TEACHERS USE OF ICT IN THE TEACHING OF LIFE SCIENCE IN THE KHOMAS REGION

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ABSTRACT

Many developing countries recognised the importance of Information and Communication Technology (ICT) in education for teaching and learning. In Namibia ICT use in the classroom remains limited. The purpose of this study was to investigate the Namibian Life Science teachers' use of ICT in their classrooms to promote collaborative and creative teaching. Activity theory was used as a lens to interprete Life Science teachers' use of ICT. Activity theory promotes technological creativity and collaboration amongst teachers. The study adopted a qualitative appraoch using multiple case studies. Two Grade 8 to 10 Life Science teachers participated in the study on the basis that they had undergone professional development on ICT use and integration, a course offered by the Ministry of Education. A pilot study was conducted in a school of a similar setting to that of the main study. Life Science teachers ICT-mediated lessons were observed and documented (fieldnotes). In addition, semistructured interviews with Life Science teachers were conducted. Thematic analysis was used to analyse the data and emerging themes were noted. The results reveal that Life Science teachers used ICT in their classroom. Classroom activities were guided by rules clearly defined between teacher and learners. Within the community of practice Life Science teachers collaborated by exchanging teaching ideas with each other to achieve desired learning outcomes but they did not co-teach. However, Life Science teachers demonstrated creative teaching. At the initial stage of ICT adoption, teachers faced challenges with network issues, time management, and parental engagement (increased number of computers for learners). Issues such as these

were addressed over time and resolved. In conclusion Life Science teachers demonstrated the use of ICT in their classrooms through smart boards connected to e-Learning Management Systems, collaborated with each other by sharing notes but did not co-teach nor developed their own teaching material. This study recommends that teachers be provided with the necessary tools, be trained to develop teaching materials, and to co-teach for purposes of enhancing collaborative teaching.

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DEDICATION

This thesis is dedicated to my dearest daughter Precious Vania Kirsten.

DECLARATIONS

I, Wilhelmina Etuna Simon, hereby declare that this study is a true reflection of my own research, and that this work, or part thereof, has not been submitted for a degree in any other institution of higher education.

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Wilhelmina Etuna Simon Date

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LIST OF ABBREVIATIONS AND ACRONYMS

Becta	British Educational Communications and Technology Agency
CPD	Continuing Professional Development
DfES	The Department for Education and Skills
ETSIP	Education and Training Sector Improvement Programme
GESCI	The Global e-Schools and Communities Initiatives
ICDL	International Computer Driving Licence
ICT	Information Communication Technology
LMS	Learning Management Systems
MoE	Ministry of Education
NDP4	Namibia's fourth National Development Plan
NIED	National Institute for Educational Development
PDF	Portable Document Format
TPASK	Technological Pedagogical Science Knowledge
TPD	Teacher Professional Development

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Information and Communication Technology (ICT) has been widely used to access information, communicate and stay connected in the global community. Many developed countries (e.g., Chile, Taiwan, Canada, and Australia) and developing countries (e.g., South Africa, Kenya, Ghana, and Nigeria) have adopted ICT in the belief that it adds value to both teaching and learning science in the classroom (Draper, 2010) and have recognised the importance of ICT in education for teaching and learning (Enrique-Hinostroza, Labbé, Brun & Matamala, 2011). A recent research study conducted in Australia that investigated teacher beliefs that influence the ways ICTs are used in learning contexts, reveals that with the advent of ICT use in education, teachers can influence their ICT practices in schools (Prestridge, 2012).

Several international studies have documented the successful use of ICT in schools by teachers (e.g., Lim & Hang, 2003; Tondeur, van Keer, van Braak & Valcke, 2008; Messina & Tabone, 2012). These studies investigate and describe what actually takes place when ICT is used in a learning context focusing on teacher knowledge (Messina & Tabone, 2012) to promote collaborative and creative teaching (Lim & Hang, 2003). In addition, several researchers (e.g., Godwin & Sutherland, 2004; Hennessy, Ang'ondi, Onguko, Namalefe, Harrison, Naseem & Wamakote, 2010) have documented that teachers can use ICT to enhance teaching and learning to make what they do in the classroom worthwhile for the learners. In the same light,

Hennessy, Harrison and Wamakote (2010) have noted that enhanced teaching and learning generate recognition for teachers.

Since independence in 1990, the teaching of science in Namibia has been a challenge due to the neglect by the previous regime that excluded the majority of black Namibians from learning science (MoE, 2006b). In the same year, the Ministry of Basic Education established the National Institute for Educational Development (NIED) as a directorate for resources and expertise into establishing systems and policies that would have an impact in science classrooms (MoE, 2007a). ICTs have been a very important part of this process, and science classrooms are benefiting from better technology. Namibia recognises the importance of ICT as a tool for educational development of the country. In 1995, the then Ministry of Basic Education, through NIED, developed a National Policy for ICT in Education in Namibia. The ICT Policy for Education is concerned with the pedagogical use of ICT as an integrated tool in the teaching-learning process at all levels in the educational system.

Early in 2004 the Ministry of Education (MoE) formed the ICT in Education Steering Committee to coordinate the many ICTs in education projects and activities to support the Vision 2030 goal of "Integrating ICT education and training into the education and training system" (MoE, 2005a, p. 3). The Vision 2030 initiative was established in 2004 as a policy framework for overall development in Namibia. Among its primary goals is the creation of a knowledge-based society in promoting science and technology (MoE, 2007a).

The MoE has made enormous investments in developing ICT practices throughout the Education and Training Sector Improvement Programme (ETSIP) to increase the efficiency of ICT (MoE, 2005b). ETSIP was introduced in 2005 to aid progress toward the goals outlined in Vision 2030, and aims at improving the current education system and increasing the supply of skilled teachers in Namibia. ETSIP will strengthen teacher competencies in pedagogical skills through the use of technology. ICT is thus an integral part of the ETSIP manifesto (MoE, 2007a).

The education sector currently occupies approximately 20% of Namibia's annual national budget (MoE, 2012). Despite this, as stipulated in Namibia's fourth National Development Plan (NDP4):

> Over the past 21 years, there is broad consensus in Namibia that the education system remains weak by international standards, and requires significant intervention as a primary priority for the future of the country. The problems associated with the education system are extensive, and range from a lack of quality to lack of infrastructure and ICT (GRN, 2012, p. 46).

In the initial phase of ICT for Education development, the Education Steering Committee worked with partners in various sectors, namely, public, private, and civil society from across the education sector, to develop the ICT Policy for Education in 2005 and the corresponding Implementation Plan in 2006. In its Implementation Plan Guide MoE (2006a, p. 20), the ICTs in Education Steering Committee also established the following educational priorities for the introduction and use of ICTs across the education sector as follows:

1. ICT utilization for teacher research, planning, and development.
2. Integration of ICTs in educational instruction.
3. ICT literacy for learners.
4. ICT for educational management.

This study focuses on the second of the above priorities, namely the integration of ICTs in educational instruction. It should be noted that 'ICT integration' was used in the policy to mean 'ICT use' and therefore in this study 'ICT use' will be used interchangeably with 'ICT integration' (Draper, 2010; Donnely, McGarr & O'Reilly, 2011; Ertmer, Otternbreit-Leftwich, Sadik, Sederur & Sederur, 2012). The Implementation Plan Guide also highlights ICT integration for educators' modules as a major component of the training provided to educators which focuses on the use of ICT in the classroom across all subject areas. The guide clearly states that:

> Along with ICT literacy training, all in-service teachers will receive on-site (school-based) training for ICT integration for educators in conjunction with the deployment of ICTs to schools. Training will also be provided at schools where ICTs already exists. Educational advisors (e.g., Advisory Teachers, Resource Teachers, Inspectors of Education, etc.) will also receive training in ICT integration for educators through workshops to assist in-service teachers to utilise ICTs more effectively to improve their teaching practice (MoE, 2006a, p. 22).

As mentioned earlier, ICT use in the science classroom to support teaching and learning is gaining importance within the education sector in Namibia. For example, at the beginning of 2006, the MoE offered in-service training and workshops to

science teachers on the use of ICT in their teaching practice by providing teachers with the ICT skills necessary to enhance teaching and learning (MoE, 2006a). Science teachers have benefited greatly from these developments, where ICT has become an indispensable aid in the classroom. Science teachers have also shared their knowledge and methodologies during workshops (MoE, 2006b).

Another factor that encouraged ICT use in Namibian schools was the fact that the science syllabuses, namely Grade 11 and 12 Biology, and Grade 8 to 10 Life Science were revised in 2009 to accommodate the ICT standards for teachers (MoE, 2010). It is also believed that the use of ICT in the teaching of science would provide benefits to teachers. In fact, the ICT Policy for Education clearly stipulates that "when ICT is used, it can bring many benefits to the classroom and the education process by providing new opportunities for teaching professionals delivering education" (MoE, 2005a, p. 2). Some examples of the benefits of integrating ICT in the classroom are that they provide:

- teachers with new sources of information and knowledge;
- greater opportunities for teacher-to-teacher and student-to-student communication and collaboration;
- greater opportunities for multiple technologies delivered by teachers;
- learners with additional resources to assist resource-based learning (MoE, 2005a, p. 2).

ICT use in Namibian classrooms is still limited due to a number of factors such as lack of ICT resources, lack of teacher training and competency (MoE, 2007b). Recent studies pertaining to ICT in teacher education and professional development

have been conducted in Namibia (e.g., Iipinge, 2010; Katulo, 2009; Matengu, 2011; Ngololo, 2010; Nuuyoma, 2012). These studies revealed that there is low use of ICT in general (Matengu, 2011) and in urban schools in particular (Nuuyoma, 2012). In the same light, these studies have indicated that ICT use at school level requires technical and pedagogical support to enhance efficiency in the professional development of science teachers (Ngololo, 2010). In addition, Katulo (2009) concluded that school principals should adopt strategies that encourage teachers to use computers in their daily routines. Nuuyoma (2012) noted that teachers have no ICT training and therefore lack the necessary skills to integrate ICT into their lessons. Similarly, Iipinge (2010) found that lecturers at the Teacher Training Colleges are not trained in ICT and therefore lack the necessary expertise to train the teacher trainees. Upon graduation teachers were absorbed in schools without the necessary relevant skills to use and integrate ICT in teaching. Having realised the problem, the MoE has taken the initiative to train some teachers in ICT integration after they have undergone the International Computers Drivers' Licence (ICDL) courses. Despite the investment, ICT use and integration in most schools in Namibia is rudimentary (Matengu, 2011), especially in the rural schools (Ngololo, 2010).

The majority of teachers outside of the Khomas region do not integrate ICT (Matengu, 2006) in their classroom, and even fewer integrate it in their science lessons (Ngololo, 2013). Given this background, this study explores how selected Life Science teachers use ICT in their lessons in the Khomas region.

1.2 Statement of the Problem

The MoE has spearheaded initiatives through the Namibian ICT in Education Initiative (Tech/Na!) to deploy and improve the implementation of the ICT policy in education. Between 2007 and 2011 the MoE ensured that 26 trainers of trainers from the Khomas region, out of 103 country-wide, were trained in ICT integration for educators, and facilitated ICT literacy through the International Computer Driver's License (ICDL) for teachers (MoE, 2012). However, it was reported that teachers in other regions were not integrating ICT into their teaching (Katulo, 2009; Ngololo, 2010; Matengu, 2011).

In Namibia, little is known about how teachers use ICT to teach subject content, especially Life Science. In this regard, teachers are expected to enhance teaching instead of using ICT as a literacy course. Given this background, the study aimed at investigating some Namibian Life Science teachers' use of ICT in their classrooms in order to promote collaborative and creative teaching.

1.3 Research Questions

The researcher formulated the following research questions to find answers related to teachers' experiences when using ICT in the teaching of Life Science to promote collaborative and creative teaching (explained in Section 1.7):

1. How do Life Science teachers use ICT in their classrooms to promote collaborative and creative teaching?
2. What are the challenges experienced by individual Life Science teachers when using ICT in the classroom?

1.4 Significance of the Study

Schools that participated in this study and have integrated ICT could conceivably serve as examples to schools with similar settings. The study also documented strategies that could be used by Life Science teachers to promote collaborative and creative teaching. Furthermore, the findings of this study could be used by policymakers for policy initiation and formulation to facilitate and strengthen ICT use in classrooms.

1.5 Limitations of the Study

The study was limited to two selected Life Science teachers from schools in the Khomas region. Given that this small number is not statistically representative of all Namibian teachers, the results of the study cannot be generalized to the larger population of all secondary schools in Namibia. However, findings are limited to schools with teachers that use ICT for teaching and learning.

1.6 Delimitations

As stated above, the study was limited to two selected Life Science teachers from Khomas region schools and therefore the data was triangulated for purposes of validity and reliability. A survey could be carried out to investigate schools that use ICT and how Life Science teachers from schools in other educational regions in Namibia integrate ICT in their teaching. However, the nature of this study is qualitative and requires rather indepth study of the selected cases.

