT in each of the following activities?

Please mark only one choice in each row.

		0	0	1	1
A	Organize, monitor and support team-building and collaboration among students	☐	☐	☐	☐
B	Organize and/or mediate communication between students and experts/external mentors	☐	☐	☐	☐
C	Facilitate collaboration (within or outside of the school) on student activities	☐	☐	☐	☐
D	Collaborate with parents/guardians/caretakers in supporting/monitoring students' learning and/or in providing counseling	☐	☐	☐	☐
E	Provide students with experiences that show them how certain activities are done in real life or by experts	☐	☐	☐	☐

Strongly disagree=0

Disagree=0

Agree=1

Strongly agree=1

___ 5

Part H: Expertise

17. Are teachers at Grade 8 to 10 required or encouraged to acquire knowledge and skills in each of the following?

Please mark only one choice in each row.

		0	1	1
A	Integrating Web-based learning in their instructional practice	☐	☐	☐
B	Using new ways of assessment (portfolios, peer reviews, etc.)	☐	☐	☐
C	Developing real-life assignments for students	☐	☐	☐
D	Using real-life assignments developed by others	☐	☐	☐
E	Using computers for monitoring student progress	☐	☐	☐
F	Organizing forms of team-teaching	☐	☐	☐
G	Collaborating with other teachers via ICT..........	☐	☐	☐
H	Communicating with parents via ICT	☐	☐	☐
I	Being knowledgeable about the pedagogical issues of integrating ICT into teaching and learning..........	☐	☐	☐
J	Using subject-specific learning software (e.g., tutorials, simulation)	☐	☐	☐

No= 0

Yes encouraged = 1

Yes required = 1

______
10

18. How much of a priority is it for your school leadership (you and/or other school leaders) to acquire competencies in the following areas?

Please mark only one choice in each row.

		0	1	2	3
A	Developing a common pedagogical vision among teaching staff in the school	☐	☐	☐	☐
B	Managing the innovation of pedagogical practices in the school	☐	☐	☐	☐
C	Explaining to teachers the relevance of encouraging students to be responsible for their own learning process and outcomes	☐	☐	☐	☐
D	Identifying best practices that exist outside the school regarding the integration of ICT in learning...	☐	☐	☐	☐
E	Promoting collaboration between teachers of different subjects	☐	☐	☐	☐
F	Managing the adoption of ICT-supported methods for assessing student progress	☐	☐	☐	☐
G	Organizing cooperation with other schools regarding the development of teaching and learning materials	☐	☐	☐	☐
H	Organizing cooperation with other schools regarding the development of ICT-based teaching and learning...............................	☐	☐	☐	☐
I	Promoting the integration of ICT in the teaching and learning of traditional subjects..	☐	☐	☐	☐
J	Developing a strategic plan for integrating ICT use in teaching and learning	☐	☐	☐	☐

Not considered =0

Low priority=1

Medium priority=2

High priority=3

____
40

Below are a few questions about your personal background.

19. Altogether, how often do you personally use a computer?

Please mark only one choice.

- ☐ Never → ***Please proceed to the end of the questionnaire*** ***0***
- ☐ A few times per year 1
- ☐ Almost monthly 1
- ☐ Weekly 2
- ☐ Daily 3

4

20. Do you use your computer for any of the following?

Please mark only one choice in each row.

		0	1
A	Writing documents and letters	☐	☐
B	Budgeting, monitoring or controlling expenses	☐	☐
C	Planning purposes	☐	☐
D	Communicating with teachers	☐	☐
E	Communicating with parents	☐	☐
F	Teaching/instruction	☐	☐
G	Time tabling	☐	☐
H	Searching for information	☐	☐
I	Developing and making presentations	☐	☐
J	Own professional development	☐	☐

No = 0
Yes = 1

10

21. Do you have access to a computer at home?

☐ ***0→ Please proceed to the end of the questionnaire.***

☐ ***1→ Please continue.***

No = 0

Yes = 1

___ 2

22. Do you use this computer for the following activities?

Please mark only one choice in each row.

		0	1
A	School related activities	☐	☐
B	Connecting to the internet	☐	☐

No = 0
Yes = 1

___ 2

Part I: Pedagogical Support for teachers using ICT

23. How frequently does each of the following persons provide pedagogical support to those teachers in Grade 8 to 10 who want to use ICT for their teaching and learning activities?

Note: Pedagogical support may consist of giving advice and guidance on issues related to teaching and learning, and also technical.

Please mark only one choice in each row.

		0	0	1	1	2
A	Experienced colleagues	☐	☐	☐	☐	☐
B	The school principal	☐	☐	☐	☐	☐
C	The technology coordinator	☐	☐	☐	☐	☐
D	Other staff from the school	☐	☐	☐	☐	☐
E	Experts from outside the school	☐	☐	☐	☐	☐

Never=0;Not applicable=0

Few times a year=1;Monthly=1

Weekly=2

____
15

.

24 ***For each of the following activities, to what extent is pedagogical support available for teachers in Grade 8 to 10 ?***

Note: Pedagogical support may consist of advice and guidance (via persons, manuals, etc.) with regard to the activities mentioned below. Please do not consider support that is only technical.

Please mark only one choice in each row.

		0	1	1	2	0
A	Having students produce outcomes of media production projects (e.g., development of websites)	☐	☐	☐	☐	☐
B	Having students work on short projects (2 weeks or shorter)	☐	☐	☐	☐	☐
C	Having students work on extended projects (longer than 2 weeks)	☐	☐	☐	☐	☐
D	Having students collaborate with others by online means, such as online discussion forums	☐	☐	☐	☐	☐
E	Having students conduct open-ended scientific investigations	☐	☐	☐	☐	☐
F	Having students engage in field study activities	☐	☐	☐	☐	☐

______
18

Part J: Obstacles

25. To what extent is your school's capacity to realize its pedagogical goals hindered by each of the following obstacles?

Please mark only one choice in each row.

	ICT-related obstacles	0	1	1	2	0
A	Insufficient qualified technical personnel to support the use of ICT	☐	☐	☐	☐	☐
B	Insufficient number of computers connected to the Internet......................	☐	☐	☐	☐	☐
C	Insufficient Internet bandwidth or speed..	☐	☐	☐	☐	☐
D	Lack of special ICT equipment for disabled students	☐	☐	☐	☐	☐
E	Insufficient ICT equipment for instruction	☐	☐	☐	☐	☐
F	Computers are out of date.....................	☐	☐	☐	☐	☐
G	Not enough digital educational resources for instruction	☐	☐	☐	☐	☐
H	Lack of ICT tools for science laboratory work	☐	☐	☐	☐	☐
I	Teachers' lack of ICT skills.....................	☐	☐	☐	☐	☐
J	Insufficient time for teachers to use ICT...	☐	☐	☐	☐	☐
	Other obstacles					
K	Pressure to score highly on standardized tests	☐	☐	☐	☐	☐
L	Prescribed curricula are too strict	☐	☐	☐	☐	☐
M	Insufficient or inappropriate space to accommodate the school's pedagogical approaches	☐	☐	☐	☐	☐
N	Insufficient budget for non ICT-supplies (e.g., paper, pencils)	☐	☐	☐	☐	☐
O	Using ICT for teaching and/or learning is not a goal of our school	☐	☐	☐	☐	☐

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Not at all=0; Not applicable=0 A little= 1; Somewhat=1 A lot= 2	____ 45

This is the end of the questionnaire.
Thank you very much for your cooperation!
Please return this questionnaire to the Inspectors Office by the 02 February 2010.

APPENDIX F:

QUESTIONNAIRE FOR SCIENCE TEACHERS

An evaluation of the implementation of ICT Policy for Education in Namibian rural junior secondary schools
(PhD study)

Questionnaire for Science Teachers

School Code	Name of the school

This questionnaire comprises the following parts:

Part A:	Demographics
Part B:	Curriculum Goals
Part C:	Leadership and vision
Part D:	Digital Learning Material
Part E:	Knowledge, attitude and skills
Part F:	ICT infrastructure
Part G:	Use of ICT
Part H:	Professional Development
Part I:	Specific Pedagogical Practice that Uses ICT

Total score
277

Introduction

The questionnaire is part of a doctoral study project. The study aims at investigating how well the Namibian ICT Policy for Education has been implemented in rural junior secondary school with a focus on the teaching of science. It is designed and administered only for graduation purposes. You and your school have been chosen to participate in this project in assessing teaching practices and how Information and Communication Technologies (ICT) supports your school, the obstacles or difficulties you experience in relation to these technologies and how to improve ICT use.

Why is this information important?

This information will give better insight into the current state of pedagogical approaches applied by science teachers and how technologies support them. It will also allow educational practitioners and policy-makers to gain a better understanding of areas needing intervention and additional support.

Confidentiality

All information is treated as confidential. At no time will the name of your school or your name will be mentioned in the study. The school will receive feedback but no one will know what you have answered; only the overall results will show.

About this Questionnaire

- This questionnaire asks for information from teachers about education and policy matters related to pedagogical practices and computers. When a question is about ICT and/or ICT use, this will be explicitly stated. The questionnaire will take you approximately 30 minutes to complete.
- The words computers and ICT (Information and Communication Technologies) are used interchangeably in this questionnaire.
- Guidelines for answering the questions are typed in *italics*.
- Most questions can be answered by marking the one most appropriate answer. A few questions (16, 17 and 18) require responses to two parts, (a) and (b). Mark one most appropriate answer for each of the two parts in each row.
- When a question refers to the "target class", it refers to a specific class you are teaching in this school year. The class identification procedure is attached (Appendix A).
- Please use a writing pen or ballpoint to write your answers.
- When you have completed this questionnaire, please return to the School Inspector's Office by the 10 February 2010.

Further information

- When in doubt about any aspect of the questionnaire, or if you would like more information about it or the study, you can reach Elizabeth NdeukumwaNgololoby phone at the following numbers (061) 207 2257 or 0811229022.

Thank you very much for your cooperation!

Procedure to identify the 'target class' in a school

Please note that the target population are science teachers and their classes in Grades 8-10. A science teacher may teach science to more than one class, e.g. one class in each of the three grades, or maybe even more than one class in one or more grades. For you to identify the target class for the study, I would like you to follow the procedures below:

Step 1: in how many of the grade 8-10 classes to which you teach science do you use ICT?

1. if the answer is in *none* of the classes, then GO TO step 3
2. if the answer is in just one class => this is the target class in this school
3. if the answer is in more than one class, then GO TO step 2

Step 2: are the classes in which you use ICT in your science teaching all grade 10 classes, or are there also classes in grades 8 and/or 9?

1. if the answer is *only* classes in grade 10, then GO TO step 3
2. if the answer is I use ICT in just one class in either grade 8 or 9 => this is the target class in this school
3. if the answer is that there are more than one class in grade 8 or 9 where ICT is used in science teaching, then GO TO step 3

Step 3: now there are for this teacher a few classes candidate for being selected as the target class, viz

(i) all grade 8 & 9 classes of the non-ICT using teacher
(ii) all grade 10 classes of the ICT using teacher who only uses ICT in grade 10 classes
(iii) all grade 8 & 9 classes in which the science teacher uses ICT in his/her teaching.

