The Relationship between teacher-learner interaction and the laboratory learning environment during Chemistry practicals in Namibia.

by

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DEDICATION

This study is dedicated to my grandmother Alexaderine Kwazikwa Katuaundu and my late mother Constancia Inaamwari Katuaundu, for all the sacrifices that they have made to raise me up and send me to school, even though they themselves never went to school in their life.

The greatest gift you can give your child is education…CT

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DECLARATION

I Colen Tuaundu (33584303) declare that **"The relationship between teacher-learner interaction and the laboratory learning environment during Chemistry practicals in Namibia"** is my own work and that all sources that I have used or quoted have been indicated and acknowledged by means of complete reference.

Signature **Date**

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ABSTRACT

The purpose of this study was to find out if there is a relationship between teacher-learner interactions and laboratory learning environment in Chemistry practicals in Namibia. Literatures and questionnaires from 1383 learners and 12 teachers have proven that the interactions between teacher and learners have great impact on the performance, understanding and the environment that prevail in the laboratory.

The main data collection methods used was the mixed method research through the use of questionnaires and interviews. The results from the study show that good teacher-learner interactions have contributed to the positive learning environment that prevails in Namibian schools. Although the majority of the learners especially the girls have negative connotations towards Chemistry in terms of content, calculations and assessment generally learners look forward and are excited to do experiments in practical work. The impact of the excitement and willingness of learners to do practical investigations has not proven to improve learners' performance in Chemistry practical work in Namibia. The majority of the learners rated their teachers as good in subject knowledge, good leaders, helpful and friendly during practical investigations. The shortage of chemicals, equipments in laboratory activities that should have inspired involvement of learners in handling equipments is one of the factors that contributed negatively to the learning environment and teacher-learners interactions. Teachers mostly resolve to demonstrations due to lack of chemicals and equipment. Some schools show low/poor level of learner-learner interactions because some learners tease, laugh and discourage others during practical investigations. Chemistry laboratories in Namibia are characterised by lack of equipment, chemicals, poorly behave learners while on the other hand there are good behaviours from the teachers' side with most learners showing that their teachers always try to make the best out of the prevailing situations in the laboratories.

The laboratory environment in Namibia closely resemble laboratory environment in other studies in Asia, Africa and Europe. From empirical evidence it can be therefore concluded that there is a relationship between teacher-learner interactions and laboratory learning environment in Chemistry practicals in Namibia. Although the

relationship is not as harmonious or congruent as it ought to be, the government of Namibia can play a greater role in creating positive, productive and enjoyable learning environment by supplying secondary schools' laboratories with the needed equipment and chemicals to support the practical work as stated in the Physical Science syllabi.

The three questionnaire used were rated by learners and teacher as effective; easy to understand; covering most areas of the Chemistry environment; not time consuming, statistically valid and consistent. The changes made to the questionnaire fit well to the Namibia Chemistry environment and it produced nearly the same reliability and validity when compared to the pilot study questionnaire and other similar questionnaires used in other country.

KEY TERMS

Practical work, Chemistry laboratory, Teacher-Learners Interactions, Learning Environment, Mixed Method Research, Experiments, Achievement, Chemistry Practical work, Namibia.

LIST OF ABBREVIATIONS AND ACRONYMS

ACPQ Attitudes to Chemistry Practical Questionnaire

AIDS Acquired Immune Deficiency Centrum

CA Continuous Assessment

ETSIP Education Sector and Training Improvement Programme

HIV Human Immunodeficiency Virus

INSTANT In-service Training and Assistant for Namibian Teacher

IT Information Technology

QTI Questionnaire of Teacher Interactions

MASTEP Mathematics and Science Teacher Diploma

MCA Millennium Challenge Account

MHEVTST Ministry of Higher Education Vocational Training Science

NAMCOL Namibia College of Open Learning

NSSCH Namibia Senior Secondary Certificate Higher Level

NJSC Namibia Junior Secondary Certificate

NTSC EU European Union

NSSC Namibia Senior Secondary Certificate

NIET Namibia Institute of Education and Training

LCE Learners Centred Education

TOSRA Test On Science Related Attitudes

TEFA Towards Education For ALL

SLEI Science Laboratory Learning Environment Inventory

USA United States of America

UNICEF United Nation Children Fund

WIHIC What is Happening in this Classroom

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Chapter 1

1.1 Introduction

Namibia is one of the countries in Southern Africa where little research in Mathematics, Science and Technology has been conducted. Very few postgraduate students enrol for Master's and Doctoral degrees in Science at the University of Namibia. Between 2004 and 2011, the University of Namibia produced 31 graduates with Masters in education and 8 graduates with Doctorates in education (Hangula, Mwandemele, Kangira, Tjiramba & Fledersbacher 2011:21; Hangula, Mwandemele, Tjiramba & Fledersbacher 2010:19; Hangula, Mwandemele, Tjiramba & Fledersbacher 2009:18; Hangula, Mwandemele, Tjiramba, Fledersbacher, Aucamus, Murray, & Smit 2008:12; Mwendemele, Tyson, & Classen 2007:16; Mwendemelo, Malamba & Otaala 2006:17; Mostert, Tjiramba, Vale & Claassen 2005:14 and Kiangi 2004:15). From these figures, it is clear that only 3 Master's students focused their studies in the field of Science Education with no specific reference to practical work in Chemistry. Most developed countries attribute their development to advancement in the knowledge of science and technology, which is regarded as crucial to the growth of any economy (Khan 2004: 64). Khan further indicates that due to the tremendous contribution that Science and Technology bring in terms of job creation, industry development and technological knowhow, it helps to make life easier for the people. On the other hand, poor enrolment and graduation rates at tertiary levels in these crucial fields of studies (Mathematics, Science and Technology) can be attributed to various factors like lack of interest and poor pass rates in Mathematics and Science at the secondary school level in Namibia.

In addition to poor performance at school level in Mathematics, Science and Technology, there is poor research in the field of Mathematics, Science and Technology both at school and tertiary levels in Namibia. There has been a trend over the past few years in Namibia, of poor performance in Grade 12 Physical Science, a subject which comprises of Physics and Chemistry, especially in Paper 3, which is the practical paper (Poolman, 2009:3). According to Olivier and Poolman (2009:3), Physical Science is one of the subjects that shows the worst performance in Namibia with less than 40, 4 % of the candidates obtaining a Grade 3 or better symbols at Higher Level and less than 35% of Ordinary level candidates obtaining 40% required to pass. This has prompted this study to focus on what is happening in Chemistry classes in terms of practical work in schools as a contribution to the efforts needed to improve the knowledge of Chemistry practical work in Namibian schools.

1.2 Background to the study

When Namibia received independence in 1990 from the then colonial South Africa, the country changed from the Cape Town administered education system to the Cambridge education system. As a result, standard eight and ten examinations were no more set in Cape Town, South Africa, but in London, England. Under the Cape education system, examinations were racially based and administered under different departments (Bantu, Indian, Coloured and White), Shilongo (2004:3). Namibia adopted the Cambridge education system for 15 years after which the Namibian government introduced the Namibian Junior Secondary Certificate (NJSC) and the Namibian Senior Secondary Certificate (NSSC) in 2005, (Fischer, 2010:1).

Namibia is a small nation with about 2 million people (NAMIBIA 2011 POPULATION AND HOUSING CENSUS 2011:41), of which the majority live in rural areas. The country is divided into 13 regions, each with a Governor as a political leader. Each region has its own educational head office run by a regional education director. In total, Namibia has about 180 secondary schools, over 1550 primary schools and 300 pre-primary schools (Fischer, 2010:1).

The Ministry of Education is responsible for maintaining high educational standards in schools through bodies like the Namibian Institute of Education and Training (NIET), Namibia Qualifications Authority (NQA); and initiatives like the Education and Training Sector Improvement Programme (ETSIP).

The Namibian school system is divided into phases organised as follows: Grades 1-4 (lower primary) and 5-7 (upper primary) and these two phases are free and compulsory, and then Grades 8-10 (junior secondary) and 11-12 (senior secondary)

Fischer (2010:1). The first two phases of education in Namibia are free and compulsory for all Namibian children (Heita in New Era, 20 Dec 2012:4). The major exit point from the system occurs at Grade 10 level, where the majority of the learners fail to proceed to Grade 11. One of the requirements of the system is that learners should not fail twice in one phase; if he/she fails the second time, he/she is automatically transferred to the next grade. For the senior phase, however, learners have to pass Grade 10 with at least 23 points or else they are not allowed to repeat the grade but rather, have to register with Namibian College of Open Learning (NAMCOL) to improve their subjects before returning to Grade 11.

With regards to Physical Science there is a prescribed curriculum in each grade which includes both Physics and Chemistry sections. Apart from preparing learners for direct employment and participation in community life, the Junior Secondary Certificate, (Grades 8-10), aims at preparing learners for post-secondary training like vocational training, Grades 11 and 12. The Grades 11-12 syllabi aim at preparing learners for commencement of university studies and other college training.

Each year the Namibian government publishes a report on grades 10 and 12 results. This report ranks scores for each school, subject and region with comments on the learners' performance. According to Olivier and Poolman (2009:1), despite efforts by the Ministry of Education to improve the pass rate of 51.3% and the billions of money allocated to education, little progress has been made and the results have, throughout, been very disappointing compared to other countries like South Africa which has a pass rate of 73.9%. During the year 2009, only 53, 3% of the Grade 10 learners managed to obtain the 23 points required for entry to Grade 11. This is regarded as the highest performance since the attainment of Namibian independence in 1990 (Maletsky, 2010:5). The results for 2011 grade 12 have shown a slight improvement of 0, 5% to 93.6 compared to the year 2010 which was 93.1% of the students graded (Ikela, 2012:1). This, however, does not mean that these students passed their grade 12 or they qualified for entry to tertiary institutions, but simply means they are graded in one or more subjects.

In terms of the teaching and learning of Chemistry in Namibia, there are several challenges experienced by both learners and teachers which result in such high failure rates. Firstly, laboratories in Namibian schools are not up to standard to meet the curriculum requirements. Secondly, there are low budget allocations for schools to buy chemicals and equipment and to upgrade laboratories. Thirdly, there is a lack of support from the Ministry of Education in terms of subject advice, text book supply, in-service training and logistics (Shipanga, 2010: 3). The above mentioned reasons are in consonance with Sjoberg's and Schreiner's (2006: 2) observation thus:

"The falling recruitment to most science and technology educations is seen as a large problem in most European countries. The same tendencies are noted in the United States and in most other countries within the Organisation for Economic Co-operation and Development." This is mainly due to declining enthusiasm among learners for the science fields.

During the past few years, many efforts have been made to improve the situation. These include: the introduction of the Education and Training Sector Improvement Programme (ETSIP); workshops, and the use of performance indicators. The other hampering factor is the high number of learners per teacher in laboratories, ranging around 40:1. This huge number hinders learner-centred education and has contributed to teachers to turn to demonstrations rather than learners engaging in practical work (Shipanga, 2010: 3). Some schools in remote areas lack teachers that are qualified in Science as most teachers prefer schools in urban areas. Lack of electricity and running water in these remote schools has contributed to difficulties in conducting Chemistry practical work and demonstrations (Ekongo, 2010:3). It is not clear how all these factors affect teacher-learner interactions in Namibian Science laboratories and what role the learning environment plays in the performance of learners in paper 3 of Physical Science paper.

1.3 The research problem

This study investigated Chemistry laboratories in Namibian schools and how the interaction between teachers and learners in Chemistry classes affects the learning environment in Chemistry practicals.

The understanding of the relationship between learners' perceptions and teacher-learners interaction; learning environments and learners' attitudes; as well as learner-learner interaction during their Chemistry practicals will help in providing primary information that will improve these classes in future practical work. According to Smith (2010:1), the perceptions and attitudes of learners in class have an effect on their performance but the relationship between perceptions and attitudes towards practical work is not clear. The next section provides a brief description of the aim of the study.

1. 4 Aim of the study

The aim of this study is to determine the relationship between teacher-learner interaction and laboratory learning environment during Chemistry practicals in Namibia. The study aims at elucidating the area of Chemistry practical work by providing new conceptual insight through the use of three internationally recognised questionnaires (Questionnaire on Teacher Interaction; Attitudes to Chemistry Practical Questionnaire and the Science Laboratory Environment Inventory) modified to fit the Namibian situation. The central focus of this study is to describe the relationship between teacher-learner interaction and Chemistry practicals in school laboratories in Namibian. In order to do this, a questionnaire on teacher-learner interaction and the laboratory learning environment was used to determine the relationship between learners' perceptions and their attitudes to Chemistry practical work, to determine the learners' attitudes to Chemistry practicals, the Attitudes to Chemistry Practical Questionnaire was used while the Science Laboratory Environment Inventory was used to determine the learning environment in Chemistry classes in Namibia.

1.5 Research questions

The following research questions were addressed:

I. What underlying relationship exists between the laboratory learning environment and learners' attitudes to Chemistry practicals? (Theoretical framework on classroom environment was investigated).

II. How do learners perceive their learning environment in Chemistry laboratory?

III. How does teacher-learner interaction influence the learners' attitudes in Chemistry practicals? (Theoretical framework on teacher-learner interaction was investigated).

IV. How does the learner-learner interaction influence the learners' attitudes to Chemistry practicals?

V. How do learners perceive the interaction between them and their teachers during Chemistry practical work?

VI. What are the characteristics of Chemistry practicals in Namibia? (Theoretical framework on characteristic of practical work was investigated).

VII. What is the nature of the current laboratories in Namibian schools?

VIII. Is the QTI and SLEI as implemented in Namibia suitable and valid instruments for use in Namibia? (Comparability with results in developed countries).

IX. Is there a relationship between learners' perceptions of Chemistry learning environment and their attitudes to Chemistry practicals?

