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:
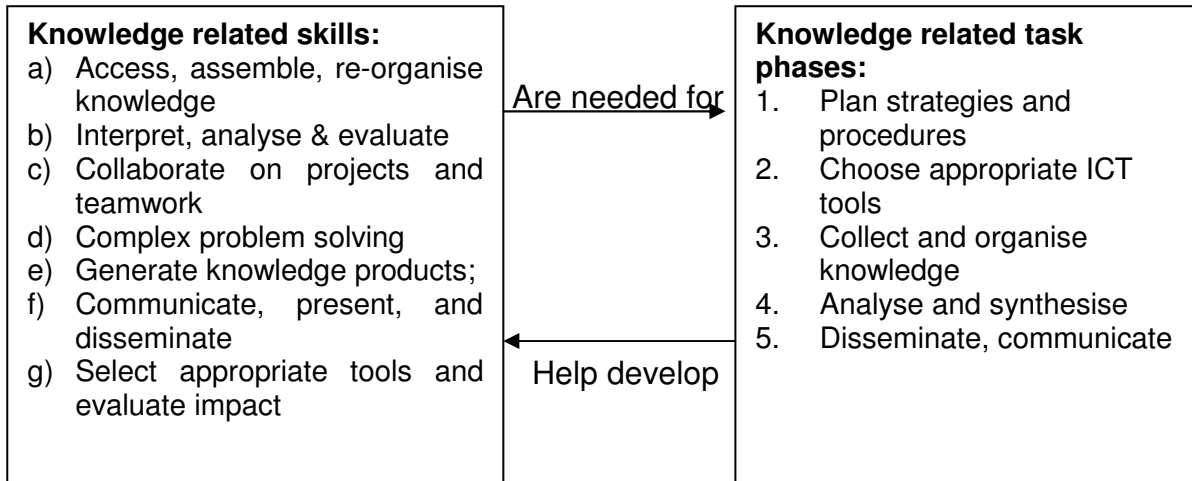
Knowledge related skills:		Knowledge related task phases:
a) Access, assemble, re-organise knowledge b) Interpret, analyse & evaluate c) Collaborate on projects and teamwork d) Complex problem solving e) Generate knowledge products; f) Communicate, present, and disseminate g) Select appropriate tools and evaluate impact	Are needed for ⟶ ⟵ Help develop	1. Plan strategies and procedures 2. Choose appropriate ICT tools 3. Collect and organise knowledge 4. Analyse and synthesise 5. Disseminate, communicate

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.

Collaboration & support

Leadership

| Vision | Expertise | Digital learning materials | ICT infrastructure |

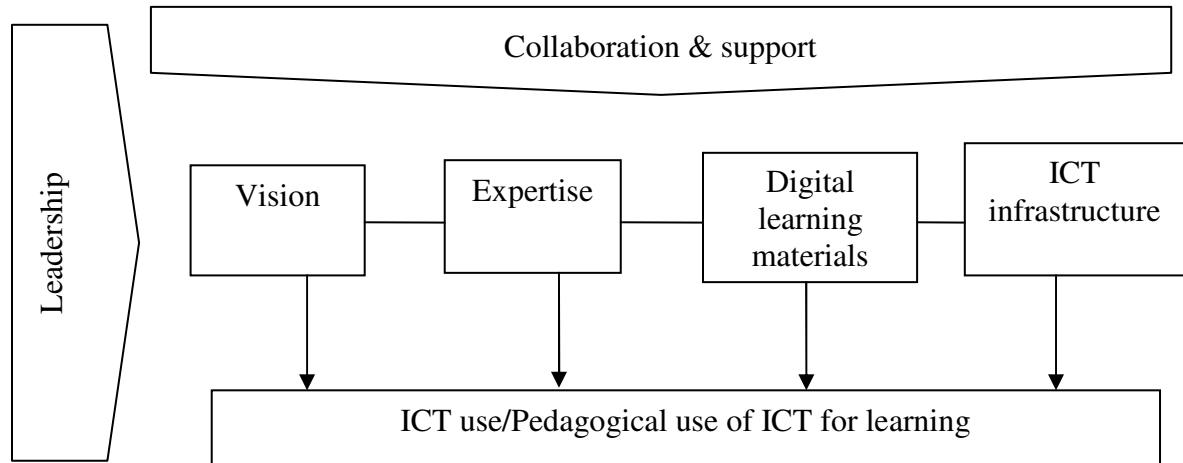ICT use/Pedagogical use of ICT for learning