1.7 Definition of Terms

In this study, the following concepts are used and should be clearly understood:

Table 1.1 *Concepts used in this report and their meaning*

Concept	Meaning
Information and Communication Technology (ICT)	Generally includes hardware, processes and systems that are used for storing, managing, communicating and sharing information (MoE, 2005a, p.4). In this study, ICT refers to available technology for Life Science teachers in the classroom.
Collaborative teaching	Teachers working together on their planning and co-teaching using ICT (Chu, Tse & Chow, 2011, p. 134). In this study, the concept is understood as teachers engagement with colleagues to co-teach, develop interesting lessons and sharing teaching resources.
Creative teaching	Teachers engagement in everyday creativity with lesson planned and improvised to meet the varied needs, interests conforming to the formal policy, curriculum and available resources (Reilly, Lilly, Bramwell & Kronish, 2011, p. 533). In this study, the concept is understood as teachers using existing and or developing interactive teaching materials to enhance ICT use.
Hardware	Physical elements of a technology, for example, computers and other devices (Petterson & Hennesy, 2008). In this study, the term hardware referred to the tools utilesed by Life Science teachers in the classroom (e.g., iPad, laptop and smart board).
ICT use	Teachers use of ICT in the classroom (Tondeur, van Braak, & Valcke, 2007). This study will focus on the classroom ICT use that aims to support and enhance teaching and learning. For example, lesson presentation, assessment, administration and communication etc.
ICT policy	Procedures (rules) set to guide users (teachers) on what is expected of them when integrating electronic equipment across the curricula for teaching and learning purposes. In this study, the term ICT policy is used to describe the ICT Policy for Education.

Concept	Meaning
Internet	The network of computers using common protocols. In this study, the term refers to wireless internet available to Life Science teachers in the classroom.
Professional development	PD is referred to as a developmental processes to engage teachers in professional learning (Smith, 2011). In this study, PD means teachers' acquisition of skills and knoweldge to impart Life Science content using ICT.
Software	Software applications and connectivity for example, access to the internet, local networking infrastructure, video conferencing (Lloyd, 2005, p.3).
Technology	Hardware, software applications and connectivity. In this study, the term technology is used synonymously with ICT.

1.8 Brief Overview of Chapters

This thesis is presented in six chapters. Chapter 1 presents an overview of the background information on the usefulness of ICT internationally and locally. A brief background of the Namibian National ICT Policy for Education is presented to put the reader into context. In addition, the chapter presents the research questions and the significance of the study. Also, the limitations of the study are presented before the operational definition for terms that will be used throughout the thesis.

Chapter 2 begins by presenting some of the current literature reviews on ICT use in science education and the challenges faced by teachers as individuals in the use of ICT in their respective classrooms. Further, the chapter presents current empirical research into teachers' professional development and collaborative and creative teaching with regard to ICT use. The literature is linked to the Activity theory as a theoretical framework on which the study is based. Activity theory was used as a

theoretical framework to provide important insights into ICT use in an effort to promote collaborative and creative teaching. Lastly, the chapter also presents the seven components of the activity theory model (subject, objects, tools, rules, community, division of labour, and outcome) which were used to interpret the data.

Chapter 3 presents and justifies both the research design and the method used to collect data. Firstly, the chapter presents a description of the qualitative research design and the multiple case study approach used. Secondly, it discusses the sample and sampling procedures. Thirdly, the chapter presents the instruments, pilot study, data collection procedure and analyis. Finally, issues of validity of the findings and ethical considerations are presented before the conclusion.

Chapter 4 presents results of the data gathered from the investigations of how Life Science teachers from two schools in the Khomas region use ICT in their classrooms. The presentation of the results is followed by the analysis compared to what the existing literature. This is done in line with the seven (7) constructs of the Activity theory and the emerging themes. The chapter concludes with a discussion on the challenges faced by Life Science teachers as individuals in the two schools and in their classroom.

Chapter 5 summarises the research findings and provides a reflection from the study on how teachers with access to technologies use ICT in their classroom. Finally, the conclusions and recommendations are presented.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter presents the reviewed literature relevant to ICT use in education, particularly with regard to Life Science teachers. The literature is presented in three parts to try and link the literature to the two research questions. Part A addresses to Research Question 1 and it begins by discussing the current literature on ICT use in science education (Section 2.2) focusing on both the benefits of ICT (Section 2.2.1) and the manner it is being applied in science education (Section 2.2.2). Section 2.3 presents the current empirical research into teachers' professional development with respect to ICT use in the classrooms. The literature on collaborative and creative teaching is presented in Section 2.4. Part B focuses on Research Question 2 and centres on the challenges faced by Life Science teachers as individuals in the use of ICT at the school and the classroom levels (Section 2.5). Part C presents a discussion on the adoption of the the Activity theory as a lens to interpret the use of ICT in the Life Science classrooms in Section 2.6 before the conclusion (Section 2.7).

Part A

2.2 ICT use in Education

Over the last two decades, the effective use of ICT has become an important topic in education (Martinovic & Zhang, 2012). In fact, several international studies have documented the use of ICT in education around the globe (e.g., Enrique-Hinostroza, Labbé, Brun & Matamala, 2011; Ertmer & Ottenbreit-Leftwich, 2010; Ertmer, Otternbreit-Leftwich, Sadik, Senderur & Senderur, 2012; Sánchez, Marcos, González & GwanLin, 2012; Suduc, Bîzoi, Gorghiu & Gorghiu, 2011; Tondeur, van Keer, van Braak & Valcke, 2008). These researchers have documented different ways that teachers use ICT (Sang, Valcke, van Braak & Tondeur, 2009) which have subsequently been categorised into personal and professional uses. Ertmer and Ottenbreit-Leftwich (2010) reported that teachers have increased their personal (e.g., administrative tasks) and professional (e.g., instructional tasks of computers in the classroom) uses of ICT. Further Ertmer and Otternbreit-Leftwich (2010) argue that effective teaching requires effective technology use. For effective technology use in the classroom, it was pointed out that teachers' use of "technology is essential to successful performance outcome" (p. 256).

In addition, Suduc et al. (2011) documented two main categories of ICT use by teachers: 1) supportive ICT use, and 2) classroom ICT use. According to Tondeur et al. (2011) supportive ICT use refers to the use of ICT for pro-active and administrative teaching, such as student administration, worksheets preparation, evaluation development activities, tracking pupils' learning progress, etc. The

second category, classroom ICT use, aims to support and enhance the actual teaching and learning process, such as the use of computers for demonstration purposes, drill and practice activities, modelling, representation of complex knowledge elements, discussions, collaboration, project work, etc. (Sang et al., 2009).

Literature reveals the different ways teachers use ICT in school in general (Enrique-Hinostroza, Labbé, Brun & Matamala, 2011), and more particularly, in the classroom (Sánchez et al., 2012). Enrique-Hinostroza et al. (2011:1359) claim that in terms of research on the use of ICT in teaching and learning, studies could be classified as belonging to those based on prescriptions of how to use ICT, and those that look for a prescription of how ICT is being used.

Enrique-Hinostroza et al. (2011) conducted a study on teaching and learning activities in state-subsidized schools in Chile to examine teachers' and students' reported teaching and learning activities in general as compared to activities using ICT. The results indicated that teachers tend to use ICT more often in specific activities that represent an opportunity to encourage ICT use in schools. The findings of the Chilean study revealed that teachers' activities with ICT are very similar, showing a lack of differentiated strategies for ICT use in teaching.

A recent research study conducted in Taiwan examined the relationship between teacher and student usage of ICT which revealed that "teacher ICT usage includes course preparation or instructional support such as creating quizzes, searching the internet to find lesson plans and resources, creating presentations, editing sounds and music, and building hosting websites" (Hsu, 2011, p. 847). Hsu (2011) conducted a study to determine the extent to which teachers are utilizing new ICT tools. The

results collected through a large-scale survey supported by the MoE in Taiwan, indicated that teachers who create complex multimedia materials were most likely to assign multimedia activities. The findings also suggested that teachers should assign multimedia activities that require a variety of ICT tools and teachers' own ICT practices which would influence the type of ICT multimedia activities in the classroom.

Similarly, in a multiple case-study research design on teacher beliefs and technology integration practices in the USA, Ertmer et al. (2012) examined a critical relationship among the pedagogical beliefs and technology practices of 12 classroom teachers. The study was conducted to gain a deeper understanding of how teachers translate their beliefs into practices. The results indicated that, teachers' beliefs and attitudes about the relevance of technology played key roles in shaping their practices. The results recommended for teachers to utilize technology tools in their classrooms for professional development.

Another study conducted in Spain investigated in-service teachers' attitudes towards the use of ICT in the classroom (Sánchez et al., 2012). The results indicated that teachers' attitudes towards ICT are highly positive but the use of them in class is scarce and subject to innovative processes. Results also concluded that new ways of teacher training need to be developed. Attitudes were explored through semistructured interviews that were carried out with the purpose of deepening into teachers' major motivations and beliefs.

Studies have shown that the successful use of ICT depends largely on the attitudes of teachers (Albirini, 2006; Al-Zaidiyeen, Mei & Fook, 2012, Prestridge, 2012; Ertmer

et al., 2012), who eventually determine how they are used in the classroom. Albirini (2006) conducted a study in Syria on high school teachers' attitudes toward ICT in education. The findings of the Syrian study indicated that teachers have positive attitudes toward ICT in education. In addition, teachers' attitudes were predicted by the five independed variables namely: 1) computer attributes, 2) cultural perceptions, 3) computer competence, 4) computer access and, 4) personal characteristics (including computer training background (Albirini, 2006, p. 379-382). The findings suggested that "technology initiatives should include measures for preparing teachers to use computers in their teaching practices" (Albirini, 2006, p. 386).

In the same light, Al-Zaidiyeen et al. (2012) conducted a case study in Malaysia on in-service teachers' attitudes and levels of technology use in the classroom. The results indicated that teachers had a positive attitude toward the use of ICT tools in the classroom. Results also concluded that "the teachers' attitudes levels towards the use of ICT had a direct relation with the use of ICT for educational purposes" (Al-Zaidiyeen et al., 2012, p. 215). The study recommends that there is a need for "future researchers to consider the detailed qualitative studies such as classroom observations and in-depth interviews to investigagate the level of ICT use by teachers" (Al-Zaidiyeen et al., 2012, p. 216).

Finally, it is evident in the literature that ICT use in Namibian schools is not well-documented. Recent studies pertaining to ICT were conducted in Namibia (e.g., Boer & Black, 2008; Iipinge, 2010; Katulo, 2009; Matengu, 2006; Ngololo, 2010; Nuuyoma, 2012) on ICT integration and adoption but not specifically related to ICT use by Namibian teachers. For instance, Boer and Black (2008) conducted a study

on practical approaches to ICT integration in Namibian classrooms. The results collected through a consultancy involving document analysis, classroom observations and interviews with educational professionals indicated that ICT integration for both the learner and the teacher was very fragmanted. In Addition, Iipinge (2010) conducted a study on the integration of ICTs in the preparation of teachers at Colleges of Education in Namibia. The results indicated that both teacher educators and student teachers used and integrated ICTs for various reasons such as for planning, organising and storing learning information. Particularly, Matengu (2006) stressed on teachers integration of ICT in the subjects they teach. The results on ICT integration at schools indicated that teachers lacked training on how to use and integrate ICT (Matengu, 2006) in the classroom. And, finally, Nuuyoma (2012) conducted a study on challenges faced by English teachers in integrating ICT in the teaching of reading and writing in rural and urban schools. The results showed that teachers lacked the skills on how to integrate ICT in their classroom. This information is useful to identify documented information about ICT use in Namibia.

2.2.1 Benefits of ICT in science education

It is necessary for science teachers to understand the benefits and rationale for using ICT in science education. A report based on an analysis of research about the use of ICT in the teaching and learning of science (British Educational Communications and Technology Agency [Becta], 2004, p. 1), identified three key benefits of using ICT in science which are:

1. ICT can make science more interesting, authentic and relevant.

2. ICT allows more time for observation, discussion, and analysis.
3. Using ICT increases opportunities for communication and collaboration.

In addition to the benefits of ICT in science, Becta (2004) also identified five benefits for teachers when they use ICTs for positive effects on the teaching and learning of science in the classroom, specifically:

1. ICT allows teachers to engage and motivate pupils to a greater degree.
2. The internet increases access to authentic data.
3. Simulations enable teachers to show experiments that would not otherwise be possible.
4. Data logging and digital video recording allow access to new sources of data in a wider range of experimental settings.
5. ICT provides quicker and more accurate data collection thereby saving lesson time and providing better quality results.

Having presented the benefits of using ICT in the clasroom, it is equally important to understand the rationale for ICT use in the Science classrooms.

2.2.2 Use of ICT in the science classroom

It has been argued that ICT can be used to enhance subject teaching (Hennessy, Harrison and Wamakote, 2010). Among other subjects, science is deemed necessary for enhancing both teaching and learning in schools (MoE, 2007b). Science teachers need to be trained in ICT skills that will enable them to effectively perform their duties in the advancement of teaching and learning.

The Department for Education and Skills (DfES) in the United Kingdom developed a study guide that offers some practical strategies for teachers to enhance teaching and learning through the use of ICT. The DfES also identified four key activities of using ICT that are particularly significant for teaching science, namely:

1. Searching and selecting.
2. Organising and investigating.
3. Models and modelling.
4. Controlling and monitoring (DfES, 2004, p. 14).

This information is useful to check if Namibian Life Science teachers use ICT for the same purposes.

In a study conducted in South Africa on understanding science teachers' use and integration of ICT in a developing country context (Draper, 2010), the results indicated that South African science teachers were able to use ICT effectively to add value to teaching and learning. South African teachers were reported using ICT in their classrooms in different ways, namely:

- for simulations;
- for data loggers during practical work;
- for conceptual understanding of science;
- for student motivation in science.

In her findings, Draper (2010) suggested ICT to be gradually introduced into schools and into teaching and learning activities. This finding is in line with the Ngololo (2010) who found that a few teachers in the northern parts of Nambia used ICT to teach Mathematics and Science. Particularly, the teachers used specific softwares for

teaching different concepts, assessed learners and also for administrative use. This information is necessary to establish if Life Science teachers in the Khomas region use ICT for the same purpose.