1.6 Significance of the study

This study provides a significant contribution to the research already conducted on teacher-learners interaction, laboratory learning environment and learner-learner interaction in Chemistry practicals all over the world. The greatest contribution of this study was to the Namibian education system that faces a lot of challenges in terms of Chemistry practical work. The need for this type of study at a time when the Namibia education system is faced with challenges like poor allocation of resources, for example, time, equipment, laboratories, chemicals and specialised science educators is of crucial effect. From past research in Chemistry education there are clear comparability short-comings in previous research between first world countries studies and third world countries studies especially in terms of cultural, social and environmental differences. Namibia calls for the importance of research in this area.

Due to the fact that little research has been conducted in the Namibian Chemistry classroom, it was imperative for this study not only to examine the current state of teaching and learning in the country's Chemistry classrooms, but also the correlation between: the learners' academic and practical achievement in Chemistry class tests or examinations and learners' attitudes towards Chemistry; and the Chemistry laboratory environment. Chemistry is regarded as an 'enabling science' because its core concepts are essential to almost all areas of science (White, O'Connor, Mousley, Cole & MacGillivray, 2003:17). Therefore, the Namibian science sectors will benefit considerably from research in the science classroom environment; means of evaluating and improving Chemistry teaching and learning in this area.

The study adds to the body of knowledge by introducing two newly localised versions of QTI and SLEI that can be used in future to gather further information on Chemistry teaching in Namibia. The study also sheds light on the reality of Chemistry laboratories as a teaching facility for schools in Namibian. The information gathered is helpful to Chemistry teaching and learning especially in practical activities and teacher training programmes at universities and colleges in the country. Science teachers and curriculum developers in Namibia will benefit from the result of this study by expanding their knowledge on how their learners actually perceive the laboratory as well as what they prefer the laboratory to be like, and how they perceive the totality of the Chemistry classroom environment. This information will assist in identifying factors relevant to the improvement of teaching and learning in the Chemistry classroom in particular, and science in general.

1.7 What is Chemistry Education?

This question was answered in three ways. First, by explaining what Chemistry is, and then explaining what education is, and lastly, by giving a definition of Chemistry education.

Chemistry and Physics are specialisations in the field of Physical Science. Chemistry refers to the study of matter and energy and the interaction and relationship between them, including their properties and the interactions that involve electrons transfer (Chiechi, 2012:1). Chemistry is one of the most important branches of science; it helps learners to make sense of the natural phenomena of things happening around them. Chemistry is often regarded as a difficult subject by students simply because it relates to matter whose characteristics involve some mathematical calculations that often repel learners (Sirhan, 2007:1). According to Sirhan (2007:1), one of the essential characteristics of Chemistry is the constant interplay between macroscopic and microscopic levels of thoughts, and it is this aspect of Chemistry learning that present a significant challenge the novice.

Generally, education occurs through any experience that has a formative effect to the way individuals think. It is a formal and informal process by which society or a generation deliberately transmits its accumulated knowledge, skills, customs and values from one generation to another (Akintunde, 2007:130). This transmission of knowledge can take place at home, school, church or university in a formal or non-formal way. Education in itself requires instruction and guidance of some sort, from knowledgeable individual or composed literature, e.g., books or articles. Although the most common forms of education result from years of schooling that incorporates studies of various subjects, knowledge can also be acquired through life experiences that provide an understanding of something. School and tertiary knowledge is assessed at school and university level through the writing of Chemistry examinations.

Chemistry education in general, refers to the teaching and learning of Chemistry as a subject in schools and universities, this includes the pedagogical methods of teaching and learning using Chemistry content intended to be taught at varies levels of education. These issues are mostly determined by the curriculum and for this reason it has become imperative for curriculum developers to focus on both high and ordinary levels of Chemistry education. Chemistry, by its nature, is highly conceptual and requires abstract intellectual capabilities to master its content (Wu, Krajcik and Soloway, 2000:1). Although much of Chemistry learning at school is acquired through rote learning (this is evident by factual narration or recall in examination papers) real understanding of Chemistry in the education setup of a school is achieved through conceptual understanding that is strengthened by continuous studies and practical investigations (Sirhan, 2007:3). It is therefore imperative to understand how practical work complements the teaching and learning of Chemistry.

1.8 The relationship between Chemistry and Practical work

Most Chemistry education literatures are littered with statements like “Science is an experimental subject, science goes hand-in-and with practical work, and science without practical work is meaningless.” In the early 90s, Hanson, Hoppè and Pritchard (1993: 29) alluded to something very interesting in Chemistry today when they stated that “Chemistry is an experimental science and its development and application demand a high standard of experimental work.” This brings the onus on the teacher to be able to train learners to be practitioners in the subject. Learning Chemistry is all about finding out what is not known and also learning what others have discovered. Most of these discoveries have taken place in the confines of a laboratory through practical work, interlinking practical work and Chemistry as a subject (Lunetta, Hofstein & Clough, 2007:402).

This means that for learners to master some complicated Chemistry concepts, they should ideally do practical experiments on a regular basis. Practical work in Chemistry helps learners, to engage in accurate observation; make Chemistry phenomenon more real to the learner, maintain interest in the subject; and to develop logical thinking and reasoning, and develop problem solving skills and critical thinking; and advance learner’s sense of ownership of Chemistry (Dillon, 2008:3). Although it appears as if practical work benefits Chemistry more than Chemistry benefiting practical work, the relationship and benefits are symbiotic. Learners need to study or investigate the Chemistry topic and through that, gain practical skills to reinforce what they learnt theoretically and to explore further the concepts not yet learnt.

1.9 The two main philosophies of teaching Chemistry

Chemistry, just like any science, has its own philosophical peculiarities that have been the focus of much investigation since the rebirth of the philosophy of Chemistry in the early 1990s. Although many philosophies of Chemistry education are developed and published, it is still the responsibility of Chemistry educators and researchers to make use of these divergent philosophies and draw from them new ideas and findings that fit their circumstances.

Chemistry is partly a liberal subject, and is as much about thinking as it is about synthesis, experimentation, and understanding of the laws. It is unfortunate that philosophy in Chemistry, which provides the most systematic analysis of ways of thinking, has been traditionally neglected by Chemists.

The philosophy of Chemistry education as an established discipline has reached a level that allows no room for mediocre or unscientific thinking. It is worth mentioning that the role of philosophy in Chemistry education on a naturalistic playground is somehow limited. This is mainly due to the fact that philosophy in Chemistry education describes the structures of scientific theories; analyses theories for logical consistency; and it elucidates semantic and pragmatic aspects of scientific terms. On the other hand, it cannot give any normative explanations in cases of terminological ambivalence or in cases where it is desirable to know in advance if a proposed statement is worth to be put under experimental scrutiny or not. Philosophy in Chemistry elucidates the provenance of objects and the methods of Chemistry as a cultural achievement by means of a methodical reconstruction of its language and its norms (Leipzig, 2012: 5). Erduran (2005: 162) argues that Chemistry education theory and practice can benefit from the application and understanding of the philosophy of Chemistry. There are two main philosophical beliefs in Chemistry education, namely, positivism and constructivism. In the next section the two philosophies are discussed briefly.

1.10 Positivism and practical work

Positivism is a concept that emphasises that only scientific knowledge is the true knowledge of the world perceived through senses (the observable phenomenon). It is a scientific way of doing research especially if it is used with quantitative methods of research. The reason science works so well with positivism is because positivism tests out its theories by devising and carrying out repeatable experimental work to ascertain consistency. Nevertheless, it is a difficult path to tread and it offers slow progress because most hypotheses are wrong and practical work is regarded as expensive. Current school science curricula present contemporary positivist epistemological related beliefs that force learners to an irrefutable right answer (Allen, 2008:319).

Although Allen argues that a positivist mind-set in school science practical work produces unwelcome attitudes among learners, e.g. bias, confusion and the belief that there is only one correct answer, it remains one of the most accurate mind-sets of arriving at truth through experiments. Many sociologists reject this approach and would rather live in their own little dream world where they can make up any theory they like and never have to go to the extent of bothering and testing it experimentally.

Auguste Comte (1798-1857), a nineteenth century philosopher, is regarded today as the architect of positivism although its origin is further back to 'the father of modern science' Francis Bacon (1561-1626) (Bosman, 2006:23). Auguste Comte rejected meta-physics and he was a strong advocator of the fact that only scientific knowledge could reveal the truth about reality. Positivism adopted David Hume's theory of the nature of reality (i.e., philosophical ontology). Hume believed that reality consists of atomistic (micro-level) and independent events. He believed in the use of the *senses* to generate knowledge about reality (i.e., scientific method). He thought that philosophical and logical reasoning could lead us to "see" non-existing links between events occurring simultaneously.

However, positivism also adopted René Descartes's epistemology (i.e., theory of knowledge). Descartes believed that *reason* was the best way to generate knowledge about reality. His deductive method implies that events are ordered and interconnected, and therefore reality is ordered and deducible. These internal beliefs eventually undermined the validity of positivism. There are mainly five basic characteristics that entail the philosophy of positivism.

- A single, tangible reality exists which can be divided into parts and which can be studied independently, in other words *a whole is made out of the parts*.
- The known phenomenon can be separated from the unknown.
- Observation is independent of the time and context, in other words; what is true in a given time and place will hold true in another time and place.
- Casualty is linear; in other words, there is no effect without cause and no cause without effect.

- Objectivities are possible; methodology guarantees that the result of an inquiry can be free from the influence of any system, (Lincoln and Guba 1985, in Bentley, Ebert & Ebert, 2000:16).

Positivism exerted an important influence on scientific practice in the natural sciences for decades in the early 20th century. This was especially true in the natural sciences where laboratory experiments can closely approximate the real world environment, thus allowing for accurate predictions. Unfortunately, in Chemistry and physics, human volition, poor training on the part of researcher and uncertainty make the laboratory experiment less reliable. This is mainly due to a certain degree of human error that can occur in the laboratory. Ultimately, its internal inconsistency resulted in the abandonment of positivism in favour of scientific approaches such as *critical multiplism,* which is based on the belief that no one approach is ever sufficient for developing a valid understanding of a phenomenon.

1.11 Constructivism and practical work

Constructivist views of learning in science practical work suggest that learners can only make sense of new situations in reference to their existing knowledge. What they know (ontological) influences what they learn and how they learn new concepts. This means that teachers should encourage learners to use active techniques (experiments, real-world problem solving) to create more knowledge and then to reflect on and talk about what they are doing and how their understanding is changed by what they do. The teacher should make sure that he/she understands the learners' pre-existing conceptions and knowledge, guides the activity to address the current problem and then builds on them. Constructivism fits well with practical work in that it makes the teachers’ role that of a facilitators in a bid to help learners construct knowledge rather than reproduce a series of facts (Lee, 2006: 8).

Constructivism is a theory that helps to explain how knowledge is constructed in the human being when information comes into contact with existing knowledge that had been developed by experiences or learning theories. For this reason, the constructivist approach to learning and teaching in Chemistry engages learners and teachers in the active construction of knowledge through practical activities (experiments) that relate to the curriculum. This allows learners to make sense of new ideas, phenomena and concepts in terms of their existing ideas as they apply understanding to fresh situations especially in Namibia where there learner-cantered approach of teaching is encouraged.

In 1954, Albert Einstein stated, that it was difficult to attach a precise meaning to the term *scientific truth* (Rosenthal-Schneider, 1980: 261). Every scientist today is striving to get to the truth about science and how it evolved. The way we perceive the truth, and how we might discover it, represents part of our individual beliefs. Indeed, to infer that we can uncover truth suggests a particular belief system, that is, belief in an objective reality (Street, 2009:8). Currently, one particular belief system, known as the constructivist paradigm, is dominant in science education and there have been numerous reports in the education and science education literature supporting constructivist-based teaching (Wing-Mui, 2002:1). There is profound influence on teachers teaching Chemistry using constructivist approaches. A constructivist approach simply employs this phenomenon, “instead of seeking proof, scientist work to convince their peers that what they propose is reasonably fit to the available data, aids understanding, and is useful in making predictions and decisions”, (Bentley, Bert and Bert, 2000: 17).

At this juncture, it is worth mentioning that constructivism rests primarily on two principle theories. The first principle theory states that: *knowledge is not passively received, but it is actively built up by the cognizing of subject*. Ideas and thoughts cannot be communicated in the sense that meaning is packaged into words and sent to another who unpacks the meaning from the sentences. That is, much as we would like to, we cannot put ideas in learners’ heads, they will and must construct their own meanings. Our attempts at communication do not result in conveying meaning, but rather our expressions evoke meaning in another; thus creating different meanings for each person. When we teach, we need to remember that the new facts and ideas that we propound do not become incorporated directly into the minds of the learner without processing; they have to be fitted into the existing structures, old subject knowledge and schemes already in the mind of the learners (Bodner, 1986: 837).

The second principle states that: *function of cognition is adaptive and serves the organization of the experiential world, not the discovery of ontological reality*. This means that we do not find truth but construct viable explanations of our experiences (Bentley et al, 2000:20).

The understanding of thesis philosophical systems and how they relate to the teaching and learning of Chemistry will help both the teacher and the learner in formulating a strong philosophical foundation that will help them in the subject matter. Finally, although, it is essential that teachers and learners develop an understanding of Chemistry as a subject in the science field, this understanding would be linked to philosophy, culture, society and every day’s life that Namibian learners encounter in their Chemistry laboratory. This will help them to become critical and analytical thinkers, a much needed skill in Chemistry practical activities in Namibia.

1.12 Investigation as a process of learning Chemistry

Generally, there is no one clear scientific method that is all encompassing or that is regarded as the best above others. Scientists believe that most scientific methods can coexist and be used in various situations to answer different phenomena. This is why the scientific process called, *investigation*, is still relevant and useful in Chemistry processes today (Carpi and Egger, 2008).