Example 1:
Teacher A uses ICT in his/her science lessons in the following classes: one grade 10 class, one grade 9 class and on grade 8 class. According to Step 2: the grade 9 and the grade 8 class are candidate for becoming target class. Teacher A has in a typical week the first science lesson to the grade 8 class on Mondays, 3rd lesson period, and the science lesson to the grade 9 class on Monday, 4th hour => the grade 8 class is the first class to which he/she teaches science in a typical week and this class then will be the target class.

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Part A: Demographics

1. To what age group do you belong?

Below 25 ☐ 25–29 ☐ 30–39 ☐ 40–49 ☐ 50–59 ☐ 60 or above ☐

2. What is your gender?

Male ☐ Female ☐

3. What is your highest level of education?

Please mark only one choice.

Secondary or high school ☐ Post-secondary education (e.g., BETD) ☐ Bachelor's degree ☐ Master's degree or above ☐

4. Do you have a teaching certificate?

No ☐ Yes ☐

5. How many years of experience do you have of teaching?

Less than 2 years ☐ 2–4 years ☐ 5– 9 years ☐ 10–19 years ☐ 20 years or more ☐

6. How many students are there in the target class?

|_|_|_|

7. What is the gender mix of this class?

All boys ☐ All girls ☐ Both boys and girls ☐

8. Approximately what percentage of students are absent in the target class on a typical school day?

Less than 5%	5–10%	11–20%	More than 20%
☐	☐	☐	☐

9. How many hours of scheduled class time do you spend with the target class per week?

Please answer these questions with reference to science, the subject (domain) that is focus of this questionnaire.

Less than two hours	2– 4 hrs	5– 6 hrs	7– 8 hrs	More than 8 hrs
☐	☐	☐	☐	☐

10. What proportion of students in your class has competence in the following?

Please mark only one choice in each row.

Operation skills	0	1	2	2	0
A Word-processing	☐	☐	☐	☐	☐
B Database software	☐	☐	☐	☐	☐
C Spreadsheet	☐	☐	☐	☐	☐
D Presentation software	☐	☐	☐	☐	☐
E Application of multimedia	☐	☐	☐	☐	☐
F E-mail	☐	☐	☐	☐	☐
G Internet	☐	☐	☐	☐	☐
H Graphic calculator	☐	☐	☐	☐	☐
I Data-logging tools.......................	☐	☐	☐	☐	☐

Nearly none = 0

Some students = 1
Majority of students = 2
Nearly all students = 2
Don't know = 0

27

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Part B: Curriculum Goals

11. In your teaching this school year, how important is it for you to achieve the following goals?

Please mark only one choice in each row.

		0	1	1	2
A	To prepare students for the world of work	☐	☐	☐	☐
B	To prepare students for upper secondary education and beyond	☐	☐	☐	☐
C	To provide opportunities for students to learn from experts and peers from other schools/countries	☐	☐	☐	☐
D	To provide activities which incorporate real-world examples/settings/applications for student learning	☐	☐	☐	☐
E	To improve students' performance in assessments/examinations	☐	☐	☐	☐
F	To increase learning motivation and make learning more interesting	☐	☐	☐	☐
G	To individualize student learning experiences in order to address different learning needs...........	☐	☐	☐	☐
H	To foster students' ability and readiness to set their own learning goals and to plan, monitor and evaluate their own progress.......................	☐	☐	☐	☐
I	To foster students' collaborative and organizational skills for working in teams	☐	☐	☐	☐
J	To foster students' communication skills in face-to-face and/or online situations	☐	☐	☐	☐
K	To satisfy parents' and the community's expectations...	☐	☐	☐	☐
L	To prepare students for competent ICT use	☐	☐	☐	☐
M	To prepare students for responsible Internet behavior (e.g., not to commit mail-bombing, etc.)and/or to cope with cybercrime (e.g., Internet fraud, illegal access to secure information, etc.)	☐	☐	☐	☐

Not at all= 0

A little= 1

Somewhat= 1

Very much = 2

______
26

Part C: Leadership and vision

12. To what extent do the following statements about school vision apply to the staff in your school?

Please mark only one choice in each row.

		0	1	1	2
A	We discuss what we want to achieve through our lessons.	☐	☐	☐	☐
B	Teachers are constantly motivated to critically assess their own educational practices.	☐	☐	☐	☐
C	Teachers are expected to think about the school's vision and strategies with regard to educational practices.	☐	☐	☐	☐

___ / 6

13. To what extent do the following statements about teachers' participation in decision-making apply to you?

Please mark only one choice in each row.

		0	1	1	2
A	I can influence the development of the school's innovation implementation plans.	☐	☐	☐	☐
B	When implementing innovations, our school considers teachers' opinions and adjusts its action plan as needed.	☐	☐	☐	☐
C	I am able to implement innovations in my classroom according to my own judgment and insights.	☐	☐	☐	☐

___ / 6

14. To what extent do the following statements about professional collaboration among teachers apply to you?

Please mark only one choice in each row.

		0	1	1	2
A	I co-teach with my colleagues.	☐	☐	☐	☐
B	I discuss the problems that I experience at work with my colleagues.	☐	☐	☐	☐
C	I work with teachers in other schools on collaborative activities.	☐	☐	☐	☐
D	I work with teachers in other countries on collaborative activities.	☐	☐	☐	☐

15. To what extent do the following statements about support to teachers apply to you?

___
8

Please mark only one choice in each row.

		0	1	1	2
A	When necessary, I receive sufficient technical support from my school/region/state (e.g., by having a technician in my classes) to support my teaching.	☐	☐	☐	☐
B	My students can access computers easily outside scheduled class time without my help.	☐	☐	☐	☐
C	The administrative work arising from the use of ICT in my teaching (e.g., booking computer laboratories, changing class schedules) is easy to do in my school. ...	☐	☐	☐	☐

Not at all= 0

A little= 1

Somewhat= 1

A lot= 2

___
6

Part D: Digital Learning material

16. In your teaching of the target class in this school year,

(a) How often is the scheduled learning time of the class used for the following activities?

(b) Has ICT been used when these activities took place?

Please mark only one choice for each of the two parts in each row.

		(a) How often is the scheduled learning time used for the following activities?				(b) ICT used?	
		0	1	2	2	0	1
A	Extended projects (2 weeks or longer) ..	☐	☐	☐	☐	☐	☐
B	Short-task projects	☐	☐	☐	☐	☐	☐
C	Product creation (e.g., making a model or a report).......................................	☐	☐	☐	☐	☐	☐
D	Self-accessed courses and/or learning activities	☐	☐	☐	☐	☐	☐
E	Scientific investigations (open-ended) ...	☐	☐	☐	☐	☐	☐
F	Field study activities	☐	☐	☐	☐	☐	☐
G	Teacher's lectures	☐	☐	☐	☐	☐	☐
H	Exercises to practice skills and procedures	☐	☐	☐	☐	☐	☐
I	Laboratory experiments with clear instructions and well-defined outcomes .	☐	☐	☐	☐	☐	☐
J	Discovering science principles and concepts	☐	☐	☐	☐	☐	☐
K	Studying natural phenomena through simulations	☐	☐	☐	☐	☐	☐
L	Looking up ideas and information	☐	☐	☐	☐	☐	☐
M	Processing and analyzing data	☐	☐	☐	☐	☐	☐

Never= 0

Sometimes=1

Often= 2

Nearly always = 2

No=0

Yes = 1

39

Part E: Expertise

17. In your teaching of the target class in this school year:

(a) How often do you conduct the following?

(b) Do you use ICT for these activities?

Please mark onlyone choice for each of the two parts in each row.

		(a) How often do you conduct the following?				(b) ICT used?	
		0	1	2	2	0	1
A	Present information/demonstrations and/or give class instructions	☐	☐	☐	☐	☐	☐
B	Provide remedial or enrichment instruction to individual students and/or small groups of students	☐	☐	☐	☐	☐	☐
C	Help/advise students in exploratory and inquiry activities	☐	☐	☐	☐	☐	☐
D	Organize, observe or monitor student-led whole-class discussions, demonstrations, presentations	☐	☐	☐	☐	☐	☐
E	Assess students' learning through tests/quizzes	☐	☐	☐	☐	☐	☐
F	Provide feedback to individuals and/or small groups of students	☐	☐	☐	☐	☐	☐
G	Use classroom management to ensure an orderly, attentive classroom	☐	☐	☐	☐	☐	☐
H	Organize, monitor and support team-building and collaboration among students............................	☐	☐	☐	☐	☐	☐
I	Organize and/or mediate communication between students and experts/external mentors	☐	☐	☐	☐	☐	☐
J	Liaise with collaborators (within or outside school) for student collaborative activities	☐	☐	☐	☐	☐	☐
K	Provide counseling to individual students	☐	☐	☐	☐	☐	☐

L	Collaborate with parents/guardians/caretakers in supporting/monitoring students' learning and/or in providing counseling	☐	☐	☐	☐	☐	☐

Never = 0

Sometimes = 1

Often = 2

Nearly always = 2

No = 0

Yes = 1

___
36

18. In your teaching of the target class in this school year:

(a) Do you use the following methods of assessing student performance?

(b) Do you use ICT to carry out these assessments?

Please mark only one choice for each of the two parts in each row.

		(a) Assessment method used?		(b) ICT used?	
A	Written test/examination	☐	☐	☐	☐
B	Written task/exercise	☐	☐	☐	☐
C	Individual oral presentation	☐	☐	☐	☐
D	Group presentation (oral/written)	☐	☐	☐	☐
E	Project report and/or (multimedia) product..........................	☐	☐	☐	☐
F	Students' peer evaluations	☐	☐	☐	☐
G	Portfolio..	☐	☐	☐	☐
H	Assessment of group performance on collaborative tasks	☐	☐	☐	☐

No= 0

Yes = 1

___
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Part F: ICT infrastructure

19. How often did you incorporate the following in your teaching this school year?

Please mark only one choice in each row.

		0	1	2	2
A	Equipment and hands-on materials (e.g., laboratory equipment, musical instruments, art materials, overhead projectors, slide projectors, electronic calculators)	☐	☐	☐	☐
B	Tutorial/exercise software	☐	☐	☐	☐
C	General office suite (e.g., word-processing, database, spreadsheet, presentation software)	☐	☐	☐	☐
D	Multimedia production tools (e.g., media capture and editing equipment, drawing programs, webpage/multimedia production tools)	☐	☐	☐	☐
F	Simulations/modeling software/digital learning games	☐	☐	☐	☐
G	Communication software (e.g.,internet, e-mail, chat, discussion forum)	☐	☐	☐	☐
H	Digital resources (e.g., portal, dictionaries, encyclopedia)	☐	☐	☐	☐
I	Mobile devices (e.g., Personal Digital Assistant (PDA), cell phone)	☐	☐	☐	☐
J	Smart board/interactive whiteboard	☐	☐	☐	☐
K	Learning management system (e.g., web-based learning environments)	☐	☐	☐	☐

Never = 0

Sometimes= 1

Often = 2

Nearly always = 2

20

Part G: Use of ICT

20. To what extent are you confident in accomplishing the following?

This question is also for non-ICT using teachers. Please mark only one choice in each row.