2.3 Professional Development

It has been posited that professional development (PD) is necessary for ICT integration in schools. In recent years, several international studies relating to teachers' professional development were conducted in different contexts around the globe (e.g., Avalos, 2011; Garcia & Roblin, 2008; Iluz, Michalsky & Kramarski, 2012; Jimoyiannis, 2010; Smith, 2011; Tytler, Symington, Malcolm & Kirkwood, 2011). These researchers documented the successful professional development practices in teaching and teacher education in general (Avalos, 2011; Garcia & Roblin, 2008) and for science teachers in particular (Jimoyiannis, 2010; Tytler et al., 2011).

In a study on discourse communities conducted in Australia for secondary school science teachers, Tytler et al. (2011) developed a framework to identify teachers' needs and the capacity of different professional development approaches. The results gathered through semistructured interviews indicated that schools made provisions for appropriate professional learning opportunities for teachers, where the latter were reported working together in professional working teams on subject-specific learning strategies (Tytler, et al., 2011).

Similarly, Jimoyiannis (2010) conducted a case study using science teachers' experiences with, and perceptions of the Technological Pedagogical Science

Knowledge (TPASK), a new model for science teachers' professional development to design a project framework for science teachers' professional development. The findings gathered through an interview schedule suggested that teachers' efforts should be placed in professional development in order to integrate ICT in the science classroom. The project's results indicated that science teachers reported meaningful TPASK knowledge and increased willingness to adopt and apply the framework in their instruction (Jimoyiannis, 2010, p. 1267).

In addition, several scholars also pointed out that improving classroom learning with ICT requires professionals development that takes into account the fact that teachers engage with their professional development in different ways and at different levels (Sutherland, Robertson & John, 2009). Within the InterActive Education project, Sutherland et al. (2009:7) established a model of professional development that enabled teachers to work together with researchers in order to ensure successful use of ICT in the classroom to enhance teaching and learning. This model would be useful in providing guidance for teachers towards the use of ICT in their classroom practices.

A number of professional development initiatives were employed by the MoE in Namibia. Since the establishment of the ICT projects in 2002, the National Institute for Educational Development established a research project model known as WorldTeach-NIED to explore and document ways teachers can integrate technology to enhance learning in the classroom (Soule, 2003). The NIED conducted training and workshops for teacher-trainers who were expected to return to their respective schools and train more teachers on ICT integration (Soule, 2003). Additionally, the

Global e-Schools and Communities Initiatives (GESCI) has also conducted Teacher Professional Development (TPD) in Namibia since September 2006 (GESCI, 2006). Although teachers were trained on ICT integration, a recent study conducted in Namibia indicated that teachers lacked training on how to integrate ICT in their classroom (Nuuyoma, 2012). In this light, the information about TPD is necessary to determine if science teachers' in the Khomas region have undergone a professional development course of any kind that could broaden opportunities for teachers to share their experiences with their peers.

A study conducted in Namibia suggested "the need for teacher development in ICT in education so that teachers acquire the right attitude and competences for integrating ICT in their teaching" (Ngololo, 2013, p. 13). However, the study also found some inefficiency in the professional development of science teachers in rural schools such as knowledge and skills in ICT in terms of teaching and learning (Ngololo, 2010). A few teachers that were found to integrate ICT in their lesson had acquired the skills through other means and not through any professional development course. The information from the study by Ngololo (2010) is necessary to understand Life Science teachers' professional development in urban schools. In the same light, Matengu (2011, p. 152) noted that "teachers must have interest and access to technology also during their own free time". This information is useful to establish the Life Science teachers' motives as a means to justify how they use ICT in their classrooms.

2.4 Collaborative and Creative teaching

Recent international studies have shown the importance of collaborative teaching practices in improving classroom instruction (e.g., Davies, Jindal-Snape, Collier, Digby, Hay & Howe, 2013; Chu, et al., 2011; Pinheiro & Simões, 2012; Reilly, et al., 2011). These studies have documented that teachers can enhance their teaching practices through creative teaching (Chu et al., 2011) to promote student learning (Davies et al., 2013).

In the same light, Pinheiro and Simões (2012) noted that the implementation of active and collaborative practices in ICT classrooms promote deeper learning and reasoning skills at a higher level. Pinheiro and Simões (2012) conducted a study in Portugal on *Constructing Knowledge: An Experience of Active and Collaborative Learning in ICT Classrooms.* The study described specific environment that makes use of collaborative tools such as wikis and forums within an e-learning platforms. The results collected through a simple questionnaire via the University's e-learning platform, indicated that online discussion forums are an increasingly common use of new ICT in education. The findings also suggested that teachers should incorporate ICT in teaching and learning to promote active and collaborative practices.

Davies et al. (2013) conducted a systematic review of 210 pieces of educational research, policy and professional literature relating to creative environment for learning in schools, commisioned by Learning and Teaching Scotland. Of the total reviewed papers, 34 case studies were used to collect qualitative data through interviews, classroom observations and teachers' reflective journals. The study identified the following:

- key characteristics of the environment and conditions that are most effective in promoting creative skills
- impact of creative school learning envirnments on the educational development
- specific roles of teachers which promote creative skills development
- ways in which teachers can best be supported to develop the skills and confidence to facilitate creative learning environments (Davies et al., 2013, p. 84)

The results of the systematic review indicated that there is evidence that suggests an impact of creative learning environments on learners' academic achievement; increased confidence and resilience; enhanced motivation and engagement; development of social, emotional and thinking skills (Davies et al., 2013). The study also suggested that teacher skills and attitudes; willingness to work as role model; awareness of learners needs; flexible approaches to curriculum and lesson structure; particular types of classroom engagement with pupils, together with the use of ICT and assessment, are important components for teaching with creativity. Furthermore, the study also highlights the importance of supporting creative practice of teachers to develop their own creativity and the importance of undertaking action research and reflection on their own practice (Davies et al., 2013, p. 88). The review by Davies et al. (2013) recommends CPD for teachers that elicits their preconceptions of creativity; stimulates dialogue around models of creativity in teaching and learning; provides opportunities to develop their own creativity; and engages them in reflective professional enquiry into their own pedagogy.

Another study conducted in Canada investigated creative teachers who demonstrated everyday creativity. Hence they were involved in creative undertakings and initiatives such as introducing inquiry teaching methods or engaging in action research to improve their practices and create living educational theory (Reilly et al., 2011). The results collected through case studies indicated that the following four major themes emerged:

- creative process
- creative person
- outcome
- community (Reilly et al., 2011, p. 536)

The results of this study show that teachers were found to be intrinsically motivated, which means that they were persistent and passionate about their work. These creative teachers focussed their creativity on activities that they themselves deemed to be important (Reilly et al., 2011, p. 537). This information is useful to identify the activities of Life Science teachers that promote collaborative and creative teaching practices using ICT.

PART B

2.5 Barriers to ICT use

As explained (Section 1.1), the term 'ICT integration' was used in the Namibian ICT Policy for Education (2005) to mean 'ICT use' and therefore in this study 'ICT use' will be used interchangeably with 'ICT integration'. Bingimlas (2009) conducted a study in Australia about barriers to the successful integration of ICT in teaching and

learning environments. The barriers to integration of ICT into education are classified at two different levels namely:

- Teacher-level barriers: lack of teacher confidence and lack of other competence.
- School-level barriers: lack of time, lack of effective training, lack of accessibility, and lack of technical support.

These barriers were identified from the reviewed literature that provides information and recommendations to those teachers who are responsible for the integration of new technologies in science education (Bingimlas, 2009).

Kopcha (2012) carried out a case study with 18 elementary school teachers by monitoring their community of practice for two years. The case study sought teachers' perceptions of the barriers to technology integration and practices before and after a course on ICT. The results collected through observation and interviews indicated that teachers engaged in desirable instructional practices but were also faced with a number of barriers when integrating technology into their instruction such as:

1. Access: teachers had useful and appropriate technology available.
2. Vision: teachers' vision to use technology across the curriculum was strong.
3. Beliefs: teachers believed that technology was important in student learning.
4. Time: lack of time was the biggest challenge as technology issues took time away from learning.

5. Professional development: integrating technology was more challenging under community of practice (Kopcha, 2012, p. 1116).

The study suggested that there is a need to "enacting a variety of situated learning activities around the principles of effective professional development and may be the key to providing teachers with the knowledge and support needed to integrate technology more fully into their instruction" (Kopcha, 2012, p. 1119).

Another study conducted in Zimbabwe explored the main barriers to effective integration of ICT in Harare Secondary schools (Ndawi, Thomas & Nyaruwata, 2013). The results obtained through close ended questionnaires showed that although teachers were aware of the benefits of using ICTs in education, there is still limited use of this pedagogy in clasrooms as teachers were facing a number of challenges such as:

- lack of clear sense of direction on how to use ICT to enhance the learning of students;
- inadequate resources and support; and
- lack of required technological skills among the teachers (Ndawi et al., 2013, p. 214).

The study recommends for teacher training programme to focus on technological skills, particularly the use of databases so that teachers become ICT proficient and have confidence to use ICT. In addition the progamme must employ startegies to encourage teachers to share ideas on successful use of ICT in the classroom (Ndawi, et al., 2013). The conclusion indicated that "the integration of ICT in education has

a lot of potential to enhance teaching and learning if it is carefully planned and adequate support is given to teachers" (Ndawi, et al., 2013, p. 215).

Knowledge of barriers to ICT integration is essential to understand how Life Science teachers use new technologies efficiently and practically in their lessons. For purposes of clarity, barriers to ICT use as identified in the literature, will inform the presentation of the challenges faced by the participating teachers at two levels namely: 1) school level and 2) classroom level, illustrating how they have been addressed at the appropriate levels.

It is vital for this study to adopt a theoretical framework that encompasses all the major issues raised in the literature review above. The following section presents the Activity theory as adopted from the literature and how it was used as a lens to investigate Life Science teachers' use of ICT in their classrooms.

PART C

2.6 Theoretical Framework

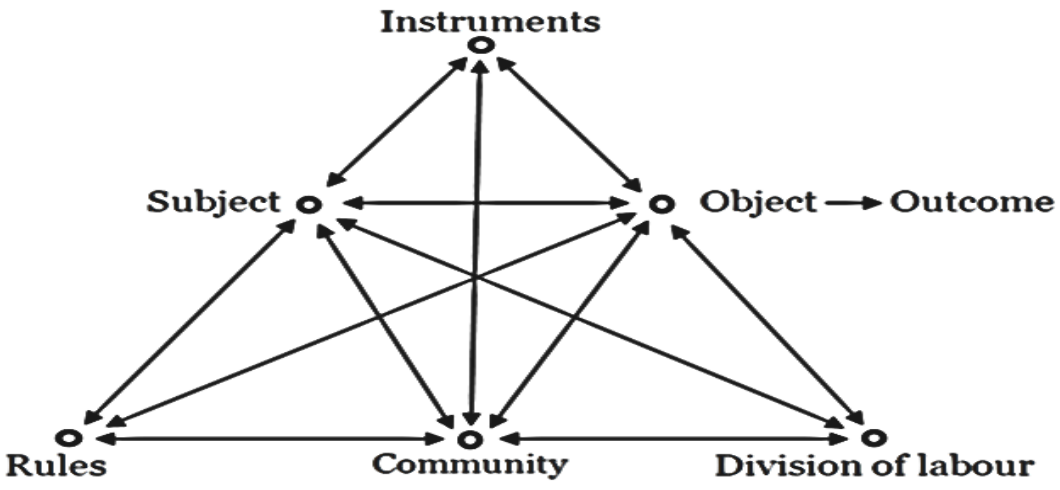
The study adopted activity theory which was originally proposed by Vygotsky student Leont'ev in 1987. Activity theory explores human activity in their natural environment, in this case teachers' teaching practices (Murphy & Rodriguez-Manzanares, 2008) to allow for a focus on the day-to-day classroom activity of teachers (Law & Sun, 2012), where their collaboration with other teachers might result in the transformation of activity (Karasavvidis, 2009). Activity in this theory system is commonly defined as a unit of subject-object interaction (Leont'ev, 1987)

with the object having the status of a motive that meets certain needs of the subject (Kaptelinin & Nardi, 2006).

The theory was further elaborated by Engeström (1987) to address systems of activity at a collective level. In order to ensure a collective level of activities, activity theory looks at artifacts and people as embedded in dynamic activity systems (Engeström, 1993). The activity system model has seven components: subject, object, tools, division of labour, community, rules, and outcome (Law & Sun, 2012, p. 480). Given that the integration of ICT in educational practice is expected to transform collective practices in activity systems (Lim & Hang, 2003), it is therefore necessary that this would require an understanding of teacher approaches to ICT in their lessons (Karasavvidis, 2009). The researcher therefore adopted activity theory as a framework to demonstrate the intimate mechanisms that link ICT, collaborative and creative teaching.

Taking activity theory as a theoretical framework would provide insights into the process of ICT use by Life Science teachers in the Khomas region, hence understanding how they use ICT in their classrooms. In addition, applying activity theory to the educational practice can promote technological creativity and collaboration among teachers (Engeström, 1993).

In this regard, the summarized components of activity theory below are relevant to the study.



*Figur*e *1.1* The structure of a human activity system (Engeström, 1987, p. 78).

The diagram illustrates that in the classroom, teachers (subject) have a motive (object) to use ICT mediating tools (instruments) with a common objective: to achieve a desired learning outcome. Teachers interact with one another in a community of practice (community) in order to enhance teaching and learning. Individuals in the classroom have different responsibilities (division of labour) and are guided by classroom rules to promote collaborative and creative teaching.