Investigation is a complex and dynamic process of thinking, creating theories, conceptualising ideas, observing phenomenon, experimenting and interpreting ideas. For teachers and learners to do investigations, they need adequate evidence after investigation. The authenticity of investigation in Chemistry is supported by cross reference of clues, the illumination of irrelevance, confirming scientific laws and principles, and the use of evidence to explain events. Practical investigations enable learners to experience for themselves the way in which knowledge and facts are discovered, bringing a greater understanding of scientific principles and concepts. It develops practical skills that are valuable for their own sake as well as for the learners' future careers and it causes the subjects to become animated, engaging learners in ways that are impossible to achieve with purely theoretical learning. In this study, some elements from both philosophies were used where they were considered fit.

1.13. Definitions of key terms and concepts

Science education is a way of learning to know the physical aspects of the norms and culture of man and his environment in its fundamental laws of nature therefore education as a process of learning aimed at equipping people with knowledge and skills

"Practical Work": Practical work in the context of this study means the teaching and learning activities in Physical Science that involve learners at some point handling or simply observing the teacher handling or manipulating tools or materials (Ogilvie, 2007:105-107).

The most recent published review of the literature on learning and teaching in the school science laboratory gives what it calls a classical definition of practical work as: *'learning experiences in which learners interact with materials or with secondary sources of data to observe and understand the natural world (for example: aerial photographs to examine lunar and earth geographic features; spectra to examine the nature of stars and atmospheres; sonar images to examine living systems)'* (Lunetta *et al.*, 2007: 332). The quality of practical work varies considerably but there is strong evidence, from literature, that: *'When well-planned and effectively implemented, science education laboratory and simulation experiences situate learners' learning in varying levels of inquiry, requiring students to be both mentally and physically engaged in ways that are not possible in other science education experiences'* (Lunetta *et al*., 2007, p. 405). Willington (1998: 12) highlighted different types of activities at school level that will be regarded as practical work:

- Teacher demonstrations;
- Class practicals with all learners or in small groups;
- Circus of experiments in small groups engaged in different activities or rotating in carousel;
- Investigation and
- Problem solving activities.

"Interactions": This refers to the continuous exchange of information between the teacher and the learner.

"Inquiry": The word inquiry refers to the quest for knowledge, data or truth. Several studies have argued that inquiry has been one of the co-founding terms in Science education (Settlag, 2003:34; Barrow, 2006: 267 & Anderson, 2007: 812). There is an idiosyncratic difference between *inquiry science teaching* and *teaching science through inquiry*. Inquiry science teaching refers to teaching science as an inquiry, meaning helping learners understand how scientific knowledge is developed; while teaching science through inquiry refers to having students take part in inquiry investigations to help them acquire more meaningful conceptual science knowledge, (Lunetta et al, 2007: 396).

"Investigation": It refers to the process of inquiring for ascertaining facts through careful examinations. Watson and Wood-Robinson (1998:84) found that teachers preferred the following two characteristics of investigations:

- *Learner investigations*: In investigative work, learners have to make their own decisions either individually or in groups; they are given some autonomy in deciding how the investigation is carried out and how it goes;
- *Variety of investigation procedures*: An investigation must involve learners in using procedures such as planning, measuring, observing, analysing data and evaluating methods. Not all investigations will allow learners to use every kind of investigational procedure and investigations may vary in the amount of autonomy given to learners at different stages of the investigative process and at different levels of education.

"*Science"*: The word science comes from the Latin "scientia," meaning knowledge. Therefore we can say science is "knowledge attained through study or practice," or "knowledge covering general truths of the operation of general laws, especially as obtained and tested through scientific method [and] concerned with the physical world" (Oluwatelure and Duyilemi, 2013: 43).

Science is the concerted, collaborated, dynamic human effort to understand, the history of the natural world and how it works, with observable physical evidence as the basis of that understanding (Oluwatelure and Duyilemi, 2013: 43). (It is done through observation of natural phenomena, and/or through experimentation that tries to simulate natural processes under controlled conditions

"Chemistry" In the context of this study is defined as a section of Physical Science taught at Senior Secondary School. Chemistry and physics are specializations of Physical Science. Chemistry is regarded as the study of matter and energy and the interactions between them. It tends to focus on the properties of substances and the interactions between different types of matter, particularly reactions that involve electrons (Russell, 2001:1). Chemistry is a basic science whose central concerns are:

- the structure and behaviour of atoms (elements);
- the composition and properties of compounds;
- the reactions between substances with their accompanying energy exchange; and
- the laws that unite these phenomena into a comprehensive system.

"Attitudes": This refers to the feelings that a person has about an object, based on their belief about the object. The 10 scientific attitudes learners should possess are beliefs, curiosity, objectivity, critical mindedness, open mindedness, inventiveness, risk-taking, intellectual honesty, humility and responsibility (National Academic of Science, 2008:2). Some of these attitudes are helpful in terms of Chemistry practical work especially curiosity, because they help learners to explore and ask questions. Learners' curiosity is at first immature, impulsive, spontaneous, easily stimulated by new things but just as easily distracted also (Lindt, 2000:57). It is worth mentioning that some attitudes can be negative and distractive in the teaching and learning of Chemistry especially in practical work. Negative attitudes have also been singled out as a reason for learners to fail science. Attitudes influence behaviours and behaviours in tern influence conduct and performance.

"Science process skills": Skills refer to the correct application of knowledge to the practical task, therefore science process skills refer to the process whereby science knowledge is applied with congruent skills to a practical task. The science practical

skills that are needed by learners are observing, inferring, measuring, communication, classifying and predicting.

1.14. Chapter division

The study consists of six chapters as outlined below.

Chapter 1 presents the introduction; the rationale of the study; research questions; significance of the study; two philosophies of teaching Chemistry and background of the study. In the end it presents the definition of terms.

Chapter 2 describes the literature that relates to Chemistry laboratories with emphasis on how it relates to the research problem.

Chapter 3 discusses the education system in Namibia, focusing on Chemistry and its practical work.

Chapter 4 describes the research methodology, the instruments used to gather data, the approach used in this study and the methods used to statistically analyse data.

Chapter 5 presents data analysis and discussion.

Chapter 6 presents the conclusion and recommendations derived from data, analysis and comparative literature studies.

1.15 Conclusion

The education and training in the field of Mathematics, Science and Technology in Namibia remain a challenge, yet that is what is needed for the country to realise its much talk about Vision 2030. The core focus of Vision 2030 is to have a country that is developed, prosperous, healthy and resilient in an atmosphere of interpersonal harmony, peace and political stability; and as such, Namibia aims at becoming a developed country to be reckoned with as a high achiever, in the community of nations by the year 2030 (Heita, 2012: 2).

In summary, this chapter has dealt with the introduction, aims and objectives of the study. It explains further, the significance of the study and the need to address the short coming in Chemistry practical work. The two philosophies of Chemistry education were discussed and explained within the Namibian situation. The chapter ends with the definitions of relevant terms used in the study to provide clarity in the terms used. Chapter 2 will cover the literature study on Chemistry laboratories and how it relates to the research problem.

Chapter 2

2.1. Literature review on Chemistry laboratories

2.1.1. Introduction

Chapter 2 describes literature about Chemistry laboratory teaching and how it relates to the research problem. The literature is reviewed under the following sections: Introduction (Section 2.1.1); Classroom environment (Section 2.2); Laboratory and the skills they provide (Section 2.3); the nature of practical work and the curriculum (Section 2.4); and the background to teacher-learners interaction (Section 2.5). It continues with the background on science laboratory environment inventory (Section 2.6); the theoretical framework (Section 2.7) and ends with the Conclusion (Section 2.8).

The literature review in this study aims at finding out what has been researched on teacher-learner interaction and laboratory learning environment globally and in Namibia in particular. This provides justification for the proposed research on how it is different to that which has been published. The literature further provides a rationale for doing the proposed study and is used to form a theoretical framework that will inform the design and methodology of the proposed study. Finally, the review of literature will identify gaps, in the respective knowledge they exist today, (Creswell, 2003:30).

Earlier studies by Mucherah, (2008: 66) and Myint & Goh, (2001: 22) reported that if classroom environment was perceived by learners as being conducive, it tended to enhance and develop a positive attitude in the subject matter and enhances better achievement in the subject. However, it is unfortunate that most classroom environment studies have been carried out in developed countries like Australia, United States of America, New Zealand and in some Asian nations like Turkey, Singapore and Taiwan (Fraser, 2001: 4). There is very little research on how classroom environment in Africa influences performance (Mucherah, 2008: 62), although, Ampiah (2006: 142) studied, how Ghanaian Senior Secondary School learners perceived their science laboratory learning environments in Biology classes, but this study did not focus on Chemistry learning environment and laboratory practical work and it provided limited information on the research topic. The findings suggest that there is a relationship between learning environments and learners' attitudes to Biology lessons.

The situation in Namibia with regards to science learning environment research is even worse (Olivier & Poolman, 2009:1). The study done by Adeyoke (2007: 8) focused on learner-centred education in Physical Science teaching in Namibia. Adeyoke (2007:6) mentioned that practical activities in science lessons presented a good opportunity for learner centred education without going into details regarding practical work. Chemistry practical work in schools in Namibia is a subject that has not been researched.

There is need for improvement in Chemistry laboratory work in Namibia. During science workshops that are organised by the Ministry of Education, some educators in Namibia argue that laboratory work is expensive and time consuming and the cost involved is not justified by the technical skills developed. Hawkes (2004:1257) shares the same view. This position has been criticised by Baker, 2005:12; Morton, 2005:998; Sacks, 2005:999; and Stephens, 2005:998. These authors argue that Chemistry educators should provide compelling evidence that laboratory classes achieve more than what Hawkes implies. On the other hand, Hofstein (2004:252) argues that practical experiments should be a fundamental teaching source. This is why laboratory activities have had a distinctive and central role in the science curriculum. As a result, science educators have suggested that many benefits accrue from engaging learners in science laboratory activities (Hofstein & Lunetta, 2004:62; Hofstein, 2004:251; Lunetta et al, 2007:402). Due to the overwhelming benefit in terms of knowledge, understanding and experience by learners doing practical work compares to the cost associated with running practical activities in schools, it is highly recommended that practical work should be part of the school curriculum as explained in sections below.

The following studies by (Knight & Sabot, 1990:307; Roberts, 2002:66; and, Gott & Duggan, 2007:272), have argued that science cannot be meaningful to learners without worthwhile practical experiences in the school laboratory. Unfortunately, the terms *school laboratory* or *lab* and *practical* have been used too often without precise definitions to embrace a wide array of activities. Typically, the terms have meant experiences in school settings where learners interact with materials to observe and understand the natural world. Some laboratory activities have been designed and conducted to engage learners individually, while others have sought to engage learners in small groups and in large-group demonstration settings.

Teachers' guidance and instructions over the years have ranged from teacher-centred to learner-centred in practical investigations. Ogilvie (2007:105-107) and Tobin (1990:404) write: "Laboratory activities appeal as a way to learn with understanding and, at the same time, engage in a process of constructing knowledge by doing science practical". They also suggest that meaningful learning is possible in the laboratory if learners are given opportunities to manipulate equipment and materials in order to be able to construct their knowledge of phenomena and related scientific concepts. According to Lunetta et al., (2007:425) meaningful learning is effective if the following variables are considered:

- Learning objectives should be practically obtainable;
- Clear instructions provided by the teacher and the laboratory guide;
- Availability of materials and equipment for use in the laboratory investigation;
- Harmonious learner–learner and teacher–learner interactions during the laboratory work;
- A good understanding by teachers and learners of how the learners' performance is to be assessed;
- Compilation of learners' laboratory reports and
- Adequate preparation, appropriate attitudes, knowledge, and behaviours of the teachers should be adequate.

The above mentioned variables become even more important in laboratory-based teaching if they are linked to appropriate techniques of teaching. They are referred to as variables because they are subject to change under different circumstances. Domin (1999:545) identifies four techniques that can be applied to the different kinds of laboratory teaching, depending on the expected outcome of the laboratory session. They are the expository, inquiry, discovery and problem-based methods.

He notes that impact will be enhanced if the following factors that promote learning are considered:

I. Allow the learners to think about the larger purpose of their investigation and the sequence of tasks they need to pursue to achieve those tasks;
II. Assessment and feedback should be done in order for learners to take practical work seriously;
III. Educators should be informed on what is best practice; and
IV. Resources for more appropriate laboratory practical work should not be limited (Hofstein & Lunetta, 2004:31).

Finally, the variables and factors referred to above should provide a learning environment where learners can link theoretical concepts and experimental observations (Hegarty-Hazel, 1990:12). According to Moore (2006:519), the following factors create a learning environment that is beneficial:

- understanding subject-matter,
- improved scientific reasoning,
- an appreciation that experimental work is complex and can be ambiguous, and
- a good understanding of how science works.

Skills that can be developed in good laboratory exercises include:

- manipulation of equipment;
- experimental design;
- observation and interpretation;
- problem solving and critical thinking;
- communication and presentation;
- data collection, processing and analysis;
- laboratory ‘know-how’, including developing safe working practice and risk assessment skills;
- time management; ethical and professional behaviour;
- application of new technologies; and
- team work (Boud D., Dunn, J. & Hegarty-Hazel, E. 1986:17 and Bennett & O’Neale, 1998:26).

All these skills when acquired by Namibian learners will not only benefit them in Physical Science Paper 3 which is a practical paper, but in many other areas and in life after school as well.

With this in mind, it has become imperative for a study of this nature to be conducted in Namibia in order to consider how the performance and understanding of learners, teachers and teacher educators in the country can be improved.