	General use of ICT	0	1	1	2
A	I can produce a letter using a word-processing program.	☐	☐	☐	☐
B	I can e-mail a file (e.g., the notes of a meeting) to a colleague.	☐	☐	☐	☐
C	I can take photos and show them on the computer.	☐	☐	☐	☐
D	I can file electronic documents in folders and sub-folders on the computer.	☐	☐	☐	☐
E	I can use a spreadsheet program for budgeting or student administration.	☐	☐	☐	☐
F	I can share knowledge and experiences with others in a discussion forum/user group on the Internet.	☐	☐	☐	☐
G	I can produce presentations with simple animation functions.	☐	☐	☐	☐
H	I can use the Internet for online purchases and payments.	☐	☐	☐	☐
	Pedagogical Use of ICT				
I	I can prepare lessons that involve the use of ICT by students.	☐	☐	☐	☐
J	I know which teaching/learning situations are suitable for ICT use.	☐	☐	☐	☐
K	I can find useful curriculum resources on the Internet.	☐	☐	☐	☐
L	I can use ICT for monitoring students' progress and evaluating learning outcomes.	☐	☐	☐	☐
M	I can use ICT to give effective presentations/ explanations.	☐	☐	☐	☐
N	I can use ICT for collaboration with others.	☐	☐	☐	☐
O	I can install educational software on my computer.	☐	☐	☐	☐

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P	I can use the Internet (e.g., select suitable websites, user groups/discussion forums) to support student learning.	☐	☐	☐	☐

Impact of use

______
16

To what extent do you agree that the use of ICT has had the following impacts on you?

Please mark only one choice in each row.

		0	1	1	2
A	My ICT skills have improved.	☐	☐	☐	☐
B	I incorporate new teaching methods.	☐	☐	☐	☐
C	I provide more individualized feedback to students.	☐	☐	☐	☐
D	I incorporate new ways of organizing student learning.	☐	☐	☐	☐
E	I monitor more easily students' learning progress.	☐	☐	☐	☐
F	I access more diverse/higher quality learning resources.	☐	☐	☐	☐
G	I collaborate more with colleagues within my school.	☐	☐	☐	☐
H	I collaborate more with peers and experts outside my school.	☐	☐	☐	☐
I	I complete my administrative tasks more easily. .	☐	☐	☐	☐
J	My workload has increased.	☐	☐	☐	☐
K	There is increased work pressure.	☐	☐	☐	☐
L	I have become less effective as a teacher.	☐	☐	☐	☐

Not at all=0

A little = 1

Somewhat**=** 1

A lot= 2

______
24

21. Do you have access to a computer at home?

☐ 1→ ***Please go to question 23.***

☐ 2→ ***Please continue.***

No=0

Yes= 1

1

22. Do you use this computer for the following activities?

Please mark only one choice in each row.

		0	1
A	Teaching related activities	☐	☐
B	Connecting to the internet	☐	☐

No = 0

Yes = 1

1

23. Looking ahead to the coming two years, what priority will you give to the use of ICT in enhancing your teaching practice in the following areas?

Please mark only one choice in each row.

		0	1	2	3
A	To monitor more effectively the progress of my students	☐	☐	☐	☐
B	To provide exercises to students in order to practice skills and procedures	☐	☐	☐	☐
C	To provide better and more interesting lectures/presentations to my students	☐	☐	☐	☐
D	To engage students in multimedia production projects	☐	☐	☐	☐
E	To provide more activities that address the individual differences among my students...........	☐	☐	☐	☐
F	To involve students in collaborative, short projects (2 weeks or shorter)	☐	☐	☐	☐
G	To involve students in extended collaborative projects (longer than 2 weeks)	☐	☐	☐	☐

H	To involve my students in scientific investigations (involving laboratory work)	☐	☐	☐	☐
I	To provide more opportunities for my students to collaborate with or learn from people outside of their classroom, including peers and external experts	☐	☐	☐	☐
J	To collaborate more with fellow teachers and others within and outside my school	☐	☐	☐	☐
K	To provide more opportunities for my students to collaborate with their classmates	☐	☐	☐	☐
L	To arrange self-accessed activities for my students..	☐	☐	☐	☐

Not at all= 0; Low priority=1, Medium priority= 2, High priority=3

36

24. Do you experience the following obstacles in using ICT in your teaching?

Please mark only one choice in each row.

		0	1
A	ICT is not considered to be useful in my school.	☐	☐
B	My school does not have the required ICT infrastructure.	☐	☐
C	I do not have the required ICT-related skills.	☐	☐
D	I do not have the necessary ICT-related pedagogical skills.	☐	☐
E	I do not have sufficient confidence to try new approaches alone.	☐	☐
F	My students do not possess the required ICT skills.	☐	☐
G	My students do not have access to the required ICT tools outside of the school premises.	☐	☐
H	I do not have the time necessary to develop and implement the activities.	☐	☐
I	I do not know how to identify which ICT tools will be useful.	☐	☐
J	My school lacks digital learning resources.	☐	☐
K	I do not have the flexibility to make my own decisions when planning lessons with ICT.	☐	☐
L	I do not have access to ICT outside of the school.	☐	☐

No = 0

Yes = 1

12

Part H: Professional Development

25. Have you participated in any of the following professional development activities? If no, would you wish to attend?

Please mark only one choice in each row.

		0	0	1
A	Introductory course for Internet use and general applications (e.g., basic word-processing, spreadsheets, databases, etc.)	☐	☐	☐
B	Technical course for operating and maintaining computer	☐	☐	☐
C	Advanced course for applications/standard tools (e.g., advanced word-processing, complex relational databases)	☐	☐	☐
D	Advanced course for Internet use (e.g., creating websites/developing a home page, advanced use of the Internet, video conferencing)	☐	☐	☐
E	Course on pedagogical issues related to integrating ICT into teaching and learning	☐	☐	☐
F	Subject-specific training with learning software for specific content goals (e.g., tutorials, simulation, etc.)	☐	☐	☐
G	Course on multimedia operations (e.g., using digital video and/or audio equipment)	☐	☐	☐

7

No,I do not wish to attend = 0

No,I would like to attend if available = 1

Yes, I have = 1

Part I: Specific Pedagogical Practicethat Uses ICT

26. Which of the following descriptionis applicable to you?

Please mark only one choice.

☐ I use ICT once a week or more in the target class.→ ***Please continue.***

☐ I use ICT extensively in the target class during a limited period during the year (e.g., in a project or a theme)→ ***Please continue.***

☐ None of the above→ ***Please go to the end of the questionnaire.***

Once a week= 1

Extensively = 2

None=0

2

27. Please describe the one most satisfying pedagogical practice (that you applied in the target class) in this school year, in which you and/or your students used ICT extensively.

Please describe the pedagogicalpractice(e.g., a research project or a multimedia production), the ICT used (e.g., data logging tools, spreadsheets or web search) and its content (e.g., curricular goals; topic) in a maximum of 20 words.

____

____

____

____

28. Has the use of ICT in this pedagogical practicedescribed in question 27 contributed to changes in the following aspects of your teaching of the target class:

Please mark only one choice in each row.

		0	0	1
A	Quality of coaching students	☐	☐	☐
B	Time available to help individual students	☐	☐	☐
C	Time needed to solve technical problems	☐	☐	☐
D	Time needed for preparation	☐	☐	☐
E	Quality of instructions given to students	☐	☐	☐
F	Time needed for classroom management	☐	☐	☐
G	Quality of classroom discussion	☐	☐	☐
H	Collaboration between students	☐	☐	☐
I	Communication with the outside world	☐	☐	☐
J	Availability of new learning content	☐	☐	☐
K	Variety of learning resources/materials	☐	☐	☐
L	Variety of learning activities	☐	☐	☐
M	Adaptation to individual needs of students	☐	☐	☐
N	Amount of effort needed to motivate students	☐	☐	☐
O	Insight into the progress of student performance	☐	☐	☐
P	Self-confidence	☐	☐	☐

Increased = 1

Decreased = 0

Made no difference = 0

______
16

This is the end of the questionnaire.
Thank you very much for your time and effort!

Kindly return the questionnaire to the School Inspector's Office by the

02 February 2010

APPENDIX G

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YUNIBESITHI YA PRETORIA

An evaluation of the implementation of ICT Policy for Education in Namibian rural junior secondary schools

(PhD study)

School code	Name of the school

QUESTIONNAIRE FOR TECHNICIANS

(This questionnaire is to be answered by the person in the school who is responsible for ICT facilities including maintenance and practical use in your school.)

This questionnaire comprises the following parts:

Part A:	ICT in your school
Part B:	Digital Learning Material
Part C:	Leadership and vision
Part D:	ICT infrastructure
Part E:	Knowledge, attitude and skills
Part F:	Professional Development
Part G:	Support facilities for ICT
Part H:	Obstacles to realize pedagogical goals

Total score

______

140

Introduction

The questionnaire is part of a doctoral study project. The study aims at investigating how well the Namibian ICT Policy for Education has been implemented in rural junior secondary school with a focus on the teaching of science.It is designed and administered only for graduation purposes. You and your school have been chosen to participate in this project in assessing teaching practices and how Information and Communication Technologies (ICT) supports your school, the obstacles or difficulties you experience in relation to these technologies and how to improve ICT use.

Why is this information important?

This information will give better insight into the current state of pedagogical approaches and how technologies support them. It will also allow educational practitioners and policy-makers to gain a better understanding of areas needing intervention and additional support.

Confidentiality

All information is treated as confidential. At no time will the name of your school or your name will be mentioned in the study. The school will receive feedback but no one will know what you have answered; only the overall results will show.

About this Questionnaire

- This questionnaire asks for information from schools about education and policy matters related to pedagogical practices and ICT. **If you are the person answering this questionnaire, it is important that you are someone who knows about the ICT facilities in your school and about practices regarding their use in your school.** If you do not have the information to answer particular questions, then please consult other persons in your school. The questionnaire will take you approximately 30 minutes to complete.
- The words computers and ICT (Information and Communication Technologies) are used interchangeably in this questionnaire.
- Please note that some questions refer to the entire school, other questions refer to Grades 8 to 10 only.
- Guidelines for answering the questions are typed in *italics*. Most questions can be answered by marking the one most appropriate answer. When a question states, "*Please mark all that apply*", you may give more than one answer.
- Please use a writing pen or ballpoint to write your answers.
- When you have completed this questionnaire, please return to the School Inspector's Office by 10th February 2010.

Further information

- When in doubt about any aspect of the questionnaire, or if you would like more information about it or the study, you can reach Elizabeth NdeukumwaNgololo by phone at the following numbers: (061) 207 7111 or 0811229022.

Thank you very much for your cooperation!

Part A: ICT in Your School

1. How many years has your school been using ICT for teaching and/or learning purposes for students in Grades 8 to 10?

Please mark only one choice.

☐	0–2 years	1
☐	3–5 years	2
☐	6–10 years	3
☐	11–15 years	4
☐	More than 15 years	5
☐	Don't know	0

______
6

2. To what extent do you agree with each of the following statements about the use of ICT in your school?

Please mark only one choice in each row.