A number of researchers (e.g., Hong, Chen & Hwang, 2012; Kaptelinin & Nardi, 2006; Karasavvidis, 2009; Law & Sun, 2012; Lim & Hang, 2003; Murphy & Rodriguez-Manzanares, 2008) have used the theory as a framework. These researchers have used the theory to understand the processes by which activities shape and are shaped by their different levels of contexts in the activity systems. These researchers recommends the use of activity theory in the field of education as

a lens for studying ICT in the context of technology use (Murphy & Rodriguez-Manzanares, 2008). Kaptelinin & Nardi (2006) argue that activity theory allows researchers to move away from the computer as the focus of interest to understanding technology as part of the larger scope of human activities. Activity theory is most useful in the context of science and technology education (Hong et al., 2012; Law & Sun, 2012), hence the theory facilitate understanding of educational technology use in educational context.

Literature points to a need for science teachers to understand how activity theory can be linked to ICT use in the classroom. Activity theory can be used to examine the technological issues in the ICT integration process at the classroom level (Demiraslan & Usluel, 2008). Hong et al., (2012) conducted a case study in Taiwan on vitalizing creative learning in science and technology through an extra-curricular club using activity theory to examine the structure of development processes. The results showed that the four major domains were used in the science and technology club for the following reasons:

- to promote student engagement;
- to transfer parents' attitudes;
- to promote peer collaboration;
- to enhance expansive learning and creativity (Hong et al., 2012).

The project by Hong et al. (2012) was designed for students, and it may still be useful in providing guidance towards the use of ICT by Life Science teachers through activity theory in the classroom.

In addition, Lim and Hang (2003) point to a need for the use of ICT in activity theory to be situated in the classroom as a learning environment to enhance teaching and learning (Hennessy et al., 2010). Enhancement of teaching and learning of Life Science could be achieved through collaboration among members of the community with various tasks participating in the activity system (Hong et al., 2012) guided by classroom rules on how to use mediating tools to achieve a specific learning outcome. The information below on the seven components of activity theory is necessary to investigate how Life Science teachers' use of ICT befits the activity system.

2.6.1 Subject and object

In activity theory subject and object are essential for effective integration of ICT in specific classrooms with particular learning activities (Lim & Hang, 2003). The subject is the individual whose point of view is taken in the analysis of the activity (Murphy & Rodriguez-Manzanares, 2008). The description of the subject also includes "teachers' tacitly understood ideological and practical beliefs about teaching and learning, their teaching experience, attitudes, knowledge and skills about ICT" (Sweeney, 2010, p.29).

The activity of the subject is directed towards the object or goal (Kaptelinin & Nardi, 2006). Thus the object embodies the meaning, motive, and purpose of the system (Karasavvidis, 2009). This information is useful to determine Life Science teachers' objective or goal of using ICT in the classroom.

2.6.2 Tools and rules

Generally, ICT tools used by teachers include, but are not limited to, personal computers, laptops, printers, LCD projectors, interactive whiteboards, iPads, cell phones, and the internet (Martinovic & Zhang, 2012). Similarly, Boateng (2009) identified communication mediation tools such as personal digital assistants (PDAs), mobile phones, laptops, computers, and other forms of portable and immovable computing technologies that would provide enduring bases for mediated interaction in human technology driven interactions in collaborative settings (Boateng, 2009, p. 17).

Howie, Muller and Paterson (2005) noted that the type of ICT used in education in South Africa were divided into two main areas, namely: 1) hardware (e.g., personal computers, graphics tablets, video projectors, scanners, colour printer) and 2) software (e.g., general purpose software and school subject-specific software). In addition, Isaacs (2007) noted that Namibian secondary schools were equipped with computers and internet connection. This information is necessary to identify ICT tools used by Life Science teachers.

In fact, Lim and Hang (2003) emphasised that teachers must understand the external and internal tools that mediate the object into an outcome. Tools shape the way humans interact with an object in the classroom (Hong et al., 2012). A number of researchers (Hong et al., 2012; Law & Sun, 2012; Liaw, Hatala & Huang, 2009) have argued that mediating tools are also changed by the interaction as an activity unfolds through the use of tools. This information is necessary to determine Life Science teachers' use of ICT tools in the classroom.

The use of mediating tools in the classroom should be guided by rules. More importantly, the mediating tools should be linked to the lesson objectives. Rules refer to "explicit and implicit norms that regulate actions and interactions within the system" (Engeström, 1993, p. 67). In the activity system, there are ongoing and reformulation of rules by the subject (Murphy & Rodriguez-Manzanares, 2008) rather than the subject abiding by the fixed rules (Lim & Hang, 2003). Information about classroom rules with regard to ICT use is necessary to determine the tools and the rules developed by the Life Science teachers to achieve lesson objectives.

2.6.3 Community and division of labour

Teachers belong to a community of practice and they collaborate with each other. In the community there are one or more individuals sharing the objective with the subject (Law & Sun, 2012). In addition, there is division of labour among the participants of the activity system in the community (Lim & Hang, 2003). It means that teachers must understand responsibilities of different individuals in their community to enable them to effectively perform their duties in promoting collaborative and creative teaching. In order to promote collaborative and creative teaching, teachers need to uphold their networking practices as they interact in their community of practice (Ryymin, Palonen & Hakkarainen, 2008). Teachers' ongoing communication is necessary to promote collaboration within the community of practice.

Wenger, McDermott and Snyder (2002) offer an insight on communities of practice and their value to organizations. Within the community of practice, Wenger et al., (2002:4) pointed to a need for teachers to collaborate on an ongoing basis to typically

share information, insights and advice. This model is used by organizations for cultivating community of practice and it may still be useful in providing guidance towards teachers' collaboration to participate in formal and informal networks of teachers.

Similarly, MacDonald (2008) found that within their community of practice teachers with different expertise shared experiences with each other to create new insights into teaching and learning. In addition, Sutherland, Robertson and John (2009) offer a model demonstrating how a community of practice can be established to improve classroom learning with ICT. These scholars argue that "the relationships established within a community of practice are crucial" (Sutherland et al., 2009, p. 7) in the enhancement of teaching and learning with ICT. This information is necessary to determine teachers' collaboration in Namibia, a platform that will enable teachers to share and deepen their knowledge and expertise of ICT use by interacting with colleagues regardless whether they are located in the same or different schools.

2.6.4 Outcome

It has been argued that an outcome can be an idea, a situational status, or a specific positive or negative emotional response (Law & Sun, 2012) in an activity system. The outcome of an activity can help participants to understand and react to changes in the system (Hong et al., 2012). Engeström (1987) offers a model demonstrating the component of the activity system that indicates the direction of the outcome.

The model conceptualizes the development of activities at a collective level rather than individual development (Law & Sun, 2012). For instance, in the classroom, teachers make use of mediating tools within a community of practice where certain rules apply and where actions and interactions with objects between participants are regulated to some extent (division of labour) in order to share a general objective (MacDonald, 2008).

Wali (2008) interpreted an outcome as an accomplished learning goal in the activity theory model that he adapted in his study titled *Reinterpreting Mobile Learning: an Activity Theoretic Analysis of the Use of Portable Devises in Higher Education*. Although this model was used to study the use of ICT by learners, it may still be useful to determine the outcome directed toward teachers' use of ICT in their lesson. It is necessary to investigate Life Science teachers with regard to the lesson outcome and ICT use in the classroom, especially in the Khomas region of Namibia because 26 teachers from schools based in the Khomas region out of 103 countrywide were trained in ICT use and integration and are equipped with ICT resources.

In brief, literature pertaining to activity theory clearly reveals that the activity itself is a context in the activity system. This means that what takes place in an activity system composed of object, actions and operation, is referred to as the context (Engeström, 1993). Context is constituted through the enactment of an activity involving people and artifacts (Law & Sun, 2012). Broadly speaking, artifacts are defined to include instruments, signs, language, and machines as mediated activity and are created by people to control their own behaviour (Kaptelinin & Nardi, 2006).

In this study, the seven components of the activity theory model are useful for understanding Life Science teachers use of ICT in their lessons in terms of how teachers share resources, etc. The components of activity theory model should therefore be understood as follows:

Table 1.2 *Components of the activity theory model*

Component	Description	Example as used in this study
Subject	An individual engaging in an activity	Biology/ Life Science teachers.
Objects	An objective or motive held by the subject for performing an activity	Learning outcome. Learning objectives.
Tools	Material or instruments mediating the subject-object interaction; ICT mediating tools;	ICTs.
Rules	Regulations of actions and interactions in an activity to enhance cooperatively and collaboratively learning; enforcement of staff training	Rules of engagement with ICTs by teacher or classroom rules.
Community of practice	One or more people sharing the same values within the objective with the subject	Classrooms or schools.
Division of labour	How tasks, power and status are divided among co-operation members of the community	Teachers and learners involvement in a class.
Outcome	The seemless integration and use of ICT into the curriculum and classrooms (Yong, n.d.).	Professional development and well-being of teachers.

Finally, it is evident from the literature that activity theory addresses human activities as they relate to artifacts and shared practices. Therefore, activity theory as a dynamic model is particularly appropriate for the study of educational practices to promote technological creativity and collaboration among teachers (Hong et al.,

2012). Teachers' educational practices in terms of how they use ICT in the classroom play important roles in promoting technological creativity and collaboration (Karasavvidis, 2009).

2.7 Conclusion

This chapter described the theoretical framework of this thesis. First, the chapter discussed the concept of ICT use in science education and explored the benefits of using ICT to show how Life Science teachers promote collaborative and creative teaching. This was followed by a discussion on teachers' professional development with regard to ICT use. The chapter also discussed collaborative and creative teaching. This was followed by a discussion on barriers faced by individual Life Science teachers when integrating ICT in their respective classrooms. The researcher concluded the literature review with a discussion on Activity theory by Leont'ev (1987) that is developed as an attempt to theorise and study ICT use in science education. Second, the central concepts of Activity theory that are relevant to this research were discussed. Literature reveals that informaion about ICT use in Namibia is rudimentary. As a results, literature was drawn from international studies, especially in the developed world. The literature highlights a number of gaps such as: insufficient information on ICT use in Namibia and literature on collaborative and creative teaching. The present study, therefore sought to document information on how teachers use ICT in their classroom daily to promote collaborative and creative teaching.

The next chapter discusses the methodology used to collect data for this study, and begins by presenting the research design followed by a description sample and the

research instruments. This is followed by a discussion of data collection procedures, data analysis, the validity of the study, and ethical considerations.

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter presents the research design of this study, a description of a sample, the research instruments utilised for collecting data, and the pilot study used to test the research instruments. Further, the context of the case study is presented in order to understand the rationale for selecting the schools that participated in this study. This is followed by an explanation of the data collection procedures, data analysis, the validity of the study, and ethical procedures.

3.2 Research Design

The researcher employed a qualitative research design, where a multiple case study approach was used in order to explore how Life Science teachers use and integrate ICT in their classrooms. According to Yin (2009) a case study method can be used to understand a real-life phenomenon in depth. The case study method is most appropriate for answering the *how* and *why* questions (Yin, 2009, p. 27). In this regard the researcher focused on the *how* question and applied the classroom observations and semi-structured interviews with the Life Science teachers. The study was carried out in the natural settings of the respondents, attempting to make sense of, or interpret events from the teachers' own perspective (Cohen, Manion, & Morrison, 2011). The data was collected from the two Life Science teachers and

analysed thematically. The results are then presented in line with the Activity theory and the emerging themes.

3.3 Sample and Sampling Procedures

The researcher used a purposive sampling method to select one pilot plus two cases resulting into a total of three secondary schools in the Khomas region that have ICT infrastructures. The purposive sampling procedure was informed by the list provided by the MoE of teachers who have been trained on ICT use and integration during the years 2007-2011. Further, some teachers have been trained in ICT use and integration through the Continuing Professional Development (CPD) Programme in their schools. The researcher visited five secondary schools selected randomly from the list provided by the MoE and compiled a list of teachers observed using ICT in their classrooms. The identified teachers were confirmed by the school principals. The researcher selected one Life Science teacher from each of the identified schools that received training. A total of three Life Science teachers were asked to participate in this study. Of these three teachers, one participated in the pilot study. The three case studies provided the researcher with knowledge and experience of the selected teachers that are information-rich or those from which the researcher can learn a great deal about the research problem (Yin, 2009; Cohen et al., 2011; Gay, Mills & Airasian., 2011).

3.3.1 Understanding the Schools Selected for the Case Study

The case study engaged two schools located in Windhoek. The characteristics of the schools are presented below to illustrate the context within which the data was collected. Schools A and B were both situated in Windhoek, in the Khomas region

of Namibia. Furthermore, both were technologically rich, that is, equipped with ICT, and had comparably similar characteristics in terms of their school management (guided by rules), curriculum, student background, and teacher qualifications.

3.3.2 School A

In School A, the class size was 15 learners. There were two computer laboratories with 26 computers in total, connected to the wireless internet and one was equipped with data projector, projector screen, smart board, printer, scanner and digital video camera. Additionally, an on-site technologist (computer technician) was available to resolve technical problems. The technician, who is also the IT manager, is the administrator of the school's network and is responsible for installing software and organising CPD for teachers. Some teachers at this school were trained and certified in ICT integration.

The Life Science teacher had a laptop in the classroom that was connected to the smart board and to a three-in-one printer/scanner/photocopier positioned in the administration block. The smart board in the Life Science classroom was used to display various biological diagrams, notes, class activities and question papers.