2.1.2 Link between the laboratory environment and teaching

Teaching in the laboratory depends on the environment that prevails in that laboratory. In today's advanced technological systems, there are new ways of creating space or environment that are accommodative to both the normal and disabled learners. Such environments should enhance learner-teacher and learner-learner interactions as well as the support for multiple mode of learning. Although normal class teaching refers to the theoretical view of transferring knowledge, teaching in the laboratory requires the active engagement, hands-on, minds-on activities through the use of laboratory materials and techniques. NIED (2005:1) suggested that the teaching of theoretical lessons should be followed by practical work on the topics that are covered in the theoretical lessons. Through this process, learners' knowledge and understanding are enhanced and consolidated by the practical activities that they go through after each theoretical teaching. As a result, these create a much needed link between theoretical teachings and practical work that usually acts as a consolidation of the content learned. Practical work is done in the laboratory mostly.

2.1.3 How the school environment relates to the classroom environment

School environment refers to the prevailing socio-cultural behaviours that are practised by the school. The environment refers to the school setting in-terms of the physical plant, the fairness and adequacy of disciplinary procedures as well as the academic environment. These involve the management of the school, sport, beliefs, rules and pride that learners have in their school. School environment arises from the various complex transactions that characterise the daily classroom as well as school life; this is influenced by the underlying, institutional values and belief systems, norms, ideologies, rituals, traditions and practice that constitute the school culture, (Myint & Goh, 2001:25).

Classroom environment refers to the place where learners and teachers interact with each other and use a variety of tools and information resources in their pursuit of learning activities in the classroom (Mucherah, 2008: 69). Although what is sometimes referred to as a classroom environment is set by the type of teacher-learner and learners-learner interactions in the classroom, it is imperative to know that research has proved that the school environment influences the classroom environment, which in turn, influences learning (Ampiah, 2006:142). Due to the fact that Taylor (2004: 23) has proved that the way learners perceive their classroom environment affects their achievements, it is important for this study to determine how learners perceive Chemistry classes in Namibia.

There is a close link between school environment and classroom environment in that the classroom environment is influenced by school environment. This means that if there are various disruptions in the running of the school for example noise, misbehaviour, lack of security and poor infrastructure, learners will tend to misbehave in the classroom. This is why the study done in Nigeria by Mucherah (2008: 72), suggested that achievement in national school examinations were influenced by the kind of school one attended and the availability of resources in that specific school.

2.1.4 How is the classroom environment related to the laboratory environments?

The classroom environment is closely related to the laboratory environment, with just a few physical differences like structure, design, settings, odour and the rules. Although teaching and learning do take place in both environments the level of safety precautions in the laboratory is high compared to the classroom due to the varies chemicals and tools in the laboratory. This will mean the rules and regulations in the laboratory will be stricter and higher supervision in the classroom will be needed due to the sensitivities of chemicals in the laboratory compared to a normal classroom. These various physical items change the learning environment in the laboratory from the one in the classroom. According to Johnstone and Al-Shuali (2005: 42) the purpose of classroom teaching in science which involves Chemistry is to teach theoretical knowledge while the purpose of laboratory teaching is to teach hands-on skills and illustrate theory in practical terms.

2.1.5. How are the three variables related; school environment, classroom environment and laboratory environment?

If the prevailing socio-cultural environment (school environment) is positive, it will foster a positive classroom environment that will encourage teaching and learning to be pleasant and encouraging. Further, this positive environment will be replicated in the laboratory because the rules and regulations there are stricter and the environment is more dangerous compared to the school or classroom environment.

2.2 Classroom environment

2.2.1 What classroom environment entails

At the onset, it is imperative to indicate to the differences between the class room environment and learning environment. The term learning environment relates to the psychology, sociology and pedagogy of the contexts in which learning takes place and their influence on learners' achievement in the cognitive and effective domains, (Doppelt & Schunn, 2008:89). A large amount of research on the science classroom environment has emphasised the psychological importance of understanding what the classroom environment entails (Fraser & Walber, 1991; Taylor, Dawson, & Fraser, 1995; Teh & Fraser 1995; Fraser 1990; Hedersson, Fischer & Fraser, 1991 and Musherah, 2008: 63). In the past, various researchers have made a distinction between the school environment and classroom environment (Anderson, 1982; Fraser & Rentoul, 1982; and Genn, 1984). The classroom environment is seen as the relationship between teacher-learners as well as learners-learners interactions (Pickett & Fraser, 2010:321).

The school environment is more advanced and global; it involves the relationship between teachers, learners, management and the Principal. In research, it is reported that teachers always refer to the importance of the classroom's environment, climate, atmosphere, tone, ethos or ambiance (Fraser, 1994: 497). Classroom environment is considered to be important in its own rights and influential in terms of learning and understanding of concepts in a Chemistry class. Fisher and Fraser (1991: 15) have described the class and school environment in broad terms like "a set of factors which give each school a personality, a spirit and a culture". For the past 20 years these two environments have been a subject of considerable research.

There are three common approaches to studying the classroom environment according to Fraser (1991: 18). First, the direct observation of events taking place in the classroom by an external observer; the second method is the case study approach whereby the techniques of naturalistic inquiry and ethnography are applied; and the third method involves assessing the perceptions of the learners and the teacher using a questionnaire. The latter method has the advantage of being less expensive and more objective and as a result it is mostly recommended to large or small scale research. Various instruments have been used to study classroom environment and most studies suggest that a conducive classroom environment tends to foster improved performance among learners (Fraser 1991: 22). There has been a significant amount of research that explores learners' cognitive and effective learning outcomes and their perception of their classroom environment (Huang & Waxman, 1994: 18, Doppelt, 2004:175 and Doppelt & Barak, 2002:13). Earlier reviews by Weinstein (1979:579) outline the impact of physical environment of the school on the learners' behaviour, attitudes and achievements. Environmental variables such as the sitting position and the presence or absence of windows, chairs and the overall use of space within the school were all found to have an effect on the classroom environment. Astin and Holland (1961: 310) had assumed that the environment is dependent on the nature of its members and that the member's typical characteristic would in turn be the dominant feature of the environment. Learners perform better and have more positive attitudes towards the subject taught when they perceive the classroom environment positively.

Earlier studies on classroom environment conducted in Mauritius by Bessoondyal and Fisher (2003: 447-454) suggested that the perception of pre-primary teachers trainees concerning teacher-learner and learner-learner interactions in a Mathematics classroom environment was positive. The mean score was quite high for the leadership, understanding and helping/friendly scale; and the mean score quite low for the uncertain, admonishing and dissatisfied scale. This study has considered the principles of Moos (1974), which define three basic types of dimensions for studying any type of human environment, namely:

I. *Relationship dimension*- which identifies the nature and intensity of personal relationship within the environment and assesses the extent to which people are involved within the environment and how they support and help each other;
II. *Personal development dimension*, which assesses basic direction along which personal growth and self enhancement tend to occur;
III. *System maintenance and system change dimension-* which involves the extent to which the environment is orderly, clear in expectations, maintains control, and is responsive to change.

The educational community regards the ideal classroom environment as one in which maximum learning and teaching take place. It is proved by studies that learners will perform best in an environment that is congruent with both their social and academic needs (Byrne, Hattie, & Fraser, 2001: 12). The positive or approving behaviour of teachers has a huge influence on learners' behaviours and how they perceive the classroom environment (Beament, 2000: 22). This is why Glasser (2001: 137) stated that "healthy oral, facial or body expression from teachers, set the tone that facilitates emotionally stable and eager learners".

Various instruments for assessing classroom environment have evolved through the years because they have been used as tools for analysing and predicting criterion variables in a medley of research studies conducted in schools all over the world. The most commonly used instruments are: Learning environment inventory (Anderson 1973); Classroom Environment Scale (Moos & Trickett, 1974); Individualised Classroom Environment Questionnaire (Fraser, 1990); My Classroom Inventory (Anderson, 1973); The Science Laboratory Environment Inventory (Fraser, Giddings & McRobbie, 1993); and The Constructivist Learning Environment Survey (Fraser & Tobin, 1990). These instruments can be conveniently administered and scored by hand or computer and they are reliable and have been extensively tested in the field with accurate results (Fraser, 1994).

Although Fraser (1994: 15) observed that the environment, climate, atmosphere, tone, ethos or ambience of a classroom exert a strong influence on learners' behaviour, attitudes and most importantly for Namibia “achievement”, there is still a lack of literature of study in this area in Namibia. This seems to suggest that, in spite of the outcry of researchers, educators and the government about improving the environment for the learners, nothing much has been done in Namibia to focus systematic research on this area.

2.2.2 Classroom environment in Science Education

Learning in the classroom takes place within diverge social relationships of formal and non-formal interactions from both the teachers and the learners. This interaction is not only between the teacher and learners but also between the learners and the physical setting of the classroom. The interaction between teachers/learners and the physical arrangement create what is referred to as classroom learning environment (Hofstein & Lunetta 2004: 51). Positive learning environment has been given a central role in science education research. Substantial amount of research in education has focused on improving the teaching and learning methodology in science education. Advanced methodology of teaching the subject helps in creating a conducive learning environment in the science classroom because the teacher will know how to keep learners constructively busy during class teaching.

Over the past 30 years, the study of classroom environments has received increased attention from researchers, educators and school administrators. As computers are nowadays an indispensable tool in carrying much of the laboratory work, for the past decade, significant data on the use of computers in the classrooms has been surfacing. Most of these studies which have focused on the effect of using the computer and how it affects learners' performance e.g. (Mucherah, 2003:37-57) have investigated the environment in the social science classrooms using technology. Mucherah (2003:34) has raised important issues concerning the inadequacy of training and support of teachers who attempted to integrate the use of computers in the curriculum. Studies by (Dellar, Cavanagh and Romanoski, 2006) investigated the association between information and communication technology learning and classroom learning culture, while Lu, Wan and Ma (2006: 79) investigated the use of wireless laptops in college classrooms that purportedly had a constructivist learning environment.

It is very important that laboratory exercise should have educational benefits for learners who undertake them and these benefits should be demonstrable, both in knowledge and skills gain. This means laboratory activities that are undertaken in a positive learning environment should train learners to become academically skilled in terms of content and also possess non-academic/technical skills like handling equipment, making measurements, etc. The learning environment is mostly determined by the interaction between teaching practice and the resulting learning approach taken by the learners engaged in laboratory activities, (Millar, 2004:4). Wickman (2004:332) have shown that the sequence of activities is an important factor in determining content learned, in part because sequencing can be a signal to the learners of what is important. The other important factor that influences the learning environment is the structure of the laboratory exercise.

2.2.3 Types of laboratory learning

The focus here is on the impact of learning environment in terms of the structure of the laboratory and what the learners experience. The *expository laboratory* usually follows a traditional verification approach, meaning that learners follow a pre-set procedure and the teacher has a known outcome that is prescribed and that the teacher should use for assessment. This is heavily criticised by (Domin, 1999: 545), who proposes the guided-inquiry approach as the best option for laboratory learning. This theory is also supported by (Teixeira-Dias, de Jesus, de Souza and Watts, 2005.1131), who claims that guided approaches allow more learners control of the learning activities which in turn promote deep learning.

Another study by Berg, Christina, Bergendahl and Lundber (2003:363) directly compared a single experiment presented in expository and inquiry formats. The finding suggests that the inquiry version led to more positive outcomes, both in terms of learners' learning and learners' perception of the exercise. Such positive outcomes contribute heavily to a positive learning environment; because learners feel ownership of their studies and positive achievement lead to a positive learning environment.

Another important consideration in enhancing positive learning environment is to ensure that laboratory activities design does not put excessive demand on assessment, therefore allowing learners to focus on the implication of what they are doing (Vianna & Johnstone, 1999: 285). According to Mayer (2004:15) it is well established that in any learning activity cognitive engagement in activities is critical if meaningful learning is to occur and that physical activity alone is not a sufficient condition for learning to take place. It is, therefore, imperative that cognitive activities be directed towards educational usefulness to foster a positive learning environment. In a study on learning environments with engineering students, Lin and Tsai (2009:193) concluded that learning environments that are learner-centred, peer interactive and teacher-facilitated help engineering students develop more fruitful conceptions of the learning environment than other methods.

2.2.4 The link between learners' outcome and their learning environment

The study by Wahyudi (2004: 17) found a strong association between learners' outcome and the status of their classroom learning environment. This study was conducted in Indonesia using a modified version of "What Is Happening In Class" (WIHIC) as an instrument. Both simple analysis and multiple regression analysis procedures showed that all scales of the Indonesian WIHIC showed statistically significant associated with other two scales of the Indonesian adapted Test On Science Related Attitudes (TOSRA) and learners' cognitive scores.

Other studies focused on the relationship between learning environment and learners' motivation and cognition (Ley & Young, 2001:99; Paris & Paris, 2001: 93 and Wigfield & Eccles, 2000: 73). The studies showed that learners' perceptions of their abilities to succeed on academic tasks and intrinsic interest in a task are positively associated with their academic performance, learning environment, choice and persistence.

Expectancy for success (self-efficacy) which in most cases is influenced by the environment, involves beliefs about how one can perform an academic activity (Linnenbrink & Pintrich, 2003: 126). The self-efficacious learner tends to put more effort to succeed on a task whether the task is content based or involves practical investigations. He will not give up easily in the face of difficulties, complex practical investigations and challenges during unknown experiments. Furthermore, studies revealed that self-efficacy beliefs affect learners' academic goal orientations, attribution, and future career choice (Linnerbrink & Pintich, 2003: 126, Hoy, 2004:17 and Usher & Pajares, 2006:133).