		0	0	1	1
A	ICT is considered relevant in our school.	☐	☐	☐	☐
B	Our school has integrated ICT in most of our teaching and learning practices.	☐	☐	☐	☐
C	We have started to use ICT in the teaching and learning of school subjects.	☐	☐	☐	☐
D	We still do not know which ICT applications are useful for our school.	☐	☐	☐	☐
E	Constraints rule out the use of ICT in our school.	☐	☐	☐	☐

Strongly disagree = 0

Disagree = 0

Agree = 0

Strongly agree = 0

___ 5

3. Approximately how often during this school year did students in Grade 8 to 10 use ICT for learning in the following subject domains?

Please mark only one choice in each row.

		0	1	2	2
A	Mathematics	☐	☐	☐	☐
B	Natural Sciences	☐	☐	☐	☐
C	Social Sciences	☐	☐	☐	☐
D	Language of instruction (mother tongue)..........	☐	☐	☐	☐
E	Foreign languages...	☐	☐	☐	☐
F	ICT as separate subject	☐	☐	☐	☐

Never= 0

Sometimes= 1

Often= 2

Nearly always = 2

___ 12

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Part B: Digital Learning Materials

4. For each of the following technology applications, indicate whether it is available and whether you need it in your school for teaching and/or learning in Grade 8 to 10.

Please mark only one choice in each row.

		1	0	0
A	Equipment and hands-on materials (e.g., laboratory equipment, overhead projectors, slide projectors, graphic calculators)	☐	☐	☐
B	General office suite (e.g., word-processing, database, spreadsheet, presentation software).........................	☐	☐	☐
C	Multimedia production tools (e.g., media capture and editing equipment, drawing programs, webpage/multimedia production tools)	☐	☐	☐
D	Simulations/modeling software/digital learning games .	☐	☐	☐
E	Communication software (e.g., e-mail, chat, discussion forum)..	☐	☐	☐
F	Digital resources (e.g., portal, dictionaries, encyclopedia)	☐	☐	☐
G	Mobile devices (e.g., Personal Digital Assistant (PDA), cell phone)	☐	☐	☐
H	Smart board/interactive whiteboard..........................	☐	☐	☐
I	Mail accounts for teachers......................................	☐	☐	☐
J	Mail accounts for students......................................	☐	☐	☐

Available= 1

Needed but not available= 0

Not needed and not available =0

______
10

Part C: ICT infrastructure

5. In your school, about how many computers (including laptops) are available?

Count terminals (if they have a keyboard and a screen) as computers

Count laptops as computers

Exclude computers which are not in use

Exclude computers which are only used as servers

Exclude graphical calculators and Personal Digital Assistants (PDAs), hand-held computers and smartphones (phone integrated with PDA)

Please write a whole number. Write 0 (zero), if none

☐☐☐☐	Available in the school altogether?
☐☐☐☐	Available to students in Grades 8 to 10?
☐☐☐☐	Available only to teachers?
☐☐☐☐	Available only to administrative staff?
☐☐☐☐	Connected to the Internet/World Wide Web?
☐☐☐☐	Connected to a local area network (LAN)?
☐☐☐☐	Multimedia computers (equipped with a CD-ROM and/or DVD)?

6. How many of the computers in your school are laptops?

Please write a whole number. Write 0 (zero), if none

☐☐☐☐	Laptops

7. In your school, about how many of the following (school-owned) technologies are available?

A Personal Digital Assistant (PDA) is a palmtop with roughly the same functionalities as a PC.

Please write a whole number. Write 0 (zero), if none.

☐☐☐☐	PDAs and smartphones (phone integrated with PDA)
☐☐☐☐	Graphic calculators
☐☐☐☐	Smartboards (interactive whiteboard system)
☐☐☐☐	Projectors for presentation of digital materials

8. In your school, about what percentage of students bring any of the following to school?

Please mark only one choice in each row.

	1	1	2	2	3
PDAs/smartphones	☐	☐	☐	☐	☐
Graphic calculators	☐	☐	☐	☐	☐
Laptops	☐	☐	☐	☐	☐

Less than 10% =1

10–24% = 1

25–49% = 2

50–75% = 2

More than 75% = 3

___
9

9. Where are the computers for teaching and learning in Grade 8 to 10 located?

Please mark only one choice in each row.

		0	1
A	Most classrooms	☐	☐
B	Some classrooms	☐	☐
C	Computer laboratories	☐	☐
D	Library	☐	☐
E	Other places	☐	☐

No=0

Yes=1

___
5

10. Who is involved in the maintenance of computers in your school?

Please mark only one choice in each row.

		0	1
A	The school's own staff..	☐	☐
B	Staff from other schools	☐	☐
C	An external company hired by the school	☐	☐
D	An external unit arranged by the ministry..................	☐	☐
E	A Non-Governmental Organisation............................	☐	☐

No = 0

Yes = 1

______
5

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Part D: Professional Development

11. Have teachers in your school acquired knowledge and skills in using ICT for teaching and learning in any of the following ways?

Please mark only one choice in each row.

A	Via informal contacts/communication	☐	☐
B	Via the ICT coordinator or technical assistant	☐	☐
C	Via in-school courses	☐	☐
D	Via training from a teacher who has attended a course	☐	☐
E	Via the school's working group or committee for ICT in education	☐	☐
F	During meetings of the teaching staff where the use of ICT/computers in education is a regular item for discussion	☐	☐
G	Via a regular newsletter (printed or electronic)	☐	☐
H	Via courses conducted by an external agency or expert (in the school or on distance)	☐	☐
I	Via observation of and discussion with colleagues	☐	☐
J	Via reading professional journals and similar publications	☐	☐

10

No = 0

Yes = 1

12. For each of the following ICT-related courses, please indicate whether it is available to teachers in your school and who provides the course (inside or outside the school).

Please mark all that apply in each row.

		0	1	1
A	Introductory course for Internet use and general applications (basic word-processing, spreadsheet, databases, etc.)	☐	☐	☐
B	Technical course for operating and maintaining computer systems	☐	☐	☐
C	Advanced course for applications/standard tools (e.g., advanced word-processing, complex relational databases)	☐	☐	☐
D	Advanced course for Internet use (e.g., creating websites/developing a home page, advanced use of Internet, video conferencing) .	☐	☐	☐
E	Course on pedagogical issues related to integrating ICT into teaching and learning	☐	☐	☐
F	Subject-specific training with learning software for specific content goals (e.g., tutorials, simulation, etc.)	☐	☐	☐
G	Course on multimedia use (e.g., digital video and/or audio equipment)	☐	☐	☐

Not available= 0

Available provider is school-based =1

Available provider is an external organization = 1

____
7

Part E: Support Facilities for ICT

13. Do you hold any of the following positions at your school?

Please mark only one choice in each row.

		0	1
A	Principal	☐	☐
B	Head of department	☐	☐
C	School secretary	☐	☐
D	Teacher	☐	☐

No = 0
Yes = 1

___
4

14. Which of the following duties do you have?

Please mark only one choice in each row.

		0	1
A	I teach ICT courses to students.	☐	☐
B	I teach ICT courses to teachers and other school staff.	☐	☐
C	I teach Science.	☐	☐
D	I teach other subjects.	☐	☐
E	I formally serve as ICT coordinator.	☐	☐
F	I informally serve as ICT coordinator.	☐	☐

___
6

No = 0
Yes = 1

15. Approximately how much time in minutes, on average per week, do the following persons spend on providing ICT support to teachers and students at your school?

Note: "Support" includes any services (formal or informal, technical or pedagogical) that help teachers and students use ICT.

Please write a whole number. Write 0 (zero) if none.

- ☐☐ Yourself
- ☐☐ ICT staff (not including yourself)
- ☐☐ Other administrators and staff (e.g., secretary)
- ☐☐ Teachers
- ☐☐ Students from own school who are assigned to provide this service
- ☐☐ Volunteers from outside the school (e.g., parents)
- ☐☐ Personnel from external companies (e.g., non-governmental organization)
- ☐☐ Others

16. To what extent is technical support available in your school if teachers want to use ICT for the following activities?

Please mark only one choice in each row.

		0	1	1	0
A	Assigning extended projects (2 weeks or longer)	☐	☐	☐	☐
B	Assigning short-task projects	☐	☐	☐	☐
C	Assigning production projects (e.g. making models or reports)	☐	☐	☐	☐
D	Involving students in self-accessed courses and/or learning activities	☐	☐	☐	☐
E	Involving students in scientific investigations (open-ended)	☐	☐	☐	☐
F	Undertaking field study activities	☐	☐	☐	☐
G	Undertaking teacher's lectures	☐	☐	☐	☐
H	Applying exercises to practice skills and procedures ..	☐	☐	☐	☐
I	Involving students in laboratory experiments with clear instructions and well-defined outcomes...........	☐	☐	☐	☐
J	Involving students in discovering scientific principles and concepts	☐	☐	☐	☐
K	Involving students in studying natural phenomena through simulations	☐	☐	☐	☐
L	Involving student to look up for ideas and information	☐	☐	☐	☐
M	Involving students in processing and analyzing data	☐	☐	☐	☐

No support= 0

Some support= 1

Extensive support= 1

Not applicable = 0

13

Part F: Obstacles to realize pedagogical goals

17. To what extent is your school's capacity affected by each of the following obstacles?

Please mark only one choice in each row.

		0	1	1	2	0
A	Insufficient qualified technical personnel to support the use of ICT	☐	☐	☐	☐	☐
B	Insufficient number of computers connected to the Internet	☐	☐	☐	☐	☐
C	Insufficient Internet bandwidth or speed	☐	☐	☐	☐	☐
D	Lack of special ICT equipment for disabled students	☐	☐	☐	☐	☐
E	Insufficient ICT equipment for instruction ...	☐	☐	☐	☐	☐
F	Computers are out of date	☐	☐	☐	☐	☐
G	Not enough digital educational resources for instruction	☐	☐	☐	☐	☐
H	Lack of ICT tools for science laboratory work	☐	☐	☐	☐	☐
I	Teachers' lack of ICT skills	☐	☐	☐	☐	☐
J	Insufficient time for teachers to use ICT	☐	☐	☐	☐	☐
Other obstacles						
K	Pressure to score highly on standardized tests	☐	☐	☐	☐	☐
L	Prescribed curricula are too strict	☐	☐	☐	☐	☐
M	Insufficient or inappropriate space to accommodate the school's pedagogical approaches	☐	☐	☐	☐	☐
N	Insufficient budget for non ICT-supplies (e.g., paper, pencils)	☐	☐	☐	☐	☐
O	Using ICT for teaching and learning is not a goal of our school	☐	☐	☐	☐	☐

45

18. Do you have access to a computer at home?

☐ 0→ ***Please proceed to the end of the questionnaire.***

☐ 1 → ***Please continue.***

No = 0

Yes = 1

____ 1

19. Do you use this computer for the following activities?

Please mark only one choice in each row.