3.3.3 School B

In School B, the class size was 13 learners. It had a computer laboratory with 29 thin clients computers connected to the wireless internet and was equipped with data projector, projector screen, smart board, printer, scanner and digital video camera. The computer teacher who is the System Administrator was also available to connect

teachers and learners' iPad to the wireless internet with an Active antivirus and firewall. The System Administrator was responsible for software installation on all the devices available in school for teachers and learners. EDU 2.0 e-Learning system was customized by the school's Administrator from http://www.edu2.0.org. Teachers were trained on ICT integration but no certificate awarded. The Life Science teacher used an iPad and a projector to display Biological drawings, notes, class activities on the whiteboard. With the wireless internet available in the classroom, the teacher post learners home work, projects and question papers on the school's website.

3.4 Research Instruments

The instruments used to collect data for this study were guided by the constructs in activity theory and are therefore consistent. This study utilised the following research instruments: non participatory observation schedule, field notes and semistructured interview guide.

3.4.1 Nonparticipant observation schedule

In order to investigate and understand the extent to which Life Science teachers integrate ICT into their classrooms, a nonparticipant observation of Life Science lessons was carried out to help the researcher understand the case under investigation (Yin, 2009). Observations enabled the researcher to gather data on the physical setting, the human setting, the interactional setting, and the programme setting, (Cohen et al., 2011). For this study, 10 Life Science ICT-mediated lessons were

observed for each participant, totalling 30 lessons. In nonparticipant observation, "the researcher observes and records behaviours but does not interact or participate in the life of the setting under study" (Gay et al., 2011, p. 382). The researcher was able to carry out structured observations by accessing identified classroom and observing what was taking place (see Appendix A).

3.4.2 Fieldnotes

The researcher documented observations with fieldnotes and described all relevant aspects of the use and integration of ICT to promote collaborative and creative teaching. Creswell (2012) describes field notes as text (words) gathered, recorded, and compiled during an observation in a qualitative study. The researcher's field notes contain two basic types of information:

1. Descriptive information about what the observer has directly seen or heard on-site through the course of the study.
2. Reflective information that captures the researcher's personal reactions to observations, the researcher's experiences, and the researcher's thoughts during the observation sessions. (Gay et al., 2011, p. 382)

3.4.3 Semistructured interviews

The researcher also used semistructured interviews as an "in-depth interview approach" (Yin, 2009, p. 107). In-depth interview were flexible and allowed the researcher to probe participants further in order to gain understanding of the events in the Life Science classroom at the sites. The researcher was guided by an unstructured interview guide during the informal interviews of the key participants

(Life Science teachers) and was subsequently able to gain clarity on how they used and integrated ICT into their classroom to promote collaborative and creative teaching (see Appendix B). The goal of the "informal interviews was not to get answers to predetermined questions but rather to find out where the participants are coming from and what they have experienced" (Gay et al., 2011, p. 386). Furthermore, the interviews were audio-recorded, and data collected from them were transcribed after the interview of each participant.

3.5 Pilot study

The researcher identified one of three schools to serve as a pilot study to test the research instruments. The school was identified for the pilot study because the informants "were easily accessible and the site was geographically convenient" (Creswell, 2012). In addition, the pilot case provided some conceptual clarification for the research design (Cohen et al., 2011). A pilot case study served to "help refine data collection plans with respect to both the content of the data and the procedures to be followed" (Yin, 2009, p.92). The pilot study enabled the researcher to make any necessary amendments to the observation system and procedures thereof. With regards to the objectives and tools, the researcher arranged for a pre-interview before the lesson to find out about the lesson objectives and follow-up questions on tutorial or exercise software during the interview of Life Science teachers. In addition, the researcher explained community of practice, programmed learning and computer assisted instructions to the teachers. The participant from the pilot study shared 'some' similar characteristics with the research participants at the

initial study (Gay et al., 2011). The researcher used feedback from the pilot study to revise the questions before interviewing the key participants.

3.6 Data Collection Procedure

Firstly, the researcher observed 30 Life Science lessons (see Appendix A), and took notes on how ICT was used and integrated by each teacher.

Secondly, with the permission of the participants (see Appendix C) 45-minute semi structured interviews were audio-recorded to obtain more information on how teachers use and integrate ICT in their lessons (see Appendix B). The purpose of the interview was to seek clarity through formulated interview questions. After each interview with participants, collected data was transcribed. According to Gay et al. (2011, p. 397), "a data transcription is a written record of the events that were recorded".

3.7 Data Analysis

The researcher used thematic analysis to analyse the data. Thematic analysis can be used to identify cases under study as one entity of analysis (Braun & Clarke, 2006, p. 79). Firstly, the researcher read through the fieldnotes describing classroom events and reflecting on the researcher's insights and themes that emerged during observation (Creswell, 2012). Secondly, the ideas or concepts from the fieldnotes and interviews were later grouped into themes. In addition, referencing units of text were sorted, coded and labelled according to meanings and patterns (Gay et al., 2011). The new emerging themes were recorded as "expected themes" (Creswell,

2012, p. 249) as a result of new data that did not match the components of the Activity theory.

3.8 Validity

In qualitative research, "validating findings means that the researcher determines the accuracy or credibility of the findings through strategies such as member checking or triangulation" (Creswell, 2012, p. 259). Gay et al. (2011, p. 393) further explain that "triangulation is the process of using multiple methods, data collection strategies, and data sources to obtain a more complete picture of what is being studied and to cross-check the information". In this study, methodological triangulation was used to check the consistency of findings generated by different data collection methods (Patton, 2002).

To establish trustworthiness of the findings, the following strategies were employed. Firstly, the researcher triangulated the data obtained from classroom observations and interviews with Life Science teachers. Golafshani (2003, p. 604) argued that, "engaging multiple methods such as observation, interviews and recordings will lead to more valid, reliable, and diverse construction of realities".

Secondly, the researcher used direct quotations to reflect teachers' insight on how they use and integrate ICT in their lessons. In fact, Johnson and Christensen (2010, p. 146) stated that "the use of verbatim and member-checking accurately portrays the meaning attached by participants to what is being studied and the degree to which the participants' viewpoints, thoughts, feelings, intentions, and experiences are accurately understood".

Thirdly, the researcher provided the Life Science teachers with a case study written report and the raw data on the findings to determine whether they consider the findings to be accurate. The feedback from all the participants agreed with the report and concurred that the interpretations thereof were accurate and credible. Creswell (2012, p. 259), emphasises "member checking as a process in which the researcher asks one or more participants in the study to check the accuracy of the account".

3.9 Research Ethics

In this study, ethical issues were considered. Ethics refer to the moral principles guiding research from its inception through to its completion and beyond (Busher, 2005). The researcher drafted a letter requesting permission from the Director of the Khomas region to carry out this research (see Appendix D). The researcher also obtained permission from the principals of the schools selected for the study and then informed the participants about their right to agree or refuse to participate in the research activities. Written consent was also obtained from the participants (see Appendix C). In addition, the researcher assured the participants that the information obtained would be used for research purposes only and that it would be treated with the utmost confidentiality and anonymity. Furthermore, the researcher ensured participants that observations were not focused on pedagogical practice or classroom management, but purely on their ICT use and integration.

3.10 Conclusion

This chapter described the research methodology employed for this study. The researcher began by presenting the research design, a description of the sample, research instruments and pilot study. This was followed by an explanation of data collection procedures, data analysis, validity and ethical considerations.

The next chapter discusses the analysis of the data gathered through observations and interviews. The chapter also presents a discussion of the findings of the study in line with the literature. The researcher begins by presenting the findings of the study based on the constructs of activity theory and the emerging themes. This is followed by a discussion of the challenges faced by Life Science teachers in their classroom.

CHAPTER FOUR: PRESENTATION OF RESULTS AND DISCUSSION OF FINDINGS

4.1 Introduction

The chapter presents the results and discussion of the findings of the study in an attempt to answer the research questions (Section 1.3). The results section is divided into two parts, each of which aims to answer research questions 1 and 2 respectively. In Part A, the results are presented (Section 4.2) following the seven constructs of activity theory which are: subject and object (Section 4.2.1), tools and rules (Section 4.2.2), community and division of labour (Section 4.2.3), and outcome (Section 4.2.4). The emerging themes from the two case studies of Life Science teachers are presented in Section 4.3.

In Part B, challenges faced by Life Science teachers when integrating ICT into their classroom are presented in Section 4.5, followed by the conclusion in Section 4.6.

4.2 Results

The results from the case studies as obtained through non-participatory observation of Life Science ICT mediated lessons and interviews are presented following the seven constructs in the Activity theory below:

PART A

4.2.1 Subject and object

As stated in Section 2.6, subjects are referred to the two Life Science teachers who participated in the case study. The objects are the lesson objectives teachers had as a

motive to use ICT in their lesson. The characteristics of the two teachers are presented below:

Teacher A

Teacher A was a male from School A, who taught Life Science/Biology for 24 years. The researcher has observed that the teacher was using ICT in the classroom daily. In addition, he had clear instructions during his lessons. The teacher promoted interaction with learners in the classroom. Teacher A testified to this by saying:

> *I am a male teacher. I love teaching. I have been teaching at this school for 6 years now and overall I have been a teacher for 24 years. I have been a Biology and Life Science teacher and I also taught Agricultural Science.* (Teacher A, 24 July 2013)

Teacher B

Teacher B was a female, Biology/Life Science teacher from school B, with 29 years of teaching experience. From observations, the teacher used ICT teaching strategies in the classroom on a regular basis. The teacher used ICT using different tools to present various concepts. In addition, the teacher constantly interacted with learners.

Teacher B testified to this by saying:

> *I am a female teacher. I have been teaching in various schools, for the past 29 years. Yes, I have been teaching for quite a while. I love it and I will still teach till the day I am going into pension.* (Teacher B, 29 July 2013).

This study found that Life Science teachers from School A and School B received training on ICT literacy and integration as initiatives of their respective schools. However, only one teacher indicated receiving training and was awarded a certificate. The other teacher was trained but no certificate awarded. The Life Science teachers each had more than 24 years of teaching experience and were motivated to use ICT teaching strategies in their respective classrooms.

In my opinion, both Teacher A and B were suitable for this study because they were found to have the necessary skills. The results are not surprising as this justifies the purposeful sampling used for this study. In addition, teachers in this study match the description of the ICT use by Sang et al., (2009). Teachers were observed as having used ICT often for demonstration purposes, drill and practice activities, modelling, representation of complex knowledge elements, discussions, collaboration, project work, etc. Teachers used ICT to support and enhance the actual teaching and learning processes in both classrooms.

The objectives for using ICT in the lesson were not stated in the lesson plans. Therefore, teachers were then asked to state the lesson objectives with respect to ICT use. Teachers stated the objectives for specific ICT mediated lessons as follows:

> *You want the learners to understand the syllabus; you want them to understand the work that they need to write the exams on. The objectives of using ICT in the classroom, is to make the work clear to the learners.* (Teacher A, 24 July 2013)

According to teacher B:

> *The objectives of using ICT at school, is not just in the classroom [but] actually to use the technology as far as possible in all different forms. In the classroom, we make use of the internet and other devices in order to make the work understandable to the learners.* (Teacher B, 29 July 2013)

The Life Science teachers could not state the objectives for using ICT in the lessons. This could be due to the fact that the teachers were not aware of the importance of linking ICT to the curriculum. However, from observation teachers used ICT for making learners understand the syllabus, thus ICT is mainly used for content delivery and for assessment. This result is in support of two of the four main reasons for using ICT by Lim & Hang (2003) who found that in Singapore, science teachers had objectives to use ICT with four main reasons, namely: for curriculum and assessment; as learning resources; for teacher development, and; as a physical and technological infrastructure. In Namibia, teachers use only two out of the four reasons: for curriculum and assessment and as learning resources.

Teacher A further indicated that:

> *The objectives of using ICT teaching strategies could afford learners the opportunity to manage their own learning* (Teacher A, 24 July 2013).

In addition, teacher B indicated:

> *Using a variety of assessment strategies that could also motivate learners to set their own goals and evaluate their own work.* (Teacher B, 29 July 2013)

This means that using a variety of teaching strategies will expose the learners to different kinds of information resources and thereby possibly choose the one they are comfortable with and that which they can manage in terms of content. Also, learners are exposed to a variety of assessments including self-assessment modes that will give results instantly. This can help the learners identify the weak areas that they must improve.

4.2.2 Tools and rules

Tools refer to instruments such as ICT that Life Science teachers use in class and for lesson preparation. Rules refer to rules of engagement with ICT as set by teachers to manage the use of ICT in the classroom.

Asked to identify tools used in the Life Science classroom, the teachers provided answers presented in Table 2.1 below.

Table 2.1 *ICT tools used by Teacher A and Teacher B*

Hardware	Software
iPad	Cyber roam captive portal
Laptop (Apple)	e-Books
Laptop (HP)	e-Learning (EDU 2.0)

Hardware	Software
Photocopy machine	E-mail
Printer	Ever note
Projector	Grade book
Scanner	Integrated electronic books
Smart Board	Interactive Biology books
White board	Microsoft outlook
Wi-Fi	PDF
	Smart document; Smart slate; Smart tech
	Smart exchange; Smart Note book

As shown in Table 2.1 above, Life Science teachers listed the hardware and software as presented in the table. As observed, all teachers were provided and equipped with the necessary ICT tools such as iPads, laptops, and smart boards bought by the schools. The researcher observed that the teachers used almost all tools listed above, especially the interactive whiteboard (smart board), in the lessons observed. For example: Teacher A was found to use a laptop, projector and smart board frequently (in each lesson observed), while teacher B utilised the iPad, laptop, projector and whiteboard more frequently in all lessons observed. This result is in compliance with the findings of Sweeney (2010) in that the teachers in Australia, the participating teachers had interactive whiteboards in their classrooms and used them regularly. In European countries such as Romania, Spain, Poland and Greece, teachers use Virtual Instrumentation in Science Education (Suduc et al., 2011).