Umbach and Wawrzynski (2005: 156) discovered that the educational environment created by teachers' behaviours, beliefs and attitudes has a dramatic effect on learners learning and engagement, Bryson and Hand (2007: 352) and Mearns, Meyer and Bharadway (2007:7) concluded that if a teacher is perceived by learners to be more approachable, well prepared, willing to help and sensitive to their needs, learners tend to get more committed, hardworking and open to express their own opinions. Learners feel part of the classroom activities and they get engaged more, if they are supported by teachers who establish inviting learning environments (Purkey & Novak, 1996: 5), demand high standards, challenge learners and make themselves freely available to assist and discuss academic issues. It is, therefore, concluded that a classroom environment which encourages and promotes learners autonomy and control, and help learners to embrace and understand the link between the effort that they put in and the success they achieved will foster and promote development of mastery goal orientation. For these reasons, many researchers have shown that the classroom environment has great influence on the learners' motivation in terms of self-efficacy, intrinsic values and beliefs, and goal orientation (Green, Miller, Crowson, Duke & Akey, 2004:472; Muller & Low, 2004: 182 and Stefanou, Perencevich, DiCintio & Tuner, 2004:105).

Green et al (2004: 476) have stressed that the relationship among learners perception of a learning environment in terms of motivating task, autonomy support, and mastery evaluations in comparison to their motivation and strategy used showed perception of task as important and relevant. Their interest was related to higher levels of self-efficacy, mastery goal orientation, and perception that the task is instrumental to the future success. This mean that learners who perceive their learning environment as supporting autonomy and mastery-oriented evaluation were more likely to perceive the learning environment as positive, and as a result, produced higher performance.

While many past learning environments and teacher-learner interaction research have employed techniques such as multiple regression analysis, only a few have used the multi-level analysis (Bock, 1989:17 and Bryk & Raudenbush, 1992: 44). Multi-level analysis takes cognisance of the hierarchical nature of classroom setting. This will help in finding out how the classroom environment is influenced by various hierarchical structures of the classroom. The fourth level of Maslow's hierarchy is deemed the best fit in situations like these because it deals primarily with confidence, achievement and respect from others. Thus data is derived from learners in intact classes to describe the specific classroom learning environment, such data are inherently hierarchical. Ignoring this nested structure in research can give rise to problems of aggregation bias (within-group homogeneity) and imprecision.

2.3 Laboratory, the skills it provides and the situation in Namibia

Traditional Chemistry teaching is not effective enough in improving learners understating of Chemistry concepts. The traditional Chemistry teaching refers to the presentation of content in a linear manner, where one concept builds on another (Brist, 2012: 3). This type of teaching differs from the context-based approach, which allows learners to develop their analytical skills, critical judgement skills, and risk-benefit assessment skills. All these skills are important to develop in order for learners to become informed members of society (Schwarts, 2006:982). In their chapter on learning Chemistry in the laboratory, Nakhleh, Polles, and Malina (2002: 78), pointed to the inadequacy of traditional learning theory to account for learning arising from the interactions in the lab. Research shows that learners of all ages learn Chemistry better by participating actively in the critical thinking and by interpreting physical phenomena through handling equipment (Donoven & Bransford, 2005: 68); and (Hofstein & Mamlok-Naaman, 2007: 105). Although Garatt

(2002: 58) argued that laboratory work provided only one of the many skills (observations) needed by the experimental scientist, it is high time to move from asking superficial questions in Chemistry laboratory class like, "*did learners enjoy the experiment* to sensible questions like, *what did the learners learned that they could not learn in a normal class?"* According to Nakhleh, Polles and Malina (2002: 79), laboratory teaching is a complex phenomena because there are interactions between learners and activities, learners and equipment, learners and teachers, and learners and learners. All these interactions cannot cater for observation only, as claimed by Garatt (2002: 58), but help to develop a variety of skills occurring within the broader framework of cognitive, effective, and psychomotor domain.

The question of whether the learner has been able to learn, has been addressed somewhat enigmatically by Bodner, MacIsaac and White (1999: 31), who emphasised that there should be a greater recognition of the breath of potential outcome of laboratory work to ensure that laboratory experiences do not focus solely on conceptual learning and the acquisition of various laboratory techniques, but also facilitate the development of investigative skills. Among the arguments is the claim that the level of learning is limited in the curriculum, and that learners are unclear of the aims of the practical work and are unsure of what the results mean or how they are applied to the theory provided in the teaching programme (McGarvey, 2004:17).

In addition, Nakhleh, Polles and Malina (2002:61) state that the traditional style of practical work oftens leaves little room for creativity or contextualisation, and often a verification of a known quantity or testing of a theory that has been presented in class. They emphasise that laboratory experiences should also be considered to have a central role in the teaching and learning of investigations and problem solving skills.

The Chemistry laboratory is viewed as a setting in which learners work cooperatively in a small group to investigate set phenomena, a unique mode of instructions, and a unique mode of learning environment (Tobin, 1990: 406). This is why laboratory experiments have the potential to enhance constructive social skills as well as positive attitudes and cognitive growth.

According to Olivier and Poolman (2009:1), in the past decade the Namibia government has spent huge amounts of money in building laboratories for schools and supplying schools with chemicals, however, it is regarded that money is not the only solution for learners to acquire these laboratory skills. Olivier and Poolman (2009:1) emphasise that, *what is needed in Namibia is a skilled workforce that applies precise thinking about educational objectives*. By simply offering a genuine, unvarnished scientific experience, a Chemistry laboratory can make a learner into a better observer, a more careful and precise thinker, and a more deliberative problem solver.

This is why the influential Roberts recommended that Government and Local Education Authorities should prioritise school science laboratory and ensure that investment is made to bring such laboratories up to standard by 2010 in order to help inspire and motivate learners to study science related subjects (Roberts, 2002: 66).

Regarding skills development in the laboratory, the questions that need to be asked are: ‘W*hat skills should learners acquire in Chemistry laboratory at school level?’* and ‘*Which of these skills can be developed traditionally without the use of the expensive laboratory equipment?’* Although some scholars will reason otherwise the Table below shows answers to the above questions:

Table 2.1 Skills to be acquire

Traditionally acquired skills	**Laboratory acquired skills**
Observation	Manipulation
Data collection	Data collection
Problem solving	Processing and analysis of data
Teamwork	Interpretation of observations
Communication	Experiment design
	Presentation
	Laboratory know-how

(Nakhleh, Polles & Malina, 2002: 61)

The shortcoming in the Namibia Senior Secondary Certificate (NSSC) is that the practical papers in Physics and Chemistry do not assess the practical skills that learners acquire during the year because there is no handling of equipment during the examination. Learners are simply assessed on theoretical knowledge that they should have about certain experiments in the syllabus. In the Namibian Senior Secondary Certificate Higher Level (NSSCH) examination, learners follow a recipe do not do practical experiments, only what Brennete & O' Neal regarded as laboratory exercise and not experiments (Brennete & O' Neal 1998: 55).

The learners read instructions from the question paper and mechanically carry out the manipulations with no real thought as to why certain actions are taken and how the overall outcome contributes to their understanding of Chemistry phenomena. Such examinations run the danger of not making the required intellectual demand; neither can such prescribed assessment cater for various skills assessment because learners do these activities without conceptual demands from their mind. Analysing and examining of skills are never simple. There is a hierarchy based on the intellectual and on manipulative demands, the assessments of such specific skills requires careful and well considered definitions. The only effective way of defining a skill is by detailing exactly with what the learner is able to do, once that specific skill has been acquired. Hunter, Wardell and Wilkins (2000: 14) suggest that practical work examination or investigations should be planned according to the following principles:

- There must be a range of things to investigate so that not more than two learners will tackle the same problem at the same time;
- There must be a clear time limit and simple objective on what outcome is required from learners;
- It should be relevant to the syllabi and every day experiences of learners;
- It should motivate learners to do more investigations by connecting theoretical knowledge to practical experiences ; and
- It should be safe.

These suggestions are in-line with Bloom's Taxonomy that divides educational objectives into three domains namely: Cognitive, effective and psychomotor which is sometimes described as (knowing/head, feeling/heart and doing/hands respectively).

Nevertheless, the pedagogy of the laboratories in Namibian schools exemplifies the type described by Domin (1999:544) as an expository style, using a given procedure by having a predetermined outcome and a deductive approach. The guided inquiry or discovery labs have changed to an inductive approach, providing a clear procedure and having a teacher predetermine the outcome. Learners would directly or indirectly be exposed to a phenomenon and are expected of them to develop an understanding of the underlying principle.

This style of teaching has its detractor as Kirschener and Huisman (2007: 671) noted that *the formation of concepts requires multiple exposures to many different instances in rich educational environments,* which is mostly not the case in Namibia. How then can a single experience or demonstration by a teacher be expected to develop this required understating? However, Hodson (1996a: 122 and 1996b: 41) was of the opinion that teachers already understand and know the principles and the underlying theories of practical work, but unfortunately the learners cannot discover something they are conceptually unprepared for. Learners do not know where to look, how to look or how to recognise it when they find it (Hodson, 1996a: 118). Therefore, using guided inquiry or a discovery style requires a careful framework by which the teacher-learners interaction is fostered in order for the learners to learn observation skills through practice.

Domin (1999: 545) highlighted the effectiveness of giving learners ownership over laboratory activities by allowing them to choose their preferred objectives from the syllabi which will help them to seek connection with prior learning or knowledge that they have. Thus, it is argued, that it fosters inquiry learning by allowing learners to design or generate their own procedure to answer questions with an undetermined outcome. Learners acquire higher order thinking skills of formulating the problem, predicting the outcome, generating a procedure, and performing the investigation. Inquiry-type laboratory work has the potential to develop learners' abilities and skills such as posing scientifically oriented questions, forming hypotheses, designing and conducting science investigations, formulating and revising scientific explanations, and communicating and defending science arguments. (Krajcik, Mamlok & Hug, 2001: 222 and Hofstein, Navon, Kipnis & Mamlok-Naaman, 2005: 796). Supportive and positive relationships between teachers and learners ultimately promote a "sense of school belonging" and encourages learners to "actively participate cooperatively in classroom activities", which in the case of this study could be "laboratory activities" (Hughes & Chen, 2011:278).

These skills are to be demonstrated in the practical examinations but also at post-secondary studies and work place (Garratt, 2002: 62). Garratt further explains that learners readily realised the importance of careful thinking, planning and interpretation of practical work. Learners are forced to decide what they need to observe and to imagine the necessary conditions and steps in order to obtain a suitable outcome to the problem. Problem-based laboratory work that uses deductive approach with learners-generated procedure in a positive teacher-learners interaction environment to investigate undetermined outcome tend to develop higher level cognitive skills (Domin, 1999b: 544).

2.4 The nature of practical work

2.4.1 Curriculum requirements

The Grade 12 syllabi in Namibia require that learners meet specific criteria in their practical work paper at the end of the year exam (Ministry of Education 2005: 57). The criteria to be met are:

- Following a sequence of instructions using appropriate techniques;
- Handling apparatus/material competently with due regard for safety;
- Making and recording estimates, observations and measurements accurately;
- Handling and processing experimental observations and data, including dealing with anomalous or inconsistent results;
- Applying scientific knowledge and understanding to make interpretations and to draw appropriate conclusions from practical observations and data; and
- Planning, designing and carrying out investigations (based on concepts familiar to learners) and suggest modifications in light of experience.

According to Iqbal, Qudsia and Norman (2007: 75), most curriculum reforms in Chemistry in the past 30 years show a major shift from the teaching of science as a body of knowledge towards increasing emphasis on high standard of practical work.

This shift is, unfortunately, coupled with the assumption by many educators in Namibia that Chemistry knowledge is best learned through experiments (practical work) either equivalent to or based on the procedures of the Chemistry curriculum. The curriculum developers aim at teachers and learners to distinguish *teaching/learning* Chemistry and *doing* Chemistry. Teaching/learning Chemistry may not coincide with doing Chemistry although the two do overlap in some domains. It is, therefore, naïve to think that theories of teaching/learning Chemistry may be extracted from doing Chemistry (Dillon, 2008: 7).

The teacher should not confuse doing Chemistry with learning Chemistry because according to Iqbal, Qudsia and Norman (2007: 75) the teacher acts as a communicator between the curriculum and the learners, and should the teacher be confused, the same confusion is transferred to the learners. Practical work should serve the purpose of affirming and illustrating what is taught or learned by the teacher in the classroom, by conveying the syntactical structure of Chemistry. It is for this reason that in the Namibian Science curriculum each topic is followed by practical tasks to be completed after completing the theoretical part of the topic. Science curricula are key factors in developing and sustaining learners' interest in science (Basu & Barton, 2007: 474), and should therefore be used as such.

2.4.2 Practical work as an important skills developer

The skills that practical works provide have been widely regarded as very important Stuurman, Ruddock, Burge, Styles, Lin & Vappula (2008: 1) and Woodley (2009: 1) define practical work in science as a hands-on learning experience which prompts thinking about the world we live in. These hands-on activities support the development of practical skills, and help to shape learners' understanding of scientific concepts and phenomena. The demonstrations, experimenting, handling equipment and analysing results that learners are exposed to during practical work are valuable life-long experiences that they can apply in future careers. Most practitioners would agree that good quality practical work can engage learners; enable them to develop important skills; help them to understand the process of scientific investigation; and develop their understanding of concepts (Woodley, 2009:

1). Practical work comprises of two streams of activities namely, scientific techniques and procedures; scientific enquiries and investigations.

Each of these streams caters for both skills development and the understanding of scientific concepts and phenomena. In general, practical work is regarded as essential in skills development. In a recent NESTA survey (n=510), 99 % of the sample of UK science teachers believed that enquiry learning had a positive impact on learners performance and attainment (NESTA, 2005: 5). Lunetta, et al. (2007: 405) state that well planned and effective practical activities at varied levels of inquiry allow learners to manipulate ideas as well as materials in the laboratory, such activities would require learners to be physically and mentally engaged in ways that are not possible in other science areas of education. The mental and physical involvement of learner encourages the development of various skills among learners. According to Brattan, Mason and Rest (1999: 59), the following skills are developed through practical work:

- The safe handling of chemical materials;
- Conducting of standard laboratory procedures correctly;
- Ability to monitor chemical properties, events or changes and the
- systematic and reliable recording and documentation thereof;
- Competence in the planning, design and execution of practical investigations;
- Ability to handle standard chemical instrumentation;
- Ability to interpret data derived from laboratory observations and measurements;
- Ability to conduct risk assessments.