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):
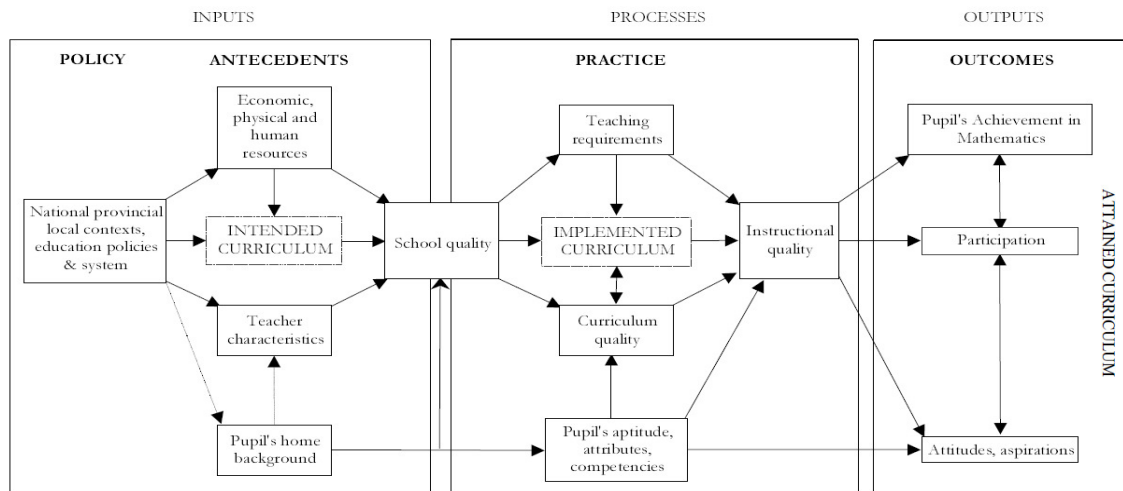

Figure 5.3
Factors related to mathematics achievement

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.

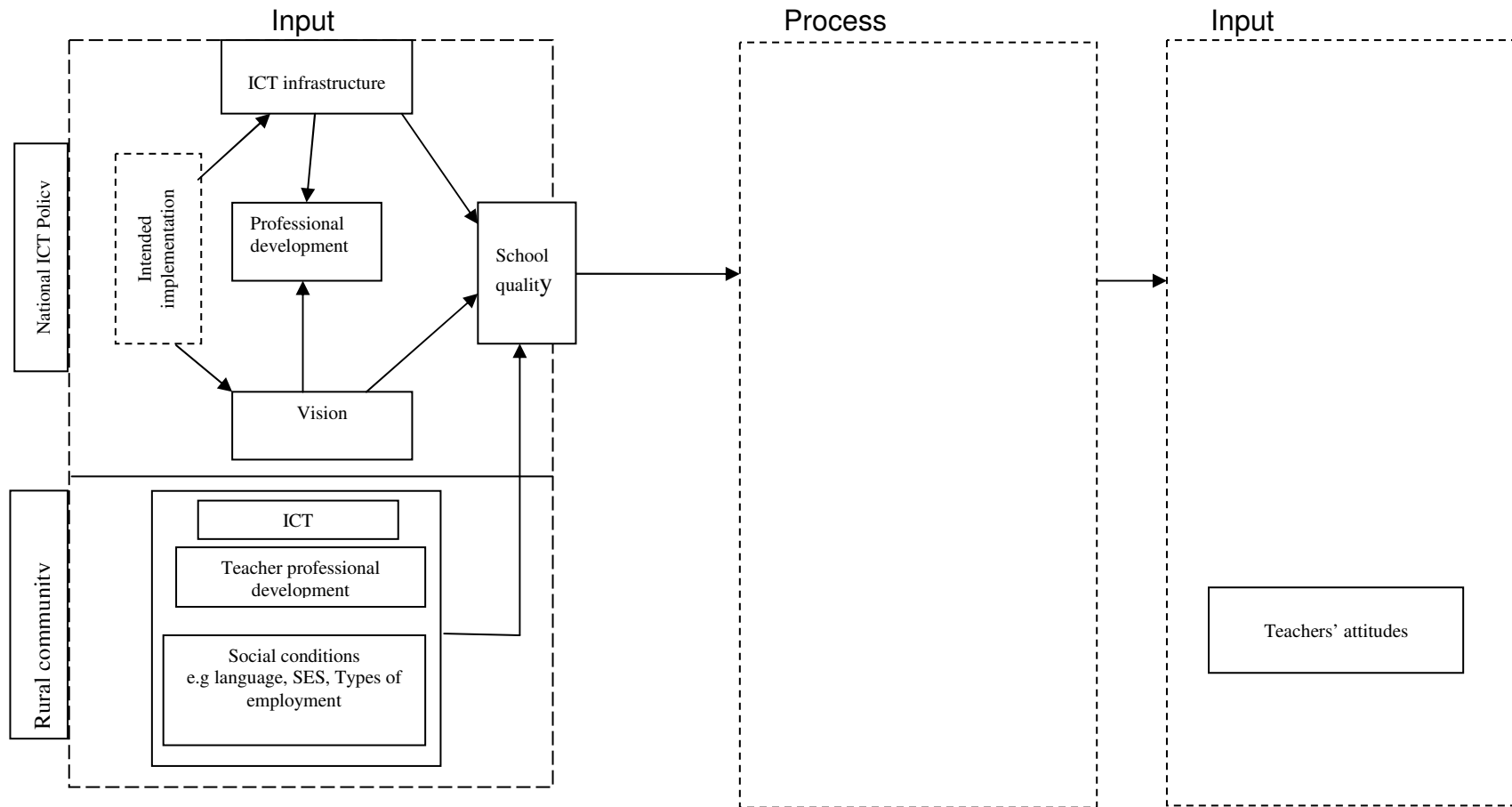The Howie model (2002) has been adapted as follows:

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.
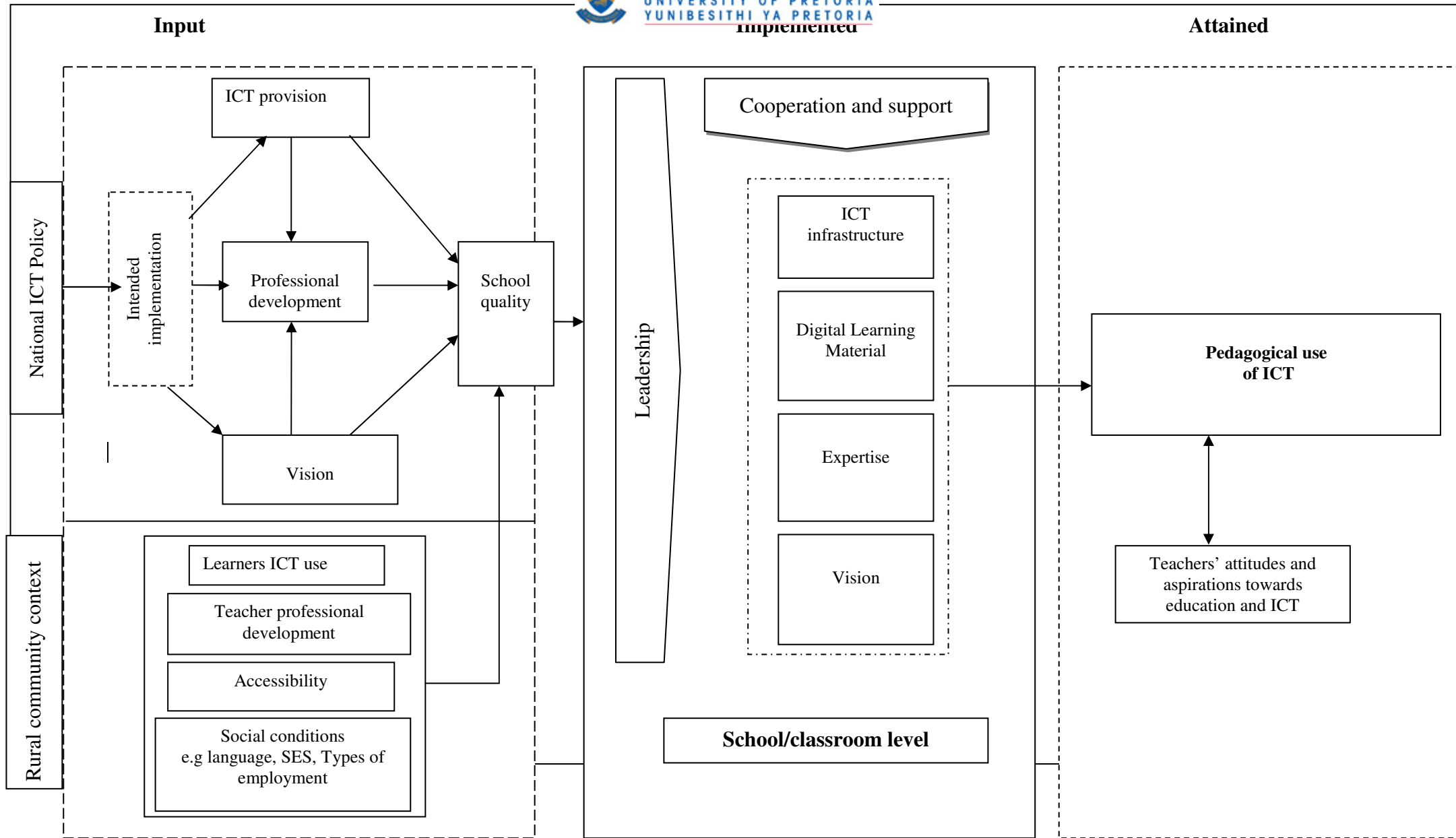
Input   **Implemented**   **Attained**

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.