		0	1
A	School related activities	☐	☐
B	Connecting to the internet	☐	☐

No = 0

Yes = 1

____ 2

This is the end of the questionnaire.
Thank you very much for your cooperation!

Kindly return the questionnaire to the School Inspector's Office by the 02 February 2010

APPENDIX H

INTERVIEW SCHEDULE FOR PRINCIPALS

This interview was designed as part of a doctoral study project. The interview will be conducted only for academic purposes. Your school was chosen to participate in this project to provide information about how ICT is implemented in your school and how to improve the situation. The interview will be conducted in an informal manner and in an conducive environment and will only last about 40 minutes. The information gathered will be treated confidential and the identity of the interviewee will be kept anonymous.

Construct	**Questions**
Biographical information	What is your name? For how long have you been a principal at this school?
Curriculum Goals	How do you apply ICT to the curriculum? What is your role in applying ICT to the curriculum?
Leadership and vision	What is the vision of your school with regard to ICT implementation? How does the school leadership facilitate the ICT implementation process? How involved is the school leadership? Does the school leadership suggest or prescribe to you the type of ICT for use in a classroom?
Digital Learning Material	Do you have any educational software available at your school? What type? Do you think the educational software is relevant to your school context? Have teachers been trained in using this software?
Expertise	Have you been trained in ICT? What specific training did you receive? If not, how did you gain the skills? What strategies should be used to train more teachers? How do teachers embrace ICT?
ICT infrastructure	How many computers do you have in your school and how are they acquired? Who is responsible for maintenance of ICT at your school and how is it done? What should be done to connect ICT to the internet?
Use of ICT	What do you use ICT for? What should be done to increase participation by teachers and students? What specific problems do you encounter? And what could be the solutions to these problems?

Collaboration and support	Do you have collaboration between teachers in your school? Do you allow community members to use your facilities? Who facilitates that and what are the benefits thereof? Who decide on issues of collaboration? How do you describe the technical support system at your school? How do you describe the pedagogical support system at your school?

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APPENDIX I

INTERVIEW SCHEDULE FOR SCIENCE TEACHER

This interview was designed as part of a doctoral study project. The interview will be conducted only for academic purposes. Your school was chosen to participate in this project to provide information about how ICT is implemented in your school and how to improve the situation. The interview will be conducted in an informal manner and in an conducive environment and will only last about 60 minutes. The information gathered will be treated confidential and the identity of the interviewee will be kept anonymous.

Construct	**Questions**
Biographical information	What is your name? For how long have you been teaching at this school? What subject are you teaching?
Curriculum Goals	How do you apply ICT to the curriculum? What is your role in applying ICT to the curriculum? Do you think your teaching practice has changed? In what way?
Leadership and vision	What is the vision of your school with regard to ICT implementation? How does the school leadership facilitate the ICT implementation process? How involved is the school leadership? Does the school leadership suggest or prescribe to you the type of ICT for use in your classroom? What can other schools learn from your school management with regard to ICT implementation?
Digital Learning Material	Do you have any educational software available at your school? What type? Do you think the educational software is relevant to the context in which you teach? Have you been trained in using the software or can you adapt it to suit your particular needs? Which software do you prefer to use most? Why?
Knowledge, attitude and skills	Have you been trained in ICT? What specific training did you receive? If not, how did you gain the skills? What strategies should be used to train more teachers? Do you think the introduction of computers had an impact on the way you teach?
ICT infrastructure	How many computers do you have in your school and how are they acquired? Who is responsible for maintenance of ICT at your school and how is it done? What should be done to connect ICT to the internet?
Use of ICT	How do use ICT? In class and for preparation? What type of ICT do you use? What motivates you to use ICT? What should be done to increase participation by teachers and

	students? What specific problems do you encounter? And what could be the solutions to these problems?
Collaboration and support	Do you allow community members to use your facilities? Who facilitates that and what are the benefits thereof? Are you involved in this decision making? How do you describe the technical support system at your school? How do you describe the pedagogical support system at your school?

APPENDIX J

INTERVIEW SCHEDULE FOR ICT TECHNICIAN

This interview was designed as part of a doctoral study project. The interview will be conducted only for academic purposes. Your school was chosen to participate in this project to provide information about how ICT is implemented in your school and how to improve the situation. The interview will be conducted in an informal manner and in an conducive environment and will only last about 40 minutes. The information gathered will be treated confidential and the identity of the interviewee will be kept anonymous.

Construct	**Questions**
Biographical information	What is your name? For how long have you been working at this school? Are you also teaching? What subject are you teaching?
Curriculum Goals	How does the teacher apply ICT to the curriculum? What is your role in applying ICT to the curriculum? Do you think the teacher's teaching practice and preparation for the class has changed for the better? Do you think teachers practices have changed?
Leadership and vision	What is the vision of your school with regard to ICT implementation? How does the school leadership facilitate the ICT implementation process? How involved is the school leadership? Does the school leadership suggest or prescribe to you the type of ICT for use in a classroom? What can other schools learn from your school management with regard to ICT implementation?
Digital Learning Material	Do you have any educational software available at your school? What type? Have you been trained in using the software? What software do teachers like to use more?
Knowledge, attitude and skills	Have you been trained in ICT? What specific training did you receive? If not, how did you gain the skills? What strategies should be used to train more teachers? Do you think the introduction of computers had an impact on how teacher teach?
ICT infrastructure	How many computers do you have in your school and how are they acquired? How do you maintain the infrastructure? What should be done to connect ICT to the internet?
Use of ICT	How often do teachers use ICT? How do teachers use ICT in the lesson and also for class preparation?

	What should be done to increase participation by science teachers and students? What type of participation in ICT you think would be relevant and for what areas? What specific problems do you encounter? And what could be the solutions to these problems?
Collaboration and support	Do you allow community members to use your facilities? Who facilitates that and what are the benefits thereof? Who decide on issues of collaboration? What strategies do you use to support teachers with technical problems at your school?

APPENDIX K

CLASSROOM OBSERVATION SCHEDULE FOR SCIENCE TEACHERS

Background information	
Code of school	
Date	
Grade	
Subject	
Topic	
Name of teacher	
Number of lesson	
Minutes	

Construct	Activities			Comments
Physical space	Where are the computers located?			
		Yes	**No**	
	Most classrooms			
	Some classrooms			
	Computer laboratories			
	Library			
	Other places			
Digital Learning Material	**What digital learning material is available in the classroom?**			
	Extended projects (2 weeks or longer)			
	Short-task projects			
	Product creation (e.g., making a model or a report)			
	Self-accessed courses and/or learning activities			
	Scientific investigations (open-ended)			
	Field study activities			
	Teacher's lectures			
	Exercises to practice skills and procedures			
	Laboratory experiments with clear instructions and well-defined outcomes			
	Discovering science principles and concepts			
	Studying natural phenomena through simulations			
	Looking up ideas and information			
	Processing and analyzing data			

Construct	Activities			Comments
Knowledge, attitude and skills	Is the teacher demonstrating the following abilities?			
		Yes	No	
	Present information/demonstrations and/or give class instructions			
	Provide remedial or enrichment instruction to individual students and/or small groups of students			
	Help/advise students in exploratory and inquiry activities			
	Organize, observe or monitor student-led whole-class discussions, demonstrations, presentations			
	Assess students' learning through tests/quizzes			
	Provide feedback to individuals and/or small groups of students			
	Use classroom management to ensure an orderly, attentive classroom			
	Organize, monitor and support team-building and collaboration among students			
	Organize and/or mediate communication between students and experts/external mentors			
	Liaise with collaborators (within or outside school) for student collaborative activities			
	Provide counseling to individual students			

Construct	Activities			Comments
ICT infrastructure	What ICT equipment is available in the classroom?			
		Yes	No	
	Equipment and hands-on materials (e.g., laboratory equipment, musical instruments, art materials, overhead projectors, slide projectors, electronic calculators)			
	Tutorial/exercise software			
	General office suite (e.g., word-processing, database, spreadsheet, presentation software)			
	Multimedia production tools (e.g., media capture and editing equipment, drawing programs, webpage/multimedia production tools)			
	Simulations/modeling software/digital learning games			
	Communication software (e.g., internet, e-mail, chat, discussion forum)			
	Digital resources (e.g., portal, dictionaries, encyclopedia)			
	Mobile devices (e.g., Personal Digital Assistant (PDA), cell phone)			
	Smart board/interactive whiteboard			
	Learning management system (e.g., web-based learning environments)			

Construct	Activities			Comments
Use of ICT	What pedagogical ICT practices are being demonstrated in and outside of the classroom?			
		Yes	**No**	
	Lesson preparation that involves the use of ICT by students.			
	Knowing which teaching/learning situations are suitable for ICT use.			
	Finding useful curriculum resources on the Internet.			
	Using ICT for monitoring students' progress and evaluating learning outcomes.			
	Using ICT to give effective presentations/ explanations.			
	Using ICT for collaboration with others.			
	Installing educational software on computer.			
	Using the Internet (e.g., select suitable websites, user groups/discussion forums) to support student learning.			

APPENDIX L: ICT USE CONFERENCE PROGRAMME

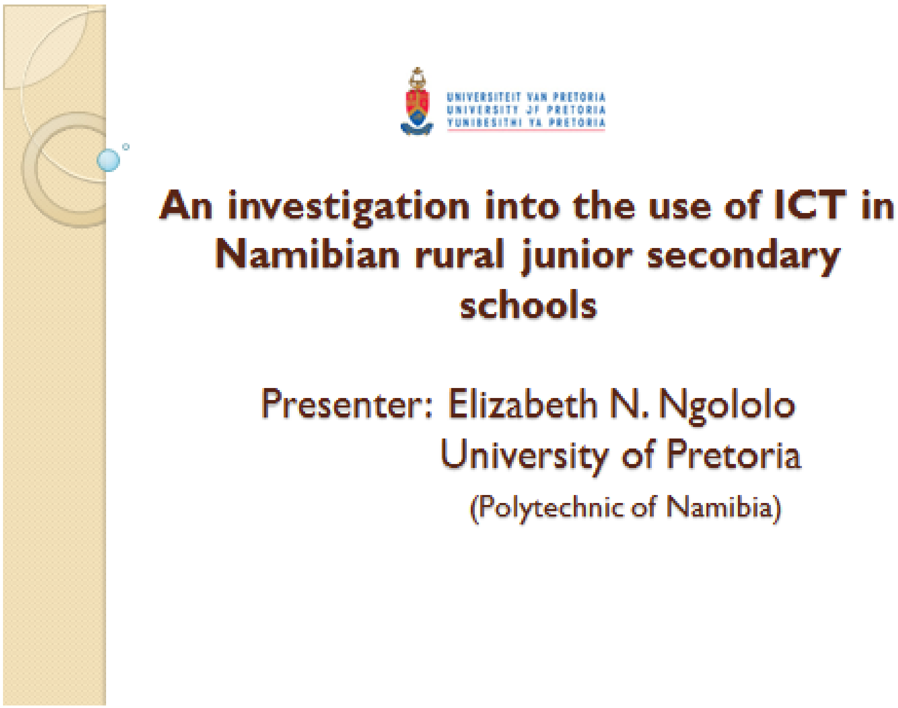
An investigation into the use of ICT in Namibian rural junior secondary schools