According to Partnership for the 21^{st} century, (2009: 3), innovative skills in the laboratory are what separate learners who are prepared for an increasingly complex life and work in the 21^{st} century and those who are not. It is for this reason that advanced skills are needed in the workforce and they are required because they contribute to productivity, innovation, competitiveness, job-satisfactions and excellent quality of work (Commission of the European Communities, 2005: 3).

It has already been accepted that Chemistry is a practical science and that appropriate Chemistry experiments and investigations are the key to enhanced learning, clarification and consolidation of theory. Practical activities are not just motivational and fun: they also enable students to apply and extend their knowledge and understanding of Chemistry in novel investigative situations, which can stimulate interest and aid learning and retention. Practical work also gives students an understanding of how Chemistry knowledge is generated by experiment and observation (Al-Naqbi and Tairab, 2005: 21).

2.4.3 Practical work can change learners' attitudes towards Chemistry

The critical questions about the importance of *attitude* (Dalgety, Coll and Jones, 2003), and of *motivation* (Covington, 2000: 188) have been investigated by many educational researchers all over the world. Unfortunately, research has revealed that much of what goes on in science classrooms is not particularly attractive to learners across all ages (Cheung, 2009: 88). This lack of appeal among learners creates unfavourable attitudes towards Chemistry as a subject. However, according to Freedman, (1997: 342), a positive attitude towards science can be developed through hands-on activities (practical work) and other methods of instruction that excite learners and encourage them to learn different phenomena. According to McNeill, Lizotte and Krajcik, (2005: 17) the reason for this is that learners understand and comprehend topics easily if teachers use evidence to construct and explain phenomena that they are exposed to in their every day's life. The real purpose of practical work in school is to:

"encourage learners to make links between things they can see and handle, and ideas they may entertain which might account for their observation ... Practical work that is intended to support the teaching and learning of scientific knowledge has to be understood, and judged, as a communicating strategy, as a means of augmenting what can be achieved by word, picture and gesture", (Millar, 1998: 29).

Science practical work may, therefore, involve the illustrations of a phenomenon; provision of experiences or getting a feel for the phenomenon examined; exercises or routines for learners to follow; developing a particular skill or becoming used to handling a piece of equipment or instrument. When learners master the requirements of practical work and can manipulate equipment, analyse data and find the unknown using practical strategies that they have learned during practical work, they will develop a positive attitude towards Chemistry because they start enjoying it.

2.4.4 Practical work helps learners to understand Chemistry

Getting learners involved in authentic experiments of inquiry-based learning such as problem solving and investigations, can help them develop scientific knowledge, creativity, and habits of mind that enable them to question and learn about the life-world phenomena around them (Haigh, 2007: 127). Practical work in the laboratory makes it possible, not only for the transfer of knowledge on a higher order cognitive level, experimental and practical skills but also to ignite interest in Chemistry among learners (Sorgo & Spernjak, 2009: 125). Piaget argues that learners thinking are increasingly sophisticated and powerful representations of the world by acting on their current understanding, and modifying this understanding in the light of the data generated. Through action, we generate sensory data which can either be *assimilated* or changed into existing schemas to *accommodate* the new data and re-establish *equilibrium* between the internal and external realities. Through such action, learners construct a view of what objects are in the world, what they are made of and what can be made from them, what they can do and what can be done to them. If Piaget is correct, then practical experience of observing and, even more important, intervening in the world is essential for understanding Chemistry.

2.4.5 Problems of Chemistry practical work

In third world countries like Namibia, the provision of adequate resources in the laboratories remains a big challenge as noted in earlier paragraphs. However, learning Chemistry is enhanced by doing Chemistry; there is no other ways of learning Chemistry without the involvement of practical work (Ashok, Padmini & Sapre, 2011: 1). Ashok at el. (2011:1) in their studies on the type of problems faced by learners in doing practical work at school in India discovered the following:

1. Some learners are poor in performing scientific experiments and are unable to develop experimental skills. They are also poor in handling instruments or apparatus. These learners did not know about laboratory wares and in

handling of the chemicals, and some do not even know the names of the chemicals;

2. The scarcity of equipment in laboratories, hence the equipment is not sufficient for the learners to perform the experiments so they cannot carry out experiments individually and they resort to group work or teacher demonstrations as given by teachers;

3. When learners perform the experiments in Chemistry some do not known the names of apparatus and some are unable to connect apparatus with each other. They were unaware of the danger of chemicals and how to handle chemicals;

4. In an experiment of Chemistry when reactions occur and chemicals or solutions undergo colour changes, some learners lack the skills to identify the change, which indicates that they have poor observational skills; and

5. In an experiment of Biology, some learners do not know the names of different plant species and get difficultly to identify the plant species. Hence they cannot locate the desired parts of a specimen accurately.

A study by Marley (2010: 1) suggests that practical work is being hindered by a crowded curriculum, too much assessment and rowdy pupils, as confirmed by the network of Science Learning Centres poll. A content-heavy curriculum was identified as the biggest problem, blamed by 69% of teachers for reducing practical work. More than four in 10 teachers said assessment demands were too frequent and 29% said poor learners behaviour was a factor (Marley, 2010: 1). Other problems that entailed practical work are:

- learners do not easily comprehend fundamental concepts,
- deficiency in knowledge,
- misleading associations,
- inability to link theoretical knowledge to observed practical phenomena, and
- inability to distinguish between the relevance and irrelevance of practical activities (Friedler and Tamir, 1990: 346).

The study by Kim and Tan (2011:466) suggested that practical work was still regarded as one of the most challenging tasks for many elementary science teachers and was practised infrequently or inefficiently in many science classrooms. Apart from all these mentioned problems practical work problems, it varied from school to school and from country to country. Researchers all over the world still insist that practical work is part and parcel of any science teaching and educators should discover numerous ways to overcome these problems (Dillon, 2008: 1).

2.4.6 Other thoughts from the literature on Chemistry practical works

Research on Chemistry practical work has been continuing for decades since the nineteenth century and a great deal of money was spent on studies in the field of practical work trying to answer many questions on the purpose of practical work (Hofstein & Lunetta, 2004: 33). By simply saying "Chemistry is a practical subject so we must do practical work" is not enough.

There is a need to list laboratory practical aims to help laboratory teachers to think clearly about their intentions and to ensure that all important goals of the syllabi are met (Hofstein, Shore & Kipnis, 2004: 50). Before highlighting other thoughts from the literature, it is imperative to define two main terms used by curriculum and syllabi, namely, the aim and objective. In the literature on practical work, the two terms are often used synonymously to give a general description of the intentions of practical work.

In Chemistry practical work, aims are seen as general statements of what the teacher intends to achieve in the long run through practical activities, while objectives are specific statements of what learners should be able to accomplish at the end of the laboratory session**.** Kerr (1963:8) carried out an important study of practical work over a period of two years in which he conducted a survey of practical work in England and Wales, asking teachers to give information about the nature, purposes, assessment and views about the type of practical work they had encountered in schools. From these surveys, he suggested a list of aims to practical work that were still relevant, namely:

- To encourage accurate observations and careful recording;

- To promote simple, common sense, scientific methods of thoughts;
- To develop manipulative skills;
- To give training on problem-solving skills;
- To meet the requirements of practical exam;
- To elucidate theoretical work so as to aid comprehension;
- To verify facts and principles already taught;
- To be integral part of the process of finding facts by investigating and arriving at principles;
- To arouse and maintain interest in the subject; and
- To make phenomenon more real through actual experience.

The fact that these aims are still relevant today after 50 years means that there is a universal consensus with regard to what a Chemistry laboratory should achieve in the long run. This seems to be supported by Buckley and Kempa (1971: 24) who produced an almost similar list of aims that laboratory work should produce. These are:

- Manipulative skills;
- Observation skills;
- The ability to interpret experimental data and;
- The ability to plan and carry out experiments.

In a major review on the role of laboratory teaching in school science education, Hofstein and Lunetta (2004: 28-54) detailed some of the factors that inhibit learning. Among these are the following:

- The recipe-style laboratory practicals used in most schools do not allow the learners to think about the larger purpose of their investigation and the sequence of tasks they need to pursue to achieve those tasks;
- Assessment is seriously neglected, resulting in the impression that laboratory work does not need to be taken seriously;
- Educators are not informed on best practice; and
- Resources for more appropriate laboratory teaching style are limited.

These factors that inhabit learning have led to a great concern among Chemistry educators who are concerned about what can be done with Chemistry instructions to improve learners' learning. From past research (Schwab, 1962: 55; Hurd, 1969: 851; Hofstein & Lunetta, 1982: 211) the Chemistry laboratory has been recognised as a unique instructional environment where learners are allowed to engage in processes of investigation and inquiry in a manner that allows learning of scientific processes (Hofstein & Lunetta, 1982: 209). As a result, the belief that this mode of learning will be more meaningful than with other forms of Chemistry instructions (e.g., didactic teaching, demonstrations, museum exhibits, etc.) has surfaced. Unfortunately, as it is traditionally structured, Chemistry laboratory instructions have the enduring reputation of failing to live up to this expectation (National Research Council, 2006:16). It is still the belief of some researchers that the goal of laboratory work is to be realised as Roth (1994: 202) clearly states, namely, that *"although laboratories have long been recognised for their potential to facilitate the learning of science concepts and the skills, this potential has yet to be realised."*

2.5 Teacher-learners interaction

2.5.1 Definition of interaction

Before the discussion of teacher-learners interaction, it is important to define the term interaction. According to Wagner (1994: 8) interactions are reciprocal events that require at least two objects and two actions. Interactions occur when these objects and events mutually influence one another. An instructional interaction is an event that takes place between learners and learners' environment. Its purpose is to respond to the learner in a way intended to change his or her behaviour towards an educational goal. Interactions does not occur naturally as events in a learning environment; but rather, it occurs as events that should be well thought out, programmed and incorporated into the overall design of the course by the teacher.

2.5.2 Background on teacher-learners interaction

Woolfolk (1998: 440) describes the classroom as an ecological system and states that "the environment of the classroom and the inhabitant of that environment namely learners and teachers are constantly interacting". Studies by Achor (2004: 25) suggested that teacher-learner interaction was a powerful force that can play a major role in developing cognitive and effective skills in learners. It has been shown that learners' experiencing high levels of interaction have shown higher levels of achievement than those experiencing lower level of interaction, and this serves as an important motivating factor that increases learners' satisfaction (King & Doerfert, 1996: 2 and Regalbuto, 1999: 3).

2.5.3 Teachers' behaviour and its influence on interaction

Wubbels and Levy (1993: 14) reaffirm the role and significance of teachers' behaviour in a classroom environment and in particular how this can influence learners' motivation leading to achievements. Herbert Walberg's Learning Environment Inventory (Anderson & Walberg, 1968: 177) and Rudolf Moos's Classroom Environment Scale (Moos, 1974; Moos and Trickett, 1974) were the first instruments developed to assess learners' perceptions of their classroom learning environment. Since that time, the influence of the learning environment and the teacher-learner interactions on educational process has received a great deal of attention, and there has been much progress in the conceptualisation, assessment and investigation of learning environment and teacher-learner interactions (Fraser, 1998: 533; Fraser, 2007: 112; Goh & Khine, 2002). The teacher-learner interaction should foster motivation towards learning and achievement.

Extensive research by Eschenmann (1991: 1) and others suggested that if teachers took the time to build relationship through interactions they could motivate their learners to learn. Other research by Whitaker (2004: 22) also suggested that teachers need to have a strong belief that building relationships are important to the motivation of their learners. Creating a positive classroom environment through teacher-learner interactions can promote positive relationships with healthy interactions that motivate learners to take part in laboratory work. Whitaker (2004: 26) further reiterated that the most important factor in evolving positive classroom learning environment is the teacher. As a leader in the class a teacher should set high expectations for their learners in their practical activities, but even higher expectations for themselves. There is a great need for these teachers to realise the importance of connecting emotionally with their learners in order for them to influence their mind to want to achieve more.

The teaching dynamic is a crucial factor in determining the content learners comprehend (Grouws, 1981: 6). During class time, the teacher establishes the pattern, speed, atmosphere and the level of interaction between the teacher and learners as well as between learners and learners. Learners on their part also establish certain types of behaviour to coincide with this pattern of the teacher. These interactional patterns of teacher's instructions and learner coinciding behavioural adaptation lead to specific classroom environment. Arends (2001: 9) is of the opinion that establishing authentic relationship patterns with learners is a prerequisite to everything else in teaching. Getzels and Thelen (1960: 21) suggested that teacher-learner interaction was a powerful force that could play a major role in influencing the cognitive and effective development of learners. For this reason it is imperative for the teacher to foster good relations among their learners because the learner perception about their teacher's behaviour in the classroom environment can influence learners' participation and, ultimately, their achievement.

It can be derived that it is important for teachers to have a caring disposition towards their learners, they should believe in their learners' ability to interact, learn and achieve in education. The level and quality of teacher's interpersonal behaviour and interaction is an indication of the quality of the leadership he/she offers in the classroom. Therefore, Arends (2001: 18) says that "effective teaching requires careful and reflective thought about what the teacher is doing and the effect of his or her action or interaction on learners' social and academic achievements".