Science teachers indicated having access to different technologies such as Multimedia Simulation, data logging, interactive whiteboards, and virtual experiments to support science teaching (Suduc et al., 2011). No studies were done in Namibia to investigate how teachers or Life Science teachers in particular use interactive whiteboards. There is a need to assess the use of the interactive whiteboard in other schools in Namibia. Also, no count was done of the many times each of the tools was being used in this study. The researcher acknowledges that this is a limitation that needs attention in other studies on ICT use. Teacher B also emphasised that the ICT tools have become the mediating tools in the classroom. Thus, the tools serve as medium for interaction between the teacher, learners and the learning objectives.

Teacher A also testified to this by saying:

> *Because everything we do today runs through the different devices…I cannot imagine teaching without using the smart board.* (Teacher A, 24 July 2013)

This is interpreted to mean that, teachers were comfortable using the tools in their lessons daily. Meaning that, they were motivated to use the tools and therefore used them in all the lessons observed.

This study revealed the types of tools found in the schools as used by Life Science teachers: the ICT tools used by the teachers were installed with educational software apps that are supported by Apple in Education; e-books; e-learning system like EDU 2.0; Smart Note with diagrams, Video Gallery, and other educational websites.

Teacher B also testified to this by saying:

> *Each teacher and learner owns an iPad registered with the school, with a unique password and is used to promote programmed learning in the classroom.* (Teacher B, 29 July 2013)

Through observation, it was evident that the e-learning system supported an online interaction between teachers through educational forums such as debates, discussions, and dialogues on the school's website. Teacher A strongly emphasised this point by saying that:

> *With the e-learning system the teacher could do the following: use variety of assessments such as quizzes, homework, classwork and essay to grade and give effective feedback for learners online. Teachers can also afford learners the opportunity to submit their work online.* (Teacher A, 24 July 2013)

Teacher B emphasised that:

> *We use ICT tools such as Grade book on the school's website to give learners feedback on Projects, Assignments, Test and Exams.* (Teacher B, 29 July 2013)

Teachers indicated that ICT tools became the mediating tools in the classroom. No alternative teaching methods were apparent during observation. This could be due to a fact that participating teachers were well experienced and had been using ICT for a long time. Over the years, teachers became confident with using ICT for daily

preparation and in their classes. These findings supports Sweeney (2010) that teachers get confident in ICT use after having undergone professional development and are using ICT frequently. Teacher A used ICT such as smart board to draw diagrams, and Video Gallery to demonstrate science concepts during the lesson. In support of creative teaching the researcher observed that, in the classroom teachers use ICT to illustrate interactive diagrams such as the structure of the heart, blood circulation and digestion just to mention but a few. The smart board has software application that enabled teachers to focus on details on specific diagrams.

The use of ICT in an interactive lesson makes the work more understandable to the learners. In addition, teachers incorporated ICT in the Life Science classroom for simulation and modelling. For instance, with regard to the structure of the heart as projected on the smart board, learners could hear the heartbeats through the speakers connected to the smart board. As an outcome of CPD, these teachers were able to use ICT in their classrooms to promote collaborative and creative teaching. Pinheiro & Simóes (2012), define collaborative and creative teaching as teachers working together to promote teaching that supports the use of ICT.

Furthermore, Teacher B used ICT tools for a variety of assessments such as quizzes, homework, classwork and essays, to grade learners, and give feedback, through e-learning tools. The finding is similar to that of Sánchez et al., (2012) that Spanish teachers have developed a positive attitude toward ICT use but do not frequently incorporate ICT in the classroom. Also, the ICT tools such as an interactive digital whiteboard, word processors, and PowerPoint presentations were commonly used in class for presentations, and image and video editing (Sánchez et al., 2012). The

similarity between Spain and the Khomas region is that both teachers used ICT for teaching purposes. However, the researcher is aware that this study sampled Life Science teachers and was found to use ICT more frequently in the classroom activities whilst Sanchez observed many teachers in Spain, on the use of ICT. In this regard, the researcher of this study could only observe few teachers' classroom activities and the results therefore cannot be generalised.

Also, in Chile, teachers were encouraged to develop methodologies and software applications to support classroom activities (Enrique-Hinostroza et al., 2011). In Namibia, this expectation is stated in the ICT Policy for Education but it is not practised in schools. It could be attributed to the fact that the training undergone on ICT did not focus on material development but on how to make use of already existing material.

In addition, this study revealed that there are clear classroom rules with regard to ICT use. When asked if the teachers have established rules with regard to ICT use in the classroom. Teacher A indicated that:

> *The uses of earphones are strictly prohibited in the school.*
> (Teacher A, 24 July 2013)

Teachers indicated that the network has a security system that restricts and blocks access to social network such as Facebook and Twitter.

Teacher B added that:

> *All submissions by the learners should be done online and closes at 00h00 midnights.* (Teacher B, 29 July 2013)

This is interpreted to mean that the teachers in this study had set classroom rules with regard to ICT use. The activity system requires that there be on going and reformulation of rules by the subject (Murphy & Rodriguez-Manzanares, 2008) rather than the subject abiding by the fixed rules (Lim & Hang, 2003). Some of the rules emphasised by the teachers included the prohibition on the use of earphones in the school environment; the active security system to block social networks such as Twitter, Facebook and Skype video calling; and the e-learning online submissions that closes at 00.00 midnight. This finding is in agreement with the result of Hong et al. (2012) in that principal rules were applied in the PowerTech contest, namely: each team is allowed to have up to four members; each team should use the same materials and parts to assemble the wooden robot; the size of the wooden robots must be within the allowed dimensions; and robots must be assembled in the morning and compete in the afternoon, all within the allocated time (Hong et al., 2012). Like in the PowerTech project, the sampled classrooms in Namibia had rules to which the learners had to abide. This is to ensure effective classroom management.

4.2.3 Community and division of labour

Community refers to Life Science classrooms and Schools A and B where Life Science teachers share skills and experiences. Division of Labour refers to how tasks are divided among Life Science teachers and learners in the classrooms.

Life Science teachers indicated belonging to a community of practice (COP) and they collaborate with each other.

At the school level Teacher A indicated that:

> *Life Science teachers meet regularly during departmental meetings to outline the scheme of work based on the division of the syllabus; identify appropriate teaching and learning tools, exchange teaching strategies and latest software with regard to ICT; share notes, videos, worksheets, tests and question papers to ensure quality teaching of Life Science across the curriculum*. (Teacher A, 24 July 2013)

According to Teacher B:

> *At the community level teachers from different schools come together to review question papers with regard to setting up and weighting of questions…share and exchange lesson preparation files, resource files and teaching aids…the teachers also share these online.* (Teacher B, 29 July 2013)

This is interpreted to mean that educational resources were shared during teachers meeting indicating collaboration with colleagues regardless of whether they were located in the same or different schools. However, there seems not to be clear evidence that teachers developed tools that may result in creative teaching. It appears as if teachers opted to share the ready-made tools which they had downloaded from the internet.

Teacher A added that:

> *At the national level teachers attend workshops and training for their own professional development.* (Teacher A, 24 July 2013)

Although teachers indicated belonging to a community of practice, they could not give a name to it. According to the teachers, there is no official name for their community of practice. However, teachers referred to it as *A Group of Life Science-Biology Teachers*. When asked to mention the name of their community of practice, Teacher B responded by saying:

> *Well, there is no name really, but we do come together with teachers from other schools…we hand out information or exchange information of what we have found and what they have found. We obviously learn from them and they learn from us. Yeah, but [meaning] it's just Biology teachers of different schools that come together. Like most of the time we come together about once a term to discuss what new things we discover and what we can improve. We did find some ICT teaching strategies that can actually be used in the classroom which will make it easier for us [teachers]*. (Teacher B, 29 July 2013)

In this study, this is interpreted to mean that, Life Science teachers may not have found it necessary to have an official name for their community of practice. Teachers preferred to meet and shared ready-made resources. For instance, Teacher

B stated that they share electronic question papers, assessment activities and lesson plans.

In addition, Teacher A also indicated sharing lesson plans online with teachers in London. It is therefore clear that Life science teachers belonged to a community of practice and that they collaborated with each other in the same school as well as abroad. However, there is no specific name for the community of practice. Also, there is no evidence that teachers do collaborative teaching nor is there clear evidence that ICT-related matters were discussed during their meetings. The participating Life Science teachers' practices within their community of practice partly satisfy Wenger et al. (2002) expectation in that they share information. Wenger suggests the need for teachers to collaborate on an on-going basis in order to share information, insights, and advice. However, there is no evidence of the type of online content shared by the Life Science teachers.

During meetings, Life Science teachers identified tools necessary for Life Science teaching. In addition, they shared notes and worksheets. They developed tests and question papers that were exchanged as online assessment tools. This result also supports the finding by Sutherland et al. (2009) that communities of practice should discuss issues pertaining to availability of resources; teachers' notes, create blogs, and develop software. In Namibia, information about teachers' community of practice is not well documented, if at all it exists. Life Science teachers do not create online discussion forums [blogs] because of limited training. Earlier, the Life Science teachers mentioned that the training was limited to ICDL and ICT use and not inclusive of creating blog (Section 4.2.2). Creating communities of practice

with clear guidelines amongst the Namibian life Science teachers would be useful in promoting collaborative teaching.

Furthermore, the researcher observed that individuals in the classrooms have various responsibilities toward teaching and learning. Life Science teachers acted as facilitators and appeared to give clear instructions, monitor learners' progress and evaluate learning outcome. Learners had the responsibility to monitor their own learning, set their own goals, and follow classroom rules on the use of ICT to ensure a technology web-based learning environment. For instance, during classroom activities, Teacher B posted an essay question on the e-learning system. Learners then submitted their answers online, and the teacher gave feedback online and recorded the learners' marks in a grade book situated on the school's website. Additionally, learners reviewed their performance and monitored their progress online. This information was used to compare learners' individual performance to the goals they had set for themselves at the beginning of the term.

4.2.4 Outcome

This section presents the outcome of the Activity theory as used in this study. It should be noted that the direct outcome of the Activity theory as used in this study is collaborative and creative teaching. However, CPD in the participating schools has enhanced the process of achieving the outcome. In this light, CPD will be discussed in relation to the outcome.

Life Science teachers indicated that they have undergone professional development on ICT use and integration. In addition, CPD was initiated by the schools. As an

outcome of CPD, these teachers were able to use ICT in their classrooms to promote to 'some extent' collaborative and creative teaching. When asked about the training received, Teacher A indicated that:

> *In the beginning it was like of course all our teachers together and one ICT specialist from South Africa who came to us and then showed us how to work with ICT. We had our laptop and he told us to practice different teaching strategies and that's how we started.* (Teacher A, 24 July 2013)

Teacher B elaborated on the training received by saying:

> *Yes we had training; every year at the beginning of the year we do [get training] from the school offered by the school's Administrator; they do send us on the courses also to South Africa to get more into the whole training for the professional development; once a year from school's side everyone that wants to can go to a course [about] what you are doing for instance. Again, we as biology teachers could not go with the math teachers because they are doing this on their own. So we have either people coming here at our school to train us or we go wherever it has to be.* (Teacher B, 29 July 2013)

Life Science teachers were trained on the operational use of ICT. The researcher observed that teachers were able to incorporate software application and hardware (e.g., iPad and smart board) in their lessons. For example, Teacher A taught a topic on 'cell structure and maintenance' using a smart board. He demonstrated the

concept of biological drawings using the smart board pen to label the different part of the cells. Advanced ICT skills were observed, this finding is consistent with the research finding by Draper (2010) were teachers were observed teaching in South African schools.

In the same light, Ertmer & Ottenbreit-Leftwich (2010) indicated that as an outcome of ICT use, teachers' personal and professional uses of ICT increased. The outcome in the activity theory model is necessary for teachers to develop activities at a collective level rather than for individual development (Law & Sun, 2012). As a result of professional development, Life Science teachers collaborated with other teachers by sharing resources but did not teach collectively as members of a group.

Life Science teachers have demonstrated creative teaching. However, it is the researcher's opinion that the CPD need to focus more on material development in order to have teachers produces their own teaching material. The fact that teachers may not have seen the necessity to link ICT to the curriculum; this may result into disintegrated use of ICT. Yong (n.d.) recommends that the Activity theory should be a seamless integration and use of ICT into the curriculum and classroom by a community of teachers.

4.3 Emerging themes

The following themes emerged from the two case studies of Life Science teachers. It should be noted that the researcher was not surprised as the themes were expected to emerge hence the use of purposive sampling. The emerging themes are knowledge and attitudes.

Knowledge

In this study, knowledge is referred to as "factual propositions and understandings" (Prestridge, 2012, p. 450). The researcher observed that teachers in this study had skills to use ICT in order to enhance collaborative and creative teaching. Teacher B indicated having an understanding of incorporating ICT in the classroom. She explained how she used the iPad in class and for preparation.