ICT use conference Programme
University of Namibia
Oshakati Campus
Oshakati
02 July 2010

Time	Agenda	Presenter
1	Welcoming remarks	Elizabeth N. Ngololo
2	Introduction of participants	Individual participants
3	Presentation of the study	Elizabeth N. Ngololo
4	**Exercise 1**	Individual participants
5	Collection of data on Exercise 1	Elizabeth N. Ngololo
6	Repeat of Exercise 1	Subgroups (principals, teachers, ICT technicians)
Break		
7	Presentation of results for Exercise 1	National ICT Coordinator
8	Presentation of preliminary findings from the main study	Elizabeth N. Ngololo
9	Conclusion on findings for Research question 2	Elizabeth N. Ngololo
10	**Exercise 2**	Individual participants
11	Discussions on main factors and how they are linked to each other	Subgroups
12	Presentation of results for Exercise 2	Director: Ohangwena Region
13	Presentation of preliminary findings from the main study	Elizabeth N. Ngololo
14	Conclusion on findings for Research question 3	Elizabeth N. Ngololo
15	Suggestions for improvement of national ICT Policy implementation	All participants

APPENDIX M

POWERPOINT PRESENTATION



Presentation layout

- Introduction
- Aims of the study
- Research questions
- Research methods
- Curriculum conference aims
- Context
- Conceptual framework
- Exercise 1
- Preliminary findings
- Exercise 2
- Suggestions for improvement

Introduction

- Governments around the world are recognizing the critical importance of education to economic development and to the high quality of life of all citizens.
- Governments and schools face decisions about whether and how to integrate ICT into teaching and learning. Choices are complex, technically demanding, and the effects are not always known (Anderson & Plomp, 2009).
- Teachers are expected to integrate ICT in the curriculum.
- There is currently little understanding of the way in which ICT is used in schools and classroom around the world. (Ainley, Enger, Searle, 2008; Anderson & Plomp, 2009; Boateng, 2007)).

The aim of the study

The aims of the study are to:

- To evaluate the implementation of the ICT Policy for Education in rural schools.
- To explore how science teachers integrate ICT in science classrooms in Namibian rural schools.
- To identify factors that affect ICT implementation in Namibian rural schools.
- To contribute to the knowledge about the implementation of ICT in rural schools in developing countries.

Research questions

How and to what extent is the intended ICT Policy implemented in the junior secondary schools in Namibian rural areas?

- How is ICT implemented in Namibian rural secondary schools?
- What factors affect ICT implementation in these schools?

Research methods

1. **Survey** to gather data that will allow description of the rural situation, and to identify standard against which to compare.
2. **Case studies** to portray what is like to teach using ICT in a real life context.
3. **Curriculum conference** to legitimate the findings

Curriculum conference aims

- To legitimate the preliminary findings from the survey; case studies; and
- To generate ideas and suggestions on how to tackle the problems and issues that have been identified in this study.

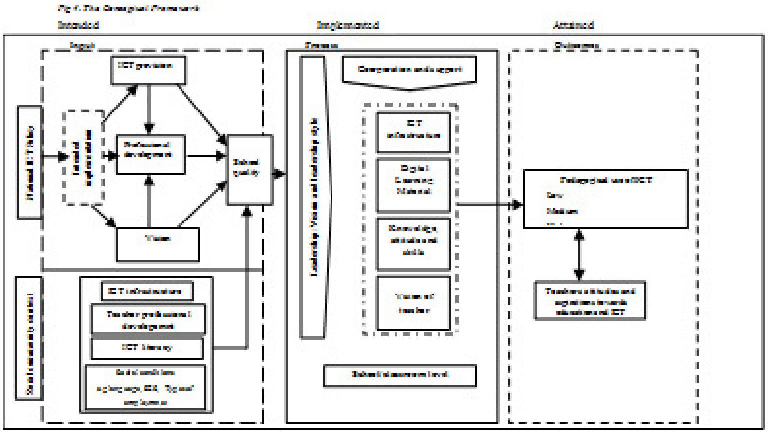
Context of the study

- The Namibian government has invested 39.171 million in the ICT programme.
- To date, no evaluation has been done to investigate how ICT is being implemented in rural schools.
- Effective strategies to improve the implementation process is needed, if Namibia is to become a technologically literate nation by 2030 (MoE, 2006).

Summary of Allocation of Funds for ETSIP for 2009 / 2010

Summary of Allocation of Funds for ETSIP for 2009 / 2010					
Sub-Programme	Percentage Of ETSIP	Amount from GRN	Amount from DP's	Total Allocation	Adjusted Programme Cost
		Millions	Millions	Millions	
General Education	61	61	54	115	415
VET	10	10	9	19	118.773
Tertiary Education	4	4	4	8	5.786
Knowledge	1	1	1	2	2.594
IALL	5	5	4	9	37.208
ICT's	14	14	13	27	39.171

Conceptual framework



ICT infrastructure

- Every school is provided with 20 computers irrespective of the number of students per school.
- 1 computer at a desk, 1 chair for 40 students.
- Some schools bought about 6-7 computers used for administrative work.

'When it comes to the ones that we bought ourselves, we are maintaining them. And the ones that were donated by School-net, when they break...[we] take to their branch in Ondangwa for their technician to repair them. ... We consult the people from where we bought them. We take them to those people and they repair them when they have breakage and they install a software if there is a need to install and then we pay for the service' (Principal B, 13 April, 2010).

- Rules are developed to maintain the computers.

ICT infrastructure…cont'd

- The technician is '*overloaded because he is the only one in the whole region. You call him and he is always telling you that he is at another school. It is difficult to see him'* (Principal C, 15 April, 2010).
- 2/3 schools have Internet. School B has a 3g (internet device) which the school is paying for. School C has Internet from the Government project and pays for N$ 500.00
- In Chile for example, the government also provided all schools with software and now in a process of trying to look into a strategy to involve schools into maintaining and renovating software (Hinostroza, Hepp, Cox, 2009).

Digital learning materials

- Encarta and MS package are available at all participating schools.
- School B and C bought extra software, e.g the one used to timetable and for producing report cards. In addition, School C has Equation 3.0
- Relevance- *'They are very much relevant and they make teachers work easier, more especially when it comes to compiling their schedules, teachers do not need to scratch their heads and used a lot of their energy. They seems to enter the marks on the computer, the computer do everything for them… and when it comes to writing report cards , the time you enter the marks on the computer is the time when the computer is writing down the report on the card.'* (Principal B, 13 April, 2010).

Professional development

- A few teachers have indicated that they have been trained in ICDL.
- At the time of data collection, training in ICDL was being rolled out to a number of schools.
- Knowledge in ICT use and technical use is acquired informally.
- No training has been offered in the pre-installed software in the computers.

Digital learning materials…cont'd

- Only a few number of schools considered buying additional digital learning materials to support innovative teaching ideas.
- Microsoft Word was the mostly used by the teachers and learners.

Knowledge, attitude and skills

- Some ICT technicians and teachers expressed knowledge in technical and software use.
- Very little or no training was done for principals and science teachers. For example:

I had some elementary training some years back, 2004 but it was not intensive. I really wanted to do Excel and PowerPoint but unfortunately it was just limited to Microsoft Word and document writing ... I would really like to be trained.... it was just Microsoft Word, on how to write letters and design and how to open and create folders. I really wanted to be trained in Powerpoint. These days when you go to a conference and you are asked to present, one uses PowerPoint' (Principal A, 12 April 2010).

'I acquired this knowledge through my brother who is an ICT technician. He has been working with computers and most times he was teaching at some institutions and he also tried to attend classes. I did not get any formal training in ICT and therefore no formal qualification in it.' (Technician A, 13 April 2010).

Knowledge, attitude and skills…cont'd

- Concept of ICT integration in Namibia seems very unclear (Iipinge, 2010; Matengu, 2006).
- Some teachers possess skills in MS Word, Excel, PowerPoint, Internet, operations of Encarta, Equation 3.0; Timetable software and Report card development software.
- Strategy for increased use- *'most of them are eager to learn. It is only that they don't have time but if that ICDL thing they have to come cause they are going to get something at the end and everybody want them to be trained...Yes and they will be a laptop to be awarded to a person to complete all the modules.'* (Technician B, 13 April 2010).
- Some teachers demonstrated confidence in using ICT, and mastery of subject content.

Vision

- Schools have a common vision towards ICT for everyone at school to be ICT literate.
- Elements of the vision outs emphasis on skills acquisition and encourage learners in rural schools to access ICT.
- School board/leadership is responsible for ICT implementation.
- The decision to use ICT rests with the teachers.
- Role of school leadership is in line with the vision of the schools- *'I think they make sure that the instructor or computer studies and they make sure that computers are there and functioning so that sometimes internet is working because I understand that it is paid for so they make sure they have these things… I think that their intention to have ICT working well in the school.'* (Science teacher B, 13 April 2010).

Support

Pedagogical support

- No pedagogical support given to teachers because of lack of knowledge in ICT by senior teachers.
- No teacher's forum developed for pedagogical support.

Technical support

- Only one ICT technician hired for one educational region.
- Limited support offered voluntarily by ICT technicians.
- ICT technician are acting voluntarily.
- Technicians lack troubleshooting skills.

Exercise 1- Baseline survey

- You are kindly asked to rate your school in terms of implementing the following variables:
  - ICT infrastructure
  - Digital learning materials
  - Knowledge, attitude and skills
  - Vision & leadership
  - Collaboration and support
- Kindly refer to the sheet provided to you:
  1. Individually
  2. In groups: principals, teachers, ICT technicians

Preliminary findings

Preliminary findings-Baseline survey

At national level:

- ICT infrastructure
- Maintenance
- Professional development

At school level:

- Vision and leadership
- Curriculum goals
- Collaboration and support
- Digital learning materials
- Knowledge, attitude and skills

ICT infrastructure

- The extent to which ICT infrastructure is made available by government is low.
- According to all respondents, there is insufficient number of computers in schools.
- A total of 20 computers are being supplied to schools to be shared by 2 learners per computer. Also, learners were observed sharing a chair in twos during lessons that use ICT.
- Some schools have bought additional computers.

Maintenance

- ICT maintenance is poorly managed.
- There is no designated position for ICT technician in the schools.
- Teachers take it upon themselves to act as ICT technicians.
- These technicians have little knowledge about trouble shooting.
- Technical support is provided during free time.
- The Regional ICT technician does not respond on time.

Professional development

- Professional development implementation stands at the medium level.
- The teachers have not been trained to use pre-installed software.
- The teachers integrate ICT the way they understand it.
- Generally, the idea of using ICT is appreciated by a few.
- Many teachers may be victims of teachers educational programmes that did not use ICT integration or taught how to integrate ICT in teaching.

Vision and leadership

- The extent of implementation of the vision statement of the National ICT Policy is very low.
- The focus of leadership with regard to ICT is to prepare teachers and learners for the 21st century although the strategy to do so is not clear.
- The school leadership takes decisions and inform the school board with minimum involvement of parents.