2.5.4 Gender and teacher-learners interactions

Several studies have researched on how gender affects teacher-learners' interactions. According to Einarsson & Granstrom (2002: 121); Nicaise, Cogérino & Amorose (2006: 43); and Nicaise, Fairclough, Bois, Davis & Cogérino (2007:326) the gender of the teacher influences learners-teacher interactions in many ways. For example, Weiller & Doyle (2000: 44) found that male teachers initiated more verbal statements to girls and female teacher initiated more verbal statements to boys during class. Davis (2000: 51) also found that male teachers consistently had more interactions with female learners than with male. These teachers are unaware that they interact more frequently with the opposite sex than with the same sex, and that is why Schon's theory of reflective practice addresses teachers' lack of awareness of gender inequalities during their interactions with their learners (Schon, 2000:12). It is therefore imperative to sensitise science teachers on their own personal gender biases for them to examine their own pedagogical practices during class activities.

2.5.5. Questionnaire on Teacher Interaction

In order to gather information on teachers' behaviour in the class room, Wubbels, Creton and Hooymayers (1985: 35) developed the Questionnaire on Teacher Interactions (QTI) because it has the advantage of being used to gather perceptions of interpersonal behaviours of both learners and teachers. Another distinctive feature of this questionnaire is that it has the ability to measure perceptions of actual classroom environment from teacher-learner interactions, but also to measure perceptions of preferred classroom environment from these interactions. For these reasons, the OTI will be one of the best instruments to use in this study because it will help in understanding the teacher-learner interactions which will ultimately help to understand the Chemistry laboratory learning environment in Namibian schools. Since its inception, the QTI has been used in various countries and in different cultures the like in the USA, Netherland, Australia and Korea with all studies suggesting that it is a useful instrument to measure the teacher interactions in class, however, this time the focus will be on the Chemistry laboratories in Namibian schools. The QTI has been changed to meet the Namibian context and also to measure practical work related laboratory interaction and not the learning environment in a normal class.

2.6 The back ground on the Science Laboratory Environment Inventory (SLEI)

Various researchers over the years have used, developed and interpreted the SLEI instrument to fit different cultures and languages, (Fisher & Khine, 2006, Fraser, 2007, Goh & Khine, 2002 and Khine & Fisher, 2003 etc). This study aims at using and modifying the SLEI, to fit the Namibian content and culture. It is therefore imperative to say more on how the SLEI was used by various researchers all over the world and how it contributed to the learning of Science laboratory environment in the Namibian situation.

The SLEI was originally developed, field-tested and validated by various researchers in six countries in a collaborative effort. A total of 5447 learners from the six countries participated in the first use of the SLEI (Fraser et al. 1992; Fraser and McRobbie, 1995; Fraser et al. 1993). Due to the high level of reliabilities, strong character of factor analysis and abilities to differentiate between different classrooms' level of cognitive; the SLEI was later used in Queensland, Australia with 1594 Chemistry learners (McRobbie and Fraser, 1993: 79). From these various researchers, it is concluded that science laboratory class environments around the world were dominated by closed ended activities and these activities were dominated by female learners who tended to perceive science laboratory classroom environment somewhat more favourably than did male learners. According to Fraser & Lee the SLEI scale is divided in five parts, as shown in Table 2.2 below, which provides the description and sample of items for each scale in the Science Laboratory Environment Inventory (SLEI).

Table 2.2. Science Laboratory Environment Inventory

Scale	**Description**	**Sample item**
Learners cohesiveness	Extent to which learners are supportive of each other	I get along well with learners in this laboratory class (+)
Open-endedness	Extent to which laboratory activities emphasise an open-ended divergent approach to experimentation	In my laboratory sessions, the teacher decides the best way for me to carry out laboratory experiments (-)
Integration	The extent to which laboratory activities are intergraded with non-laboratory and theory classes	I use theory from my regular science class sessions during my laboratory activities (+)

Rule clarity	Extent to which behaviour in the laboratory is guided by formal rules	There is a recognised way for me to do things safely in the laboratory(+)
Material environment	Extent to which laboratory materials are adequate	I found that the laboratory is crowded when I am doing experiments (-)
Items designated (+) are scored 1, 2, 3, 4 and 5, respectively, for the responses Almost Never, Seldom, Sometimes, Often and Very Often Items designated (-) are scored 5, 4, 3, 2 and 1, respectively, for the responses Almost Never, Seldom, Sometimes, Often and Very Often		

Fraser & Lee (2009: 70)

Some researchers often reduce the items of the SLEI to suit the need of the research and the participants at the particular time and place. For example, Lightburn and Fraser (2007: 155) used the SLEI to evaluate the effectiveness of using anthropometry activities in Grade 9 and 10 Biology classes in the USA. They used only four of the five SLEI scales (with the Open-endedness being omitted). The learners' higher cohesiveness and Material Environment scale score was around $1/5^{th}$ of the standard deviation score for the experimental group than for the comparison group of Biology learners. The SLEI was also found to be valid for testing visitors to informal Science learning environments by Soper and Fraser (2006: 56) because of its ability to differentiate between classrooms and the reliability values as stated in Table 2.2 above. With regards to the record of prior research that used the SLEI in developed and developing countries like Europe, Asia and the USA it is highly expected that the use of SLEI can provide useful information on the nature of laboratory work in Namibia.

2.7 The underlying theoretical frame-work

The theoretical framework will be discussed by answering the following two questions:

1. What is the research problem?
2. Why is the chosen approach a feasible solution?

According to Kuhn (1962: 12), scientific practice is often controlled by conceptual framework, worldview or paradigm, that is highly resistant to change, and this established framework is rarely overturned by a single anomaly. Kuhn, further considered that science progresses through a paradigm shift, not necessarily in a particular direction or methods, but change does take place. There are two major types of phases that science undergoes according to Kuhn (1962: 14); normal science and revolutionary science. When science is in the normal phase the current paradigm dominates all scientific research and theory. When revolutionary science occurs, then the dominant paradigm is discredited and new ones are set up in its place. To answer the first question of the two above mentioned questions, we look back at the aims and objectives of the study as previously stated in Chapter one of this study; the research is seeking answers to the following questions:

a. What relationship exists between the laboratory learning environment and learners' attitudes to Chemistry practical?
b. How do learners perceive their learning environment in a Chemistry laboratory?
c. How does the teacher-learner interaction influence learners' attitudes in to Chemistry practicals?
d. How does the learner-learner interaction influence the learners' attitudes to Chemistry practicals?
e. How do learners perceive the interaction between them and their teachers during Chemistry practical work?
f. What are the characteristics of Chemistry practicals in Namibia?
g. What is the nature of the current laboratories in Namibian schools?
h. Are the Namibianised versions of the QTI and SLEI suitable and valid instruments for the use in Namibia?

Referring to the second question; why is the chosen approach a feasible solution? The researcher strongly considers the fraternisation of human behaviour formula proposed by (Lewin, 1936) and Vroom (1995) Expectancy Theory. The fraternisation of these two different models will help in addressing the problem from both a psychological and social perspective. Lewin was an American psychologist who was highly influenced by Gestalt psychology. Gestalt psychology is a school of thought that looks at the mind and behaviour of human being and how they are influenced by parts. The belief of Gestalt Psychology that the whole is greater than the sum of the individual parts and that the part-processes are themselves determined by the intrinsic nature of the whole can be used to study the behaviour of learners in Chemistry practical work. Lewin studied problems that influenced and motivated individuals and groups in a given situation and proposed a human behaviour formula: B= f (P, E), which explain (B) as human behaviour; is a function of both individual personalities (P) and environment (E). With this in mind, the study will consider the effectiveness of specific examples of practical work, or specific practical task to elaborate the influence and motivation of practical work problems on learners' behaviours. Millar, Marechal & Tiberghien (1999: 18) propose a model of the process involved in designing and evaluating a practical task, which is summarised in **Table 2.3** below:

Table 2.3 Model for designing and evaluating practical Tasks

Model	**Specific duties**	**Explanations**	**Examples**
Model A	Work out teaching learning objectives.	What the teacher wants the learners to learn.	Collection, analysis and interpretation of empirical evidence.
Model B	Design or develop a practical task.	To enable the learners to achieve learning objectives.	Investigation of rate of reaction between metals and acid.
Model C	Inquire what learners do to complete the task. Are they doing the correct thing?	The teacher should design questions that will be asked during the process.	Which reaction seems to be faster? What did you observe?
Model D	Inquire if the learner learn what the teacher originally intended.	Is there a correlation between what the teacher intended to do and what the learners learned?	Did the learners discover the relationship between surface area and rate of reaction?

Millar, Marechal & Tiberghien (1999: 18)

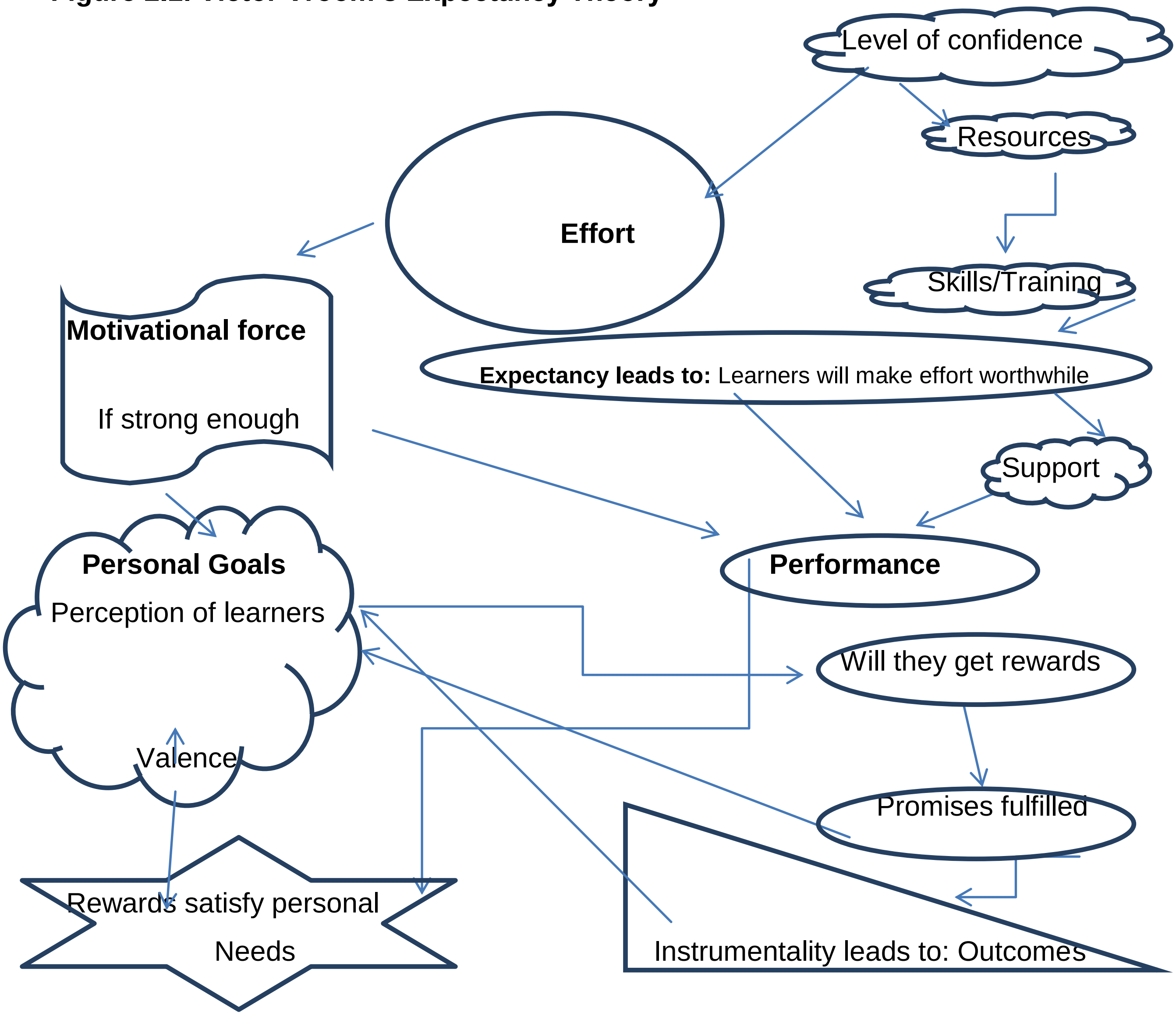
The starting point, model (A), refers to the teacher learners' objectives, what the teacher wants the learners to learn, this might be a specific aspect of scientific inquiry or a specific piece of substantive scientific knowledge. Model (B) the teacher selects or designs a practical task that might enable learners to achieve the learning objectives discussed in model A. In Model C the teacher asks what the learners are actually going to do when they are doing the prescribed task. Here, the teacher considers features like thinking, skills, conversations, understanding of instructions, relation between mental and physical actions. The last model D is concerned with what the learners learn, as a result of undertaking the task. Here, there are two areas of effectiveness that must be considered. The first one is "*did the learners learn what the teacher intended them to learn*" meaning, is there a link between what the teacher wanted the learners to learn and what the learners actually learnt. The second one, whether *the learners learnt to do what the teacher intended them to learn*, in other words whether there was a correlation between the skills that the learners acquired and what the teacher wanted them to acquire.

The "Victor Vroom's Theory" is chosen due to the fact that it is regarded as the best theory for exploring the significance of what goes on in the individual. It further explores the variables that influence achievement and motivation (Schunk, Pintrich & Meece, 2008). It postulates that individuals are motivated by the desire to experience positive, instead of negative outcomes (Vroom, 1995: 16), by emphasising three elements:

Expectancy, Valence, and Force see Figure 2.1 on the next page.

Theoretical Framework

Figure 2.1. Victor Vroom's Expectancy Theory



Vroom, 1995: 16.

The individual's conviction concerning the probability that a specific act will result in a specific and desired outcome becomes the expectancy of that learner (Vroom, 1995: 21). The argument here is that no matter the tasks from which an individual can choose, learners will not only select tasks for which the outcome is favourable, but also tasks for which they believe the outcome is possible. This table suggests that the high level of confidence propels learners to put more effort which will result in good performance provided that necessary support is rendered.