> *I do all my preparation on my iPad now, so I would say I use it in full. I do have electronic notes not in a book form [hard copy]. At the moment, everything is on my iPad either in the diary of the iPad or in different parts of the iPad but it's all in there. It would be devastating if I lose it because then I will have nothing.* (Teacher B, 29 July 2013)

In this study, this is interpreted to mean that teachers have the knowledge of how to use ICT and are 'addicted' to them. As a result, the teacher cannot do without the iPad. Hence, Teacher B has all her notes on the iPad and shares these with the learners online. However, the disadvantage of having all notes in the iPad may be that if it gets lost or if technology failed due to other reasons, then it would be great loss. The researcher did not ask if Teacher B had a back-up of the information loaded on either the hard drive or in print format. This information could have been necessary to establish if the teachers make contingency plans to have backup systems and also to demonstrate their knowledge of hardware and software. Teachers in Spain were also comfortable to use Tablet PCs and smart boards as teaching and

learning resources in their classrooms (Sánchez et al., 2012), assuming they had the knowledge of the hardware and software used in the classroom.

Attitudes

Attitudes are key factors in whether teachers accept computer as a teaching tool in their teaching practices. Thus the success of technology use in the educational settings largely depends on teachers attitudes toward technology use (Albirini, 2006). Attitude is further related to the usage frequency of technology and usage amount of technology (Al-Zaidiyeen et al., 2010). From my observation, Teacher B was very enthusiastic to emphasise the use of IPad in her classroom. Teacher B stated:

> *iPad is the easiest device to use and most of them [learners] do have one in my class… they [learners] also get the E-books so they can now participate fully in their own learning process…these makes us [teachers] comfortable to share resources as we have enough [resources]*. (Teacher B, July 2013)

The participating Life Science teachers seemed positive towards ICT use and feel comfortable to share tools with other teacher in the same or other schools. This result is inline with the findings of Sánchez et.al (2012) who observed that science teachers in Spain developed a positive attitude toward the use of ICT for pedagogical purposes. Attitude measures were used to improve the motivation and academic performance of teachers. In addition, some characteristics of the participating Life Science teachers matched those of the Syrian High School EFL teachers in that they

had positive attitude towards ICT use (Albirini, 2006). However, the study by Albirini focused deeply on the teachers' attitude using the following domains: affective, cognitive and behaviour in relation to their perception on the computer attributes. The teachers in this study showed a positive attitude within the affective domain.

PART B

4.5 Challenges Faced by Life Science Teachers When Integrating ICT into Their Classrooms

The second question aimed at identifying the challenges experienced by Life Science teachers when using ICT in the classroom. Life Science teachers revealed that when they started using ICT in the beginning, several challenges surfaced. These challenges were classified under two levels of management namely: school level and classroom level.

4.5.1 School level

Some of the challenges faced at the school level were slow network at both schools, and insufficient ICT tools at School B. However, these challenges were experienced at the introduction of ICT in the respective schools but the situation was resolved over time. Both schools A and B took the initiative to purchase a Wi-Fi network and a Learning Management System (LMS). Further, school B also purchased iPads in bulk to support the e-learning system. However, parents were informed to

purchase the iPad from the school either as a once off payment or in monthly instalments.

Further, the results regarding the challenges faced by teachers at the two schools are presented below:

Network failure:

When asked to mention the challenges faced, the teachers mentioned network failure as one of them. Teacher B indicated that:

> *When the e-learning system was introduced in the school, the Wi-Fi system was poor to handle the e-learning system.* (Teacher B, 29 July 2013)

Teacher A emphasised that:

> *The school could not get the fast Wi-Fi in Namibia to accommodate all users on e-learning system at the same time.* (Teacher A, 24 July 2013).

On the one hand, School A was challenged by its Wi-Fi system coverage. On the other hand, School B had challenges with an increase in number of ICT tools. The fact that the network was slow could mean that teachers could not access the information from the internet during lesson presentation. Also, it could mean that displaying videos from YouTube was very slow and it could also be cut in bits.

Over time, these challenges were solved as explained by Teacher B:

> *The school purchased the fast Wi-Fi internet system. The new Wi-Fi has a fast speed to cater to all users online in the school.* (Teacher B, 29 July 2013)

This means that multiple users could access information from the internet faster. The situation was similar in School A and was also resolved accordingly. Teacher A also emphasised that:

> *The internet they [teachers] had which was believed to be very slow, but now the school has upgraded to a fast Wi-Fi.* (Teacher A, 24 July 2013)

This is interpreted to mean that the challenges faced by Life science teachers as individual in their respective schools have been addressed. Another challenge reported at the school level which was faced by Teacher B was 'parental engagement' and the results are presented below:

Parental engagement:

Teacher B indicated that:

> *This was a challenge hence … the school management and teachers had to convince the parents on the significance of the iPad for the e-learning.* (Teacher B, 29 July 2013)

Further, Teacher B stated that:

> *When the e-learning system was introduced in the school, few parents did not understand the usefulness of internet as a learning tool for their children [learners]. Although, this was believed to be challenging the school, it was addressed during parent/teacher/learner conferences through presentations on the usefulness of internet and ICT devices as learning tools were emphasised.* (Teacher B, 29 July 2013)

The Life science teacher stated that after parent/teacher/learner conferences were conducted, most parents developed a positive attitude toward the use of technologies in the school. As a result most parents then also purchased iPad devices for their children (learners).

4.5.2 Classroom level

There was only one challenge reported at both schools which was 'time'. The results regarding this challenge are presented below:

Time

Teachers A and B indicated that they did not have sufficient time to make sure that their lessons were incorporated with ICT. Teacher A stated that:

> *Most of the lesson plans and the Biology Grade 10, 11 and 12 text books took him some time to compile.* (Teacher A, 24 July 2013)

Teacher B also added that:

> *To get the assessment activities and question papers ready for the learners on the e-learning system as PDF formats was time-consuming.* (Teacher B, 29 July 2013)

This means that teachers needed more time to prepare for hand-outs, notes and to develop assessment activities. It should be noted that these challenges were overcome with time as teachers went through CPD. The teachers acquired ICT skills through CPD to enable them to use ICT for purposes of teaching. As a result, teachers were able to manage their time effectively.

In summary, the challenges faced by the Life Science teachers are not strange as these were similar to those found by Bingimlas (2009) in terms of time and Kopcha (2012) in terms of time and development of teaching material. The findings indicated that after professional training, teachers had enough time to plan and prepare lessons that use technology (Kopcha, 2012).

Similarly, the participating teachers went through training on ICT integration and professional development to be able to address the said challenges. It is also noted that in some part of Africa, there is a lack of affordable access to connectivity (Isaacs, 2007; Ndawi et al., 2013). However, this challenge is not applicable to this study due to the sampling procedure; the sampled schools were well equipped with ICT tools and wireless internet.

4.6 Conclusion

This chapter presented qualitative data gathered from respondents during observations of Life Science lessons, field notes as well as during the interviews. The results were presented in line with the activity theory constructs and other subtopics relevant to answer the research questions. From the case study context, the results indicated that both Teachers A and Teacher B used ICT in their classroom on a regular basis. The schools have sufficient ICT tools including learning management systems, smart boards, etc. Life Science teachers used ICT to prepare lessons; to compile notes, to assess tasks, to compile question papers; to evaluate learning outcome, and to give effective feedback to learners. In their interviews, Life Science teachers indicated that the availability and use of ICT has made their work easier and that they could manage their time effectively as they used ICT in their respective classrooms. Evidence of creative teaching was demonstrated and some aspects of collaborative teaching. There was no evidence of co-teaching in the same or different schools. Several challenges experienced by Life Science teachers were time, parental engagement, network issues and time to use ICT in the classroom. However, these were addressed over time. These findings were validated by participants through member-checking.

In the next chapter, the researcher will present a summary of the study, draw conclusions, and make recommendations for practice and future research.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter begins by presenting a summary of the research processes (Section 5.2). Additionally, a description of the research findings with regard to ICT use and integration by Life Science teachers is presented (Section 5.3). This chapter also presents a statement on reflections from the study (Section 5.4). Furthermore, conclusions drawn from the research findings of this study are presented (Section 5.5). Finally, based on the evidence presented in this study, the chapter concludes with recommendations on ICT use and integration to inform Life Science teachers (Section 5.6) and for future research (Section 5.7).

5.2 Summary of the Research Processes

The study was designed as qualitative research using a multiple case study approach. A purposive sampling method was used to select three secondary schools in the Khomas region of Namibia. The schools were selected on the basis that they had the infrastructure and that the Life Science teachers were regularly using ICT in their classrooms as recommended by the school principals. Three Life Science teachers from Grade 8-10 were sampled. Two teachers participated in the main study and one in the pilot. The teachers were picked to participate on the basis that they were trained in ICT use and integration through the intervention programmes by the MoE. This study employed the following research instruments: non participatory observation schedule, field notes and a semi-structured interview guide to collect data. The instruments were guided by the constructs of the activity theory and are

therefore consistent. Thematic analysis was used to analyse the data and the emerging themes were noted.

5.3 Summary of the Research Findings

The findings of this study indicated that Life Science teachers A and B were trained on ICT literacy and integration as an initiative from the MoE and also through CPD initiatives from their respective schools. The objective of using ICT in the Life Science classrooms was that of making the content understandable to the learners. The Life Science teachers used different types of ICT tools daily, (e.g., iPad, smart board, and the internet) in their respective classroom. For lesson presentation purposes, the smart board was frequently used in both classrooms. Teachers used videos and other media to demonstrate different concepts in Life Science curriculum. Also, classroom rules with regard to the use of ICT were clearly stated and implemented for effective classroom management.

Life Science teachers promoted a culture of collaboration with colleagues regardless of whether they were located in the same or different schools. The Life Science teachers have shown evidence of creative teaching and some aspects of collaborative teaching as there was no evidence of co-teaching in the same or different schools. In their respective communities of practice, Life Science teachers shared lesson plans, teaching material and assessment tools. Furthermore, as an outcome of CPD, Life Science teachers have acquired knowledge and skills that enabled them to use ICT comfortable in their lessons. However, it was not evident that the CPD programme focused on material development to allow teachers to produce their own teaching material.

Finally, the study found that at the initial stage of ICT adoption at the two schools, Life Science teachers as individuals were faced with challenges such as: at the school level (network issues, parental engagement); and classroom level (time management). These challenges were addressed over time as the management of the schools became more supportive of ICT use.

In summary, the current study has contributed to the research about the use of ICT in the context of teaching and learning in the Khomas region of Namibia. The findings of this research have given more attention to the use of ICT in order to increase and encourage the use of ICT tools in the Khomas region in general and by Life Science teachers in particular. The study contributed to the existing body of research regarding the utilization of ICT to promote collaborative and creative teaching in Namibia.

5.4 Reflections

The sample used in the case study was small and therefore not intended to represent all Namibian Life Science teachers. The schools were selected based on them being technologically rich, and had teachers that regularly used ICT. More schools could have participated, but this was not possible due to their limited ICT resources.

The Activity theory was used as a lens through which the researcher investigated Life Science teachers' use of ICT through collaborative and creative teaching. This study is in line with the description of the Activity theory in that Life Science teachers demonstrated how the seven constructs are interrelated to promote creative and collaborative teaching of Life Science. In other words, teachers have sufficient skills to use ICT in their classroom through the smart boards; assessed learners

online and at the same time managed the classroom to their satisfaction and also interact with other teachers in the same or other schools. However, there is lack of evidence for co-teaching and materials development by the participating Life Science teachers.

From the data, emerging themes such as knowledge and attitudes were noted (Section 4.3). In as much as the constructs of the Activity theory are useful in understanding teachers use of ICT, there is a need for practitioners to look into the issues of attitudes and knowledge. Several researchers indicated that, teachers' attitudes influence the acceptance of technology in their classrooms (Albirini, 2006; Al-Zaidiyeen et al., 2010; Ngololo, 2013). Also, for successful ICT use in the classroom, there is a need for teachers to acquire knowledge of incorporating various tools (Prestridge, 2012).

5.5 Conclusion

This study investigated Life Science teachers' use of ICT to promote collaborative and creative teaching. In Namibia, information about Life Science teachers' use of ICT is not well documented if it exists. Therefore, the current study sought to investigate Life Science teachers' use of ICT through collaborative and creative teaching. The study falls within a qualitative paradigm, using a multiple case study approach. The data collection methods used was non-participatory classroom observation schedule; semi-structured interviews protocol; and filed notes. Two Life Science teachers participated in the study on the basis that they were trained on ICT use. The findings of the study indicated that, Life science teachers used various ICT tools in their classrooms to demonstrate Life Science concepts mainly through

smart boards connected to the e-Learning Management Systems. Assessment was also done online.

This study concluded that Life Science teachers demonstrated creative teaching in their respective classrooms. Also, to some extent teachers collaborated with colleagues in the same school and abroad for the purposes of sharing teaching and learning materials but did not co-teach nor did they developed their own teaching materials.

5.6 Recommendations for Practice

Established on the findings of this study, the researcher recommends the following:

1. Teachers must continuously undergo CPD to update themselves with the new and necessary ICT tools and also update their skills. Also, teachers must be encouraged to develop their own tools as well as content materials.

2. Teachers must be encouraged to develop lesson plans that reflect the motive of ICT use and integration.

3. There is a need for Life Science teachers to establish a community of practice within which activities are clearly defined as well as the terms of reference. For participating member teachers must be encouraged to co-teach.

4. Teachers must be encouraged to up keep classroom rules and make the necessary changes with new technological development.

5.7 Recommendations for Future Research

The researcher also suggests the following recommendations for future research:

1. Research is needed in other educational regions to complete the view of ICT use in Namibian schools.
2. There is a need for a study to determine the extent to which schools customise and implement e-learning systems. Do schools have e-learning systems and how effective are these systems for the realization of ICT integration in the classroom?

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Appendices

Appendix A

1. Introduction

In order to investigate and understand the extent to which Life Science teachers use and integrate ICT into their classrooms, the researcher carried out nonparticipant observation of Life Science lessons. The researcher ensured the teachers that classroom observation is not focused on pedagogical practice or classroom management, but purely on their ICT use and integration.