Curriculum goals

- The extent to which the curriculum goals statements are supported by ICT, is medium.
- Teachers expressed disappointment that the science curriculum is not explicit about ICT use.

Collaboration and support

- According to the principals, collaboration and support in general is vey high.
- Teachers communities are not developed within and between schools.
- Local communities are not allowed to use the ICT laboratories in the schools, although the schools could generate money from such activities to buy toner and also have their computers repaired by outside technicians.

Pedagogical support

- Pedagogical support in schools is very low.
- Teachers receive very little pedagogical support from their seniors in schools.
- Many experienced teachers do not know how to integrate ICT in their lesson and therefore they are not in a better position to offer such services.

Technical support

- Technical support in schools is also very low.
- The hardware, software, and networking services are performed during deployment of computers to schools.
- The daily technical support needed not available on regular basis, due to lack of the ICT technician at school and if it were provided at regional level, it would take very long.

Digital Learning Materials

- Digital learning materials level of implementation is very low.
- The teachers are not trained to use the pre-installed software.
- Not much investment goes into acquiring the digital learning materials.
- Access to acquiring digital learning materials is limited. The government has signed an agreement with Microsoft to be supplying computers to schools, thereby limiting the use of free software that is available through Linux.
- The teachers use digital learning materials occasionally. The digital learning materials have a weak link with the school's overall educational approach and its use.
- Some schools have bought additional software to enhance effectiveness of their work.

Knowledge, attitude and skills

- The extent of implementation of knowledge, attitude and skills in rural schools is medium.
- Principals, teachers and ICT technicians acquired knowledge on ICT in an informal forum.
- Repairs of computers is done on a gut feeling by ICT technicians.
- ICDL training was about to start. Training on how to integrate ICT into the science lessons is not evident.
- Introduction of computers made teachers' life easy as they are able to complete the tasks in a reasonable time.

Exercise 2-Case studies

Individual activity:

- Rate the factors that affect ICT implementation on a 4 point scale.

Group activity:

- Show the link between the factors.

Kindly refer to the additional sheet provided to you.

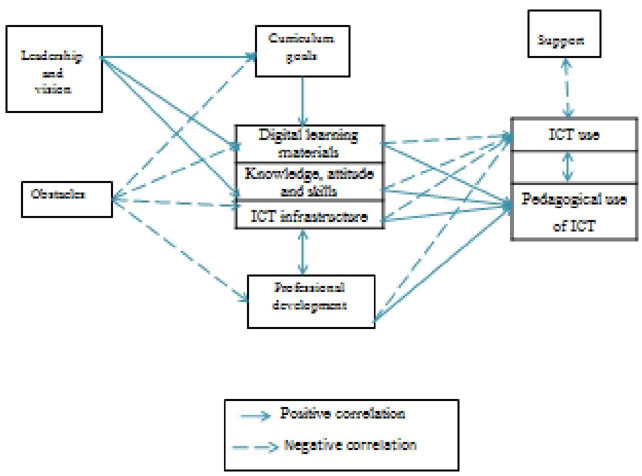
Factors affecting ICT implementation

Independent variables	
Factors	**Level of significance**
Vision and leadership	Not significant
Collaboration and support	Not significant
ICT infrastructure	significant
Digital learning material	significant
Knowledge, attitude and skills	significant
Professional development	significant
Curriculum goals	Not significant
Obstacles	Not significant

Dependent variables

- Pedagogical use of ICT

Linkage of factors



Suggestions for improvement

Variables	Suggestion
ICT infrastructure	
Digital learning materials	
Knowledge, attitude and skills	
Vision & leadership	
Collaboration and support	

APPENDIX N: ICT USE CONFERENCE

An evaluation of the implementation of ICT Policy for Education in rural Namibian junior secondary schools
(PhD study)

ICT USE CONFERENCE QUESTIONNAIRE

School code	Name of the school

Position held at school

Introduction

The questionnaire is part of a doctoral study project which aims at investigating how and to what extent the Namibian policy on ICT in education has been implemented in rural areas since its establishment in 2005. The questionnaire is designed and will be administered only for graduation purposes. You and your school have been chosen to participate in this curriculum conference in assessing the preliminary results of this study on how Information and Communication Technologies (ICT) support your school, the obstacles or difficulties you experience in relation to these technologies and how to improve ICT use.

Why is this information important?

This information will give better insight into the current state of pedagogical approaches utilized in schools and how technologies support them. It will also allow educational practitioners and policy-makers to gain a better understanding of areas needing intervention and additional support.

Confidentiality

All information is treated as confidential. At no time will the name of your school or your name be mentioned in the study. The school will receive feedback but no one will know what you have answered only the overall results will show.

Exercise 1

1.1 To what extent do you agree with each of the following statements about ICT in your school?

Constructs	Variables	Strongly agree	Agree	Disagree	Strongly disagree
ICT infrastructure	**Statements**				
	There is sufficient number of computers available.				
	Computers at our schools are well maintained.				
	My school has invested a substantial amount of money in buying ICT tools.				

Digital learning materials	**Statement**	**Very sufficient**	**Rather sufficient**	**Somewhat sufficient**	**Not sufficient at all**
	Our school has invested in buying software for teaching				
	Statement	**Very relevant**	**Rather relevant**	**Somewhat relevant**	**Not relevant at all**
	The digital materials we have at our school are relevant for teaching science.				
	Statement	**Very much**	**Rather well**	**somewhat**	**Not at all**
	I possess skills that will enable me to use the digital learning material available at my school.				

Knowledge, attitude and skills	**Statements**	**All relevant**	**Most relevant**	**Some relevant**	**Hardly any relevant**
	I have relevant knowledge of ICT for use in teaching.				
	My ICT skills are relevant to assist or teach colleagues in their use of ICT.				
	Statement	**Very much agree**	**Rather agree**	**Somewhat agree**	**Disagree**
	Science teachers at my school possess the right attitude to use ICT.				

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Vision & leadership	Statements	Strongly agree	Agree	Disagree	Strongly disagree
	The vision statement of our school articulates the general use of ICT very well.				
	The vision statement of our school articulates the use of ICT in teaching science very well.				
	Statement	**Very much active**	**Rather active**	**Somewhat active**	**Not at all active**
	Our school leadership is very active in all ICT related matters.				
	Statement	**Very much encouraging**	**Rather encouraging**	**Somewhat encouraging**	**Not at all encouraging**
	Our school's leadership is encouraging teachers to use ICT.				

Collaboration	**Statements**	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
	Our school collaborates very well with other schools on ICT related matters.				
	I collaborate very well with other teachers in my circuit on ICT related matters.				
	I belong to a very well established teachers' online forum.				
Support	**Statements**	**Very much**	**A little**	**Somewhat**	**Not at all**
	I receive/render the necessary technical support on time.				
	I receive/render the necessary pedagogical support on time.				

Professional development	**Statements**	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
	I have been very well trained in the use of ICT.				
	I have been very well trained in integrating ICT in my teaching.				
	The training I received was relevant for teaching science.				

Exercise 2

Please indicate the degree of importance of factors which have a greater influence on ICT use and pedagogical use of ICT.

Factors	**Very important**	**Rather important**	**Somewhat important**	**Not important**	**Suggestions**	
Vision and leadership						
Collaboration						
Pedagogical Support						
Technical support						
ICT infrastructure						
Professional development						
Digital learning materials						
Knowledge, attitude and skills						
Pedagogical use of ICT						
ICT use in general						
Other factors, please specify						

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Exercise 1

Constructs	**Variables**	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
ICT infrastructure	**Statements**				
	There is sufficient number of computers available.				
	Computers at our schools are well maintained.				
	My school				

Digital learning materials	**Statement**	**Very sufficient**	**Rather sufficient**	**Somewhat sufficient**	**Not sufficient at all**
	Our school has invested into buying software for teaching				
	Statements	**Very relevant**	**Rather relevant**	**Somewhat relevant**	**Not relevant at all**
	The digital materials we have at our school are relevant for teaching science.				
	I possess skills that will enable me to use the digital learning material available at my school.				

1.1 To what extent do you agree with each of the following statements about ICT in your school?

Knowledge, attitude and skills	**Statements**	**Very relevant**	**Rather relevant**	**Somewhat relevant**	**Not relevant at all**
	I have relevant knowledge in ICT				
	I have relevant skills in ICT to teach/assist colleagues.				
	Science teachers at my school possess the right attitude to use ICT.				

Vision & leadership	**Statements**	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
	Our school has a vision statement with regard to ICT.				
	Our school leadership is very active in all ICT related matters.				
	Statements	**Very encouraging**	**Rather encouraging**	**Somewhat encouraging**	**Not at all encouraging**
	Our school's vision encourages the use of ICT in class.				
	Our school leadership is encouraging teachers to use ICT.				

Collaboration	**Statements**	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
	Our school collaborate with other schools on ICT related matters				
	I collaborate with other teachers in my circuit on ICT related matters				
	I belong to a teachers' online forum.				
Support	**Statements**	**Very much**	**A little**	**Somewhat**	**Not at all**
	I receive/render necessary technical support on time.				
	I receive/render the necessary pedagogical support on time.				

Professional development	**Statements**	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
	I have been trained in ICT.				
	I have been trained in ICT integration.				
	The training I received was relevant for teaching science.				

Exercise 2

2.1 Please indicate the degree of importance of factors which have a greater influence on ICT use and pedagogical use of ICT.

Factors	**Very important**	**Rather important**	**Somewhat important**	**Not important**
Vision and leadership				
Collaboration				
Pedagogical Support				
Technical support				
ICT infrastructure				
Professional development				
Digital learning materials				
Knowledge, attitude and skills				
Pedagogical use of ICT				
ICT use in general				
Other factors, please specify				

2.2 Based on the degree of importance of factors above, please illustrate how each factor is linked to another.

Any other comment

___

___

___

APPENDIX O: TABLE OF INDICES

Table of Indices/indicators at classroom and school level*)

Construct	*Data source*	*Description*	*Computation*	*Reliability (Cronbach alpha)*
ICT use	Principals	General use of ICT for administrative purposes.	A sum of scores was computed across 10 items based on on yes=1, no=0 (See Appendix A: Principal Questionnaire, items 19, 20, 21 and 22.	0.856
Pedagogical use of ICT	Science teachers	ICT use for teaching science.	A sum of scores was computed across 33 items based on yes=1, no=0 (See Appendix B: Science Teachers Questionnaire, items 16, 17 and 18).	0.887
Leadership	Science teachers	Developing an overall view of how to use ICT, channelling school development and inspiring goals.	A sum of scores was computed across 3 items based on Likert scale: not at all=0, a few times= 1, monthly=1, often=2) indices (See Appendix B: Science Teachers Questionnaire, item 13).	0.613
	Principals		A sum of scores was computed across 20 items based on yes=1, no=0 and another sum of scores 9 based on indices not at all=0, a few times= 1, monthly=1, often=2. (See Appendix A: Principal Questionnaire, items 9 and 10).	0.872
vision	Science teachers	The focus of ICT implementation in the education system, particularly with ICT use in enhancing science education.	A sum of scores was computed across 3 items based on indices not at all=0, a little= 1, somewhat=1, a lot=2) (See Appendix B: Science Teachers Questionnaire, item 12).	0.786
	Principals		A sum of scores was computed across 10 items based on indices Strongly agree=1, agree=1, disagree=0 strongly disagree=0. (See Appendix A: Principal Questionnaire, items 8)	0.090

Construct	*Data source*	*Description*	*Computation*	*Reliability (Cronbach alpha)*
Science curriculum goals on ICT	Science teachers		A sum of scores was computed across 13 items based on Likert scale: not at all=0, a little= 1, somewhat=1, very much=2) indices(See Appendix B: Science Teachers Questionnaire, item 11).	0.877
Collaboration	Principals	collaboration between teachers in the same school sharing knowledge in a team and the ability to consult teachers from other schools.	A sum of scores was computed across 4 items for the first set of questions based on strongly agree=1, agree=1, disagree=0 strongly disagree=0. (See Appendix A: Principal Questionnaire, items 11)	0.441
	Science teachers		A sum of scores was computed across 4 items based on indices not at all=0, a little= 1, somewhat=1, a lot=2) (See Appendix B: Science Teachers Questionnaire, item 14). .	0.625
Support on assessment	Principals	Supporting teachers with the use of ICT, i.e, pedagogical support and or supporting teachers technically.	A sum of scores was computed across 8 items for the first set of questions based on strongly agree=1, agree=1, disagree=0 strongly disagree=0. (See Appendix A: Principal Questionnaire, items 12)	0.784
Pedagogical support	Principals	Availability and frequency of providing pedagogical support.	A sum of scores was computed across 11items based on Never=0; Not applicable=0, Few times a year=1; Monthly=1, Weekly=2; 6 items based on Not at all=0, a little=1, somewhat=1, a lot=2.(See Appendix A: Principal Questionnaire, items 23 and 24)	0.901

Construct	*Data source*	*Description*	*Computation*	*Reliability (Cronbach alpha)*
Technical support	ICT technicians	Technical support given to science teachers when necessary to support teaching. Students also be able to access computers	A sum of scores was computed across 23 items based on yes=1, no=0; and 6 items based on yes=1, no=0. (See Appendix C: ICT technician Questionnaire, items 16)	0.847
	Science teachers		A sum of scores was computed across 3 items based on indices not at all=0, a little= 1, somewhat=1, a lot=2) (See Appendix B: Science Teachers Questionnaire, item 15).	0.756
Professional development	Science teachers	Teacher training programme with regard to ICT skills and ICT integration in the science subjects.	A sum of scores was computed across 7 items based on no, I do not wish to attend=0, No, I would like to attend if available=1, Yes, I have=1. (See Appendix B: Science Teachers Questionnaire, item 25).	0.685
	ICT technicians		A sum of scores was computed across 17 items based on yes=1, no=0; 7 items based on not available=0, available, provider is school based=1, and available provider is an external organization=1. (See Appendix C: ICT technician Questionnaire, items 11 and 12).	0.905

Construct	***Data source***	***Description***	***Computation***	***Reliability (Cronbach alpha)***
Digital learning materials	Science teachers	All digital learning educational content whether formal or informal. This includes educational computer programmes.	A sum of scores was computed across 13 items based on never=0, sometimes=1, often=2, nearly always=2. (See Appendix B: Science Teachers Questionnaire, item 16).	0.922
	ICT technicians		A sum of scores was computed across 10 items based on available=1, needed but not available=0, not needed and not available=0. (See Appendix C: ICT technician Questionnaire, items 4)	0.738
Expertise (ICT related)	Science teachers	Teachers need to have sufficient knowledge and skills in order to utilise ICT to achieve educational objectives.	A sum of scores was computed across 12 items based on never=0, sometimes=1, often=2, nearly always=2, no=0, yes=1. (See Appendix B: Science Teachers Questionnaire, item 17 and 18).	0.898
	Principals		A sum of scores was computed across 20 items based on No= 0, Yes encouraged = 1, Yes required = 1; 10 items based on not considered=0, low priority=1; medium priority=2; and high priority=3; 4 items based on never=0, a few times per year=1, almost monthly=1, weekly=2, daily=3; 10 items based on no=0, yes=1; 1 items based on yes=1, no=0; and 2 items based on yes=1, no=0. (See Appendix A: Principal Questionnaire, items 17, 18,19,20)	0.904

Construct	***Data source***	***Description***	***Computation***	***Reliability (Cronbach alpha)***
Confidence in ICT use[ii]	Science teachers	Skills beyond basic ICT skills to operate a computer.	A sum of scores was computed across 8 items based on not at all=0, a little= 1, somewhat=1, a lot=2) (See Appendix B: Science Teachers Questionnaire, item 20 A-H).	Not enough variance
Confidence in Pedagogical use of ICT	Science teachers	Pedagogical ICT skills are also necessary to help structure and organise learning processes.	A sum of scores was computed across 8 items based on not at all=0, a little= 1, somewhat=1, a lot=2) (See Appendix B: Science Teachers Questionnaire, item 20 I-P).	0.890
ICT infrastructure	Principals	Availability and quality of computers, networks, and Internet connections.	A sum of scores was computed across 14 items based on not applicable= 0, subject department/teacher =1; school leadership=2; and 10 items based on yes=1 and no=0. (See Appendix A: Principal Questionnaire, items 13 and 14)	0.868
	Science teachers		A sum of scores was computed across 10 items based on never=0, sometimes=1, often=2, nearly always= 2. (See Appendix B: Science Teachers Questionnaire, item 19).	0.846
	Technicians		A sum of scores was computed across 13 items based on less than 10% =1, 10-24% = 2, 25-49% = 2, 50-75% = 2, more than 75% = 3. (See Appendix C: ICT technician Questionnaire, items 8, 9 and 10).	0.746

Construct	*Data source*	*Description*	*Computation*	*Reliability (Cronbach alpha)*
Obstacles	ICT technicians	Obstacles experienced during the process of ICT implementation such as ICT not considered in school, lack of time to develop and implement activities.	A sum of scores was computed across 15 items based on Not at all=0; 0, Very little= 1; Somewhat=1, to a great extent= 1; Not applicable=0. (See Appendix C: ICT technician Questionnaire, items 17).	0.925
	Principals		A sum of scores was computed across 12 items based on Not at all=0; Not applicable=0, A little= 1; Somewhat=1, A little= 1; Somewhat=1. (See Appendix A: Principal Questionnaire, items 25)	0.861
	Science teachers		A sum of scores was computed across 12 items based on Yes=1; No=0 (See Appendix B: Science Teachers Questionnaire, item 24).	0.938

*) Legend:

- Unless mentioned otherwise, all indicators are calculated as the arithmetic mean of constituting items
- Interpretation of indicator level: *low* if mean ≤ 33.3%; *medium* if mean between 33.3% and 66.6%; *high* if mean ≥66.6%.

APPENDIX P

CORRELATIONS TABLE

	Curriculum_goals	Effort_P	Vision_P	Vision_S	Leadership_P	Leadearhip_S	Collaboration_S	Collaboration_P	Support_S	Support_P	DLM_S	Attitude_S	Expertise_S	Expertise_P	ICT_Infrastructure_S	ICT_Infrastructure_P
Curriculum_goals	1	-0.099	0.471	0.313	0.425	-0.148	0.263	-0.09	0.05	-0.005	-0.015	0.111	0.164	-0.037	0.001	-0.114
Effort_P	-0.099	1	0.012	0.067	0.021	0.244	-0.216	0.109	0.025	0.114	0.099	0.037	0.004	0.254	-0.018	0.529
Vision_P	0.471	0.012	1	0.074	0.467	-0.08	0.324	-0.112	-0.023	-0.01	0.172	0.167	0.036	-0.04	-0.043	0.03
Vision_S	0.313	0.067	0.074	1	0.233	-0.006	0.04	0.119	0.04	0.198	-0.03	-0.05	-0.024	0.187	0.038	0.105
Leadership_P	0.425	0.021	0.467	0.233	1	0.044	0.26	-0.115	0.22	0.041	0.096	0.07	0.077	-0.002	-0.002	0.14
Leadearhip_S	-0.148	0.244	-0.08	-0.006	0.044	1	-0.339	0.105	-0.014	0.127	-0.094	-0.095	-0.049	0.295	-0.048	0.334
Collaboration_S	0.263	-0.216	0.324	0.04	0.26	-0.339	1	-0.067	-0.036	-0.084	0.042	-0.079	0.095	-0.165	-0.099	-0.215
Collaboration_P	-0.09	0.109	-0.112	0.119	-0.115	0.105	-0.067	1	0.078	0.457	-0.004	-0.005	0.173	0.193	-0.009	0.072
Support_S	0.05	0.025	-0.023	0.04	0.22	-0.014	-0.036	0.078	1	0.227	-0.022	0.083	0.199	0.07	0.337	-0.018
Support_P	-0.005	0.114	-0.01	0.198	0.041	0.127	-0.084	0.457	0.227	1	0.033	0.125	0.079	0.05	-0.01	-0.017
DLM_S	-0.015	0.099	0.172	-0.03	0.096	-0.094	0.042	-0.004	-0.022	0.033	1	0.697	0.331	0.156	0.269	0.163

	Curriculum_goals	Effort_P	Vision_P	Vision_S	Leadership_P	Leadearhip_S	Collaboration_S	Collaboration_P	Support_S	Support_P	DLM_S	Attitude_S	Expertise_S	Expertise_P	ICT_Infrastructure_S	ICT_Infrastructure_P
Attitude_S	0.111	0.037	0.167	-0.05	0.07	-0.095	-0.079	-0.005	0.083	0.125	0.697	1	0.516	-0.06	0.388	0.165
Expertise_S	0.164	0.004	0.036	-0.024	0.077	-0.049	0.095	0.173	0.199	0.079	0.331	0.516	1	0.072	0.442	0.008
Expertise_P	-0.037	0.254	-0.04	0.187	-0.002	0.295	-0.165	0.193	0.07	0.05	0.156	-0.06	0.072	1	0.098	0.272
ICT_Infrastructure_S	0.001	-0.018	-0.043	0.038	-0.002	-0.048	-0.099	-0.009	0.337	-0.01	0.269	0.388	0.442	0.098	1	0.096
ICT_Infrastructure_P	-0.114	0.529	0.03	0.105	0.14	0.334	-0.215	0.072	-0.018	-0.017	0.163	0.165	0.008	0.272	0.096	1
ICT_use_P	-0.169	0.476	-0.092	0.093	-0.057	0.238	-0.172	0.109	-0.013	0.072	0.063	0.023	-0.001	0.461	0.081	0.432
Pedagogical_use_S	0.045	0.163	-0.166	0.01	-0.09	0.219	-0.325	0.107	0.279	0.187	0.109	0.306	0.388	0.059	0.424	0.067

APPENIDX P: LETTER FROM THE EDITOR

Acknowledgment of Language Editing

I have edited the following thesis to academic standards of English:

An evaluation of the implementation of ICT Policy for Education in Namibian rural schools

By Elizabeth Ngololo

Date: Monday 13th September, 2010

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