2. Classroom observation

Classroom observation schedules for Life Science teachers

Background information	
Code of classroom	
Code of teacher	
Observer's name	
Date	
Grade	
Theme and Topic	
Time (minutes)	

Component	Activities			Comments
Subject *Lim & Hang (2003)*	**What is the role of the teacher in the Life Science classroom?**			
		Yes	No	
	Teacher acting as a facilitator.			
	Clear instructions given.			
	ICT teaching strategies used			
	Interaction between teacher and students			
Objects *Lim & Hang (2003)*	**What are the classroom objectives?**			
		Yes	**No**	
	Lesson objectives support ICT integration.			
	Common objectives for different individuals.			
	Shared ownership of the objectives.			
Tools ICT infrastructure Ngololo (2010)	**What ICT tools are available in the classroom?**			
		Yes	No	
	Computer tools (e.g., computer mediated tools, learning and teaching tools, overhead projectors, projectors,)			
	Tutorial/exercise software			
	General office suit (e.g., word-processing, database, spreadsheet, presentation software)			
	Multimedia production tools (e.g., media capture and editing equipment, drawing programs, production tools webpage/multimedia			
	Simulations/modeling software/ digital learning games			
	Communication software (e.g., internet, email, chat, discussion forum)			
	Digital resources (e.g., portal, dictionaries, encyclopedia)			
	Mobile devices (e.g., personal digital assistant (PDA), cellphone)			
	Smart board /interactive white board			
	Learning management system (e.g., web-based learning environment)			

Component	Activities			Comments
Community Use of ICT *Lim & Hang (2003)*	**How do Life Science teachers promote collaborative and creative teaching?**			
		Yes	No	
	Lesson preparation that involves the use of ICT by teachers.			
	Knowing which teaching situations are suitable for ICT use.			
	Finding useful teaching resources on internet.			
	Using ICT for monitoring students' progress and evaluating learning outcome.			
	Using ICT to give effective presentations/explanation			
	Using ICT for collaboration with others.			
Ngololo (2010)	Installing educational software on computers.			
	Using the internet (e.g., select suitable websites, user groups / discussion forum to support student learning			
Rules	**What are the rules of engagement with ICT by teacher?**			
		Yes	No	
	Cooperative and collaborative learning.			
	Clear classroom rules with regard to ICT use.			
	Expected student behavior with ICT use.			
Division of labour *Lim & Hang (2003)*	**What are the teacher's and learner's involvement in classroom activities?**			
		Yes	No	
	Tasks equally distributed between teacher and students.			
	Different responsibilities of different participants in classroom activities.			
Outcome	**What is the learning outcome set by teacher with respect to ICT integration?**			
		Yes	No	
	Teacher appears to be motivated.			
	Learners are engaged			
	The use of ICT supports learning.			
	Challenges observed			

Appendix B

Interview guide for Life Science teachers

1. Introduction

The interview will be conducted for research purposes only. Your school was selected to participate in this study to provide information about how teachers use and integrate ICT in the teaching of Life Science and what are the challenges experienced by teachers when using and integrating ICT to promote collaborative and creative teaching. The interview will be conducted in an informal way, in a conducive environment and will only last for about 45 minutes. The information gathered will be treated with utmost confidentiality and anonymity.

2. Interview (A semi-structured interview will be conducted).

Component	**Questions**	**Indicator**
Biographic information (Subject)	Tell me a bit about yourself. For how long have you been teaching at this school?	Self-confidence / motivation
Objects *Lim & Hang (2003) (ICT integration)* *Sang, Valcke, van Braak & Tondeur (2009)* *Lloyd (2005)*	What are the objectives of the classroom (with respect to ICT use and integration? How do you ensure that alternative teaching aids are created based on learners' interest and ideas? How do you implement alternative strategies in your classroom? Is there a shared ownership of mediating tools development by teachers and learners? How do you engage the learners in classroom activities with regard to participation? How do you use a variety of assessment strategies in your classroom? How do you involve learners in evaluating their own work and setting their own goals? How do you afford learners opportunity to manage their own learning? How much can you do to motivate learners who show low interest in schoolwork in your classroom?	Evidence of lesson preparation Evidence of alternative teaching aids created by learners Evidence of tools development Evidence of learners assessment tool (individual learners or in pair or group)

Component	Questions	Indicator
Tools *ICT infrastructure* *Lim & Hang (2003)*	What types of ICT tools do you mostly use in the teaching of Life Science in your classroom? Which ICT tools do you normally use and why? What motivates you to use ICT tools? Have the ICT tools (if there is) become the mediating tools in the classroom? Why do you say so? What are some of the most useful software that you use in your classroom?	Knowledge of ICT tools operational Evidence of ICT tools Evidence of software
Rules *Use of ICT* *ICT integration* *Sang et al., (2009)* *Lloyd (2005)*	How do you use ICT? In class and for preparation? Describe cooperative and collaborative learning in your classroom? What are some of the strategies employed to facilitate the actual use of the computers in your school? How would you describe your own abilities to use technology in your classroom? Are there rules in your classroom with regard to ICT use? How much can you do to get learners follow classroom rules? How do you make it a priority in your classroom to give learners to work together when you are not directing them? Would you describe your classroom behaviors as a crucial variable that accounts for effective teaching of Life science? Elaborate. Are your lesson presentation based on computer assisted instruction (CAI)? Why do you say so? How do you incorporate ICT into teaching to support student learning? Describe programmed learning in your classroom. How would you describe your knowledge reflecting on ICT integration in your classroom? How do you distinguish ICT integration from an operational use of hardware and software? Describe how you make the following decisions in your classroom with regard to: ➢ Instructional approaches (lecturers, discussions, labs) that will help to capture learners' interest or to achieve learning objectives. ➢ Curriculum approaches (orientation / position) in relation to how curriculum	Evidence of lesson preparation file Teacher self-efficacy Teacher beliefs Teacher attitudes Evidence of lesson plan

	is developed and designed (i.e., traditional approach, learner-driven approach, critical approach etc.) ➢ Grouping learners to meet instructional needs (Teacher-led group, Learner-led group) ➢ Developing the Teaching Sequence i.e., division of syllabus (use the cycle of: review, teach, practice, apply in your lesson planning) How do you ensure that integration is planned and purposefully enacted in your classroom?	
Community *Lim & Hang (2003)*	Do you belong to a community of practice? What is the name of your community of practice? Do you have collaboration between teachers in your school and teachers out of your school? If so, how do you work with those teachers?	Evidence of belonging Evidence of website
Division of labour	Do you have ICT representatives of teachers, ICT-coordinator or technical support staff at your school? How would you encourage your learners to undertake tasks or follow up classwork at home on the computer? What are the responsibilities of different individuals in your classroom with regard to ICT use and integration? Who assist you with lesson preparation? How do you describe the technical support and pedagogical support from the ministry of education?	Job descriptions of individuals
Outcome *Ngololo (2010)* *Lloyd (2005)* *Lim & Hang (2003)*	Have you undergone any professional development? Elaborate. How would you bring about desired outcomes of learners engagement and learning in your classroom? Even among those learners who may be difficult or unmotivated. What would you highlight as one of the positive impact on your teaching? Can you term ICT integration as a component of the overall outcomes of your teaching? Why do you say so? Describe the training you think is relevant but have not been train in it?	Proof of training (Evidence of certificate)

What challenges do teachers experience when using and integrating ICT?

Elaborate on the challenge you face when integrating ICT in the teaching of Life Science? What could be the solutions to these challenges?

How would you improve your teaching with regard to the following?

- Open to new ideas and more willing to experiment with new teaching strategies.
- Experiment with instructional materials.
- Seek improved teaching methods.

Appendix C

INFORMED CONSENT FOR RESEARCH PARTICIPANTS

Information sheet

Purpose of the study: As part of the requirements for master of education degree (M. Ed) at the University of Namibia, I have to carry out research study. The study is concerned with how Life Science teachers use and integrate ICT in their classroom for lesson preparation and presentation.

What will the study involve? The study will involve the observations of ten (10) Life science lessons to be carried out by the researcher. An interview session is scheduled for one (1) life science teacher which will last about 45 minutes and will be Audi-recorded.

Why have you been asked to take part? You have been asked because your school is equipped with ICT infrastructures and that you may be able to provide information on how teachers use and integrate ICT in their classroom.

Do you have to take part? No, participation is voluntary. You have to sign a written consent form and keep a copy. You may withdraw at any time, before the study has commences even if you agreed to participate or discontinuing after data collection has started.

Will your participation in the study be kept confidential? Yes, I will ensure that no clues to your identity will appear in the thesis report. Any extracts from what you say that are quoted in the thesis report will be entirely anonymous.

What will happen to the information which you give? Data will be kept confidential for the duration of the study. On completion of the thesis, they will be retained for a further six months and then destroyed.

What will happen to the results? The results will be presented in the thesis. They will be seen by my supervisor and co-supervisor, a second marker, and the external examiner. The thesis may be read by future students on the course. The thesis may be published in a research journal.

What are the possible disadvantages of taking part? I don't envisage any negative consequences for you in taking part. It is possible that talking about your experience in this way may cause some distress.

What if there is a problem? At the end of the interview, I will discuss with you how you found the experience and how you are feeling. If you subsequently feel distressed, you should contact my supervisor

Who has reviewed this study? Approval must be given by the University of Namibia Post graduate committee before studies like this can take place.

Any further queries? If you need any further information, you can contact me on my mobile number and email address provided to you.

If you agree to take part in the study, please sign the written consent form below.

WRITTEN CONSENT FORM

I, the undersigned confirm that I have read and understand the research study statement as explained to me in writing and have had the opportunity to ask questions.

I understand that my participation is voluntarily and that I am free to withdraw from the research study at any time, without giving reasons. I understand that any information I provide is confidential. I therefore give permission for my interview to be Audio-recorded. I understand that anonymity will be ensured in the write-up by disguising my identity.

I agree to take part in the study and also give permission to quotation/ publication of extracts from my interview.

_____	_____	_____
Name of participant	**Date**	**Signature**
_____	_____	_____
Name of researcher	**Date**	**Signature**

Appendix D

Permission letter to the Director of Education

P O Box 25221

Windhoek, Namibia

Tel 061-228733 (h)

Cell 0812866812

03June 2013

The Director of Education (Khomas region)

Ministry of Education

P/Bag 13186

Windhoek

Dear Madam

Request for permission to conduct research studies at selected schools in Khomas region

My Name is Wilhelmina E. Simon, a Master of Education student (student number 200403079) at the University of Namibia. I am requesting the director's permission to conduct research at selected schools in Khomas region. The title of my research is: *Teachers use and integration of ICT in the teaching of Life Science in the Khomas region.* The study will be supervised by Dr. E. N. Ngololo and Ms. M. C. Keyter.

Information collected through either observation or interview will be treated with utmost confidentiality and will only be used for the purpose of this research. I will ensure that no participant will be harmed in any way.

Further, I want to promise that no class lessons will be interrupted during data collection process. I will also ensure that one final copy of the research study will be given to the school.

Thanking you in advance and I look forward to your positive response.

Yours in education,

Wilhelmina E. Simon

Cc. The Permanent Secretary of the Ministry of Education

Appendix E

Reply letter to conduct research from the Director of Khomas region

REPUBLIC OF NAMIBIA

KHOMAS REGIONAL COUNCIL

DIRECTORATE OF EDUCATION

Tel: [09 264 61] 293 4356
Fax: [09 264 61] 231 367/248 251
Enquiries: T.L. Shivute
File No.: 12/2/6/1

Private Bag 13236
WINDHOEK

June 17, 2013

Ms W.E. Simon
P.O Box 25221
WINDHOEK

Dear Ms Simon

REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN KHOMAS SCHOOLS

Permission is hereby granted to you to do research in Khomas in the schools of your choice on the following conditions:

- The Principal of the selected government school to be visited must be contacted before time and agreement will be reached between you and the principals.
- The school programme should not be interrupted.
- Learners/teachers who will take part in this exercise will do so voluntarily.
- You have to contact private schools directly to get permission from them.
- Khomas Education Directorate should be provided with a copy of the findings of your report/thesis.

We wish you a success in your study

Yours sincerely

MINISTRY OF EDUCATION
PRIVATE BAG 13236. WINDHOEK
17 JUN 2013
KHOMAS REGION

MS T. SEEFELDT
DIRECTOR OF EDUCATION

Appendix F

Reply letter to conduct research from the Permanent Secretary of Education

REPUBLIC OF NAMIBIA

MINISTRY OF EDUCATION

OFFICE OF THE UNDER SECRETARY: FORMAL EDUCATION
Private Bag 13186, WINDHOEK

Tel: 061 293 3354
Fax: 061 293 3368

10 June 2013

Ms. Wilhelmina E. Simon
P.O. Box 25221
Windhoek

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH STUDIES IN GOVERNMENT SCHOOLS

Your letter dated 03 June 2013 requesting permission to conduct a research in schools has reference.

Kindly be informed that the Ministry does not have objection to your request to conduct a research on Government Schools. Nevertheless, you are advised to contact the Regional Office to work on the logistics of such a research and schools to cover.

Should you be allowed to go into the schools, kindly ensure that the normal schools programmes are not disturbed and take proof that a UNAM student.

Yours Faithfully

MINISTRY OF EDUCATION
Head Office
Dept.: Formal Education
10 JUN 2013
P/Bag 13186
WINDHOEK - NAMIBIA

10/6/13

Mr. Charles M. Kabajani
Under Secretary: Formal Education