Vroom (1995: 17) describes a positive valence task as one in which a learner has the desire to attain good results in it, and a negative valence if the learner is trying to avoid the task or results. The task does not have valence at all when the learners are indifferent to the outcome. Valence therefore is the desire of a learner for or the "effective orientations towards positive or good outcome".

Force is the element which causes the individuals to act on what they believe about the possibility of achieving a good outcome for a task that they consider positively valent, or to avoid a task that they consider negatively valent. According to Vroom (1995: 18) the greater the expectancy that an act will lead to the desired outcome, the degree of how valent that outcome is, will affect the force to perform the act whether negatively or positively. The force called motivation will cease to exist without the individual expectation that he/she can be successful at the task, or if the individual considers the task to be too insignificant in value to expend the effort to achieve the task. The two very fundamental model theories of Millar, Marëchal & Tiberghein, (1999) and Vroom (1995), were interlinked according to Table 2.4.

Table 2.4 Millar, et al 1999 and Vroom1995 frameworks model

Millar et al 1999 framework model	Vroom 1995 framework model
Model A: What the teacher wants the learners to learn.	Personal goals: If strong enough learners will make effort worthwhile.
Model B: Design or develop a practical task.	Effort: Level of confidence, resources, skills/training and support.
Model C. Acquire what learners do to complete the task. Are they doing the correct thing?	Performance: Perception of learners: Will they get a reward; Is the promised fulfilled?
Model D: Did the learner learn what the teacher intended them to learn?	Outcomes: Valence, rewards satisfy personal needs, does it lead to personal goals of learner, teacher and the subject?

Millar, et al 1999 and Vroom1995

The above table shows the inter-linkages of theories to form a theoretical framework that the researcher took to answer the research question. If the teacher sets standards required and develops clear goals and objectives of what he/she expects the learners to achieve in a certain practical task, the learners will have high expectancy (Vroom, 1995: 21), which will nurture strong personal goals that result in worthwhile effort from the learners. It is imperative for the teacher to be able to design a method on how he/she will access not only the outcome of the task, but the procedures that the learners follow to come to the desired results. Learners should be rewarded for following the correct scientific procedures and arriving at the correct answers. The focus should not just be on getting the correct answer, but also on following and learning the correct scientific processes and skills that will enable them to apply to other situations in future. If the learner learns what the teacher intended them to learn and they are rewarded for their effort, this will lead to greater force called motivation (Vroom, 1995: 18).

The theoretical framework of this study also considered the phenomenography theory that implies that, different people will not experience the same phenomenon the same way (Orgill, 2007: 1). It, therefore, attempts to elucidate from the learners their understanding of their experiences in a Chemistry laboratory through questionnaires. The role of the researcher in a phenomenographic study is to describe the variations in understanding of a set of participants experiencing a particular phenomenon to establish a collective meaning (Barnard, et al. 1999: 214). This is achieved exclusively through participant self-reports, primarily through interviews (Orgill, 2007: 1). These interviews may or may not be formal, but should serve the purpose of getting more understanding of how they perceive the given situation. Besides being essential to phenomenographic studies, self-reports are considered a common method of data generation for a number of different types of qualitative inquiries (Lawrenz, Huffman, and Robey, 2003: 415) and possess the following identified strengths (Fraser and Walberg, 1981: 77; Huffman, Lawrenz, and Minger. 1997: 788):

- Learner’s perceptions are based on the complete experience, not just on a limited number of observations or surveys.
- The perceptions of all the learners participating in self-reports can be pooled together and analysed.

- What the learner perceives may be of more significance than what an outsider would observe.
- Learner’ perception data can be analysed to provide information about the perceptions of different learners within the same class.

2.8 Conclusion

This chapter has revealed that there are different types of learning environments that can contribute to the conceptual understanding and growth of the learner during laboratory work. According to Wiestra, Kanselaar, Van der Linden, Lodewijks and Vermunt (2003: 511) in order to develop a high level of learning among learners, it is critical to apply learners oriented learning environment that fosters critical thinking, rather than a learning environment that encourages memorisation of facts without understanding because this will lead to learners learning passively and unproductively.

Most researchers agree that practical work should be part of any science curriculum for meaningful learning to take place in science. Practical work is an essential component of science teaching and learning, both for the aim of developing learners’ scientific knowledge and that of developing learners’ knowledge about science.

Further, it may be concluded that the establishment of warm, positive, healthy teacher-learner relationships may be more crucial in these contemporary times of volatility, uncertainty and complexity in the education system in Namibia. There are numerous variables which determine, to differing degrees, the ‘success’ of any particular learning environment and one of the key variables is the nature of the learner-teacher interaction.

Chapter 3

3.1 Education systems in Namibia

3.1.1 Introduction

The education systems in Namibia stem from a dark history of 300 years of South African colonial oppression. During this time of apartheid the education system was designed to favour the white minority. With independence in 1990, the Government of the Republic of Namibia introduced extensive reforms in order to eliminate these disparities, by allocating annually up to 28% of the government budget to the education sector (Fischer, 2010: 3).

Although the Namibian government aspires to make transition from poor education and economic background to high value-added and knowledge based economy, the acute skills shortage in the country's labour market currently impedes the realisation of these national development goal and vision 2030 (MCA Compact, 2008: 1). A legacy of severe historical inequities in access to education, coupled with an ineffective education and training system, continues to affect the quality of education in Namibia from the primary to the secondary and tertiary levels (MCA Compact, 2008: 1). This chapter focuses on the education system in Namibia and how it influences and affects the teaching and learning of Chemistry practical work as well as the learner-teacher interaction in a Chemistry class.

As narrated earlier in Chapter 1 the education system in Namibia is divided in three types: formal, non-formal and tertiary education. Formal education has five levels that learners should go through, pre-primary, junior primary, senior primary, junior secondary and senior secondary education. From first year in primary school to the last year in secondary school it takes 12 years to complete. Non-formal education in the Ministry of Education has taken the task of improving literacy level among the nation. Tertiary education in Namibia focuses on after school qualifications and vocational training of school dropout or graduates.

3.2 Chemistry education in Namibia

Education refers to the way people acquire skills and gain knowledge. Namibia as a country that is emerging out of imbalances of the past has embarked upon the formation of educational policies that address the primary objective of the education system. Promulgated in December 2001, the education policies on sustainable development aim at among other things to provide accessible, equitable, qualitative and democratic national education service (Adejoke, 2007: 1). The above four mentioned points are further explained in the NIED Document (2003: 5-6) as follow:

- **Accessible** does not only mean getting all Namibian children to school but, also making knowledge and understanding accessible to them. This means that what they learn, and how they learn, has to be approached in such a way that all learners can develop as fully as possible, and achieve the best of their abilities.
- **Equitable** education means that learners are not only treated equally, but where there are inequalities, measures are taken to redress them. This is particularly true in terms of gender, race, and social class where there can be overt and covert prejudice, or bias, or assumptions. It is not only the question of the teacher treating the learner equitably, but also brings up the learners to treat each other equitably.
- **Quality** means that the relevance, meaningfulness and reasonableness of challenge in education are in the forefront. The curriculum, the teacher, materials and the learning environment should all be of high standards. Those standards should be definite so that the quality of education can be monitored and improved where necessary.
- **Democracy** means that education should be democratically structured, democracy should be taught and experienced, and the aim should be to promote democratic principles in the society.

There are enormous technological changes taking place in Namibia and the world at large, with regard to education. These make it difficult for educators and curriculum developers to predict which knowledge and skills will be useful in the future. That is why Adeyoke (2007: 23) emphases that "learners need to know how to find the information they will need and to see for themselves what fit their situation. By doing this, they will learn to think for themselves and become independent thinkers."

Chemistry by nature involves creativity and experimental activities that are fuelled by observation and inquiry methods of learning. That is why it is referred to as experimental science or central science because many important branches of further studies emerge from Chemistry, e.g., medicine, engineering, agriculture and earth science (Brown, 2000: 2). The development of Namibia as a nation that aims at becoming an industrialised nation by 2030, needs specialised knowledge and skills in areas like medicine, agriculture, water, fertilisers, paints, chemicals and health which are all tied to Chemistry education as an important subject for economic development. These make Chemistry an important subject in schools (Jamison, 2001:3).

Chemistry gives learners the opportunity to acquire and develop basic scientific skills and knowledge that they can apply to new life situations they face. The basic scientific methods of inquiry developed through Chemistry in learners can be easily applied to other subjects in solving problems; and also be used in helping learners cope with the ever changing technological development that has become so much part of our lives (Jamison, 2001: 3).

3.2.1 Chemistry at School level

Teaching Chemistry presents many challenges and problems in a majority of countries around the world and Namibia is not an exception. Research shows that Chemistry is one of the complicated, boring and declining subjects in terms of enrolment and interest at comprehensive school level (Gedrovics, Wareborn & Jeronen, 2006: 79 and Seetso & Taiwo, 2005: 8). Most Natural Science Primary School teachers show lack of competence in teaching the subject and developing materials for practical work (Lamanauskas, Vilkoniene and Vilconus, 2007: 59). Yet this is the most crucial state in the development of learner's mind and interest for future career choice. The level of propaedeutic knowledge on Chemistry acquired at this stage of primary education is crucial to the learners' Chemistry knowledge.

The teaching of Chemistry in Namibia starts at an early age of junior primary school level, where it is known as Integrated Natural Science education. The term

“Chemistry” is, however, not used until at the junior secondary phase. Chemistry content intensifies with in Integrated Natural Science at senior primary level and it becomes more detailed in Junior Secondary and Senior Secondary level. Physical Science at Junior Secondary, level comprises of two sections; Physics and Chemistry. At the junior secondary level, the syllabi require intensive detailed practical work for each topic taught. At the senior secondary level the syllabi run over a two year period of Grades 11 and 12 with two levels of content (Higher level or Ordinary level) that learners must choose. The curriculum also makes provision for more practical work by allowing more time to practical work in the subject time allocation. This is also the same in South Africa whereby a subject like Physical Science has more teaching hours compared to others (Curriculum and Assessment Policy Statement 2011: 6). Learners who wish to continue with Chemistry at tertiary level can do so at universities, polytechnics, colleges or vocational training institutions.

3.2.2 Physical Science Subject policy

The purpose of the subject policy is to guide subject management in schools, but also leave scope for the teacher to be able to take his/her own initiative, especially in presenting the subject content and in facilitating learning (National Subject Policy for Physical Science, 2009: 1). The aim of the subject policy is to:

- provide guidelines for subject managers in controlling teaching and learning activities;
- guide teachers in organising their administrative duties and in planning teaching and learning to meet the expectations of the national standards and performance indicators;
- provide guidelines for the effective teaching and management of Physical Science in the Junior and Senior Secondary phase at National level;
- list some roles, responsibilities and accountability of the department heads, subject head and teachers within the Physical Science department of the school; and

- provide an effective teaching of Physical Science in cooperation with existing manuals, policies, guides and procedural documents (as listed in the appendix) (National Subject Policy for Physical Science, 2009: 1).

Unlike the South African Physical Science policy, the Physical Science policy in Namibia does not have statements on how it will develop the learners through studying Physical Science that involves Physics and Chemistry. The South African Physical Science policy has the following aims with regards to the South African learners (Physical Science Subject Policy, 2011: 3).

- Giving learners the ability to work in Scientific ways or to apply scientific principles which have proved effective in understanding and dealing with the natural and physical worlds in which they live;
- Stimulating their curiosity, deepening their interest in the natural and physical worlds in which they live and guiding them to reflect on the universe;
- Developing insights and respect for different scientific perspective and a sensitivity to cultural beliefs, prejudices and practices in society;
- Developing useful skills and attitudes that will prepare learners for various situations in life, such as self-employment and entrepreneurial ventures and;
- Enhancing understanding that the technological applications of the Physical Sciences should be used responsibly towards social, human, environmental and economic development both in South Africa and globally.

According to the National Subject Policy for Physical Science (2009: 2), the Namibian government has implemented Physical Science in their curriculum to accomplish the following goals among the learners:

- acquire understanding and knowledge in Physical Science through a learner-centred approach;
- acquire sufficient understanding and knowledge to become confident citizens in the technological world;
- caring about the environment;
- take or develop an informed interest in matters of scientific importance;
- develop an awareness that the study of science is subject to social, economic,

technological, ethical and cultural influences and limitations, and that the application of science may be both beneficial and detrimental to the individual, the community and the environment; and

- be suitably prepared for studies beyond the Secondary level in pure sciences, in applied science or in science-dependent vocational courses.

In the subject Policy there is a comprehensive guideline on what the syllabi should provide in the teaching and learning of Physical Science in Namibia. A syllabus is a course description for a subject within the curriculum. It is a concise and general statement of intended learning which describes the following:

- the *purpose* of the subject - these are the rationale and aims which give the reason for and direction of the course;
- the *content* of the subject - this is described in terms of themes and topics;
- *objectives*, defined in terms of what learning is intended to happen at the level of a subject;
- *competencies* are the significant cognitive operations, skills, attitudes and values which all learners should be able to demonstrate, and which can be assessed; and
- *assessment* describes how learner achievement will be *assessed* and how the course will be *evaluated.*

It is the duties of school principals, managements and subject head to see to it that subject Policies of the ministry of education are implemented at class level and that all clauses are fully operational in their schools. This will help in the achievement of the Ministry of Education goal and objective in Physical Science.

3.3 Roles of the Namibian Government in providing education

Since independence in 1990 the Namibian government through the Ministry of Basic Education has provided the following structure and programmes in order for all Namibians to have access to education, (Education for All, National Plan of Action, 2001-2015, 2002; National Report on Development in Namibia, 2004 & Keyter, 2002: 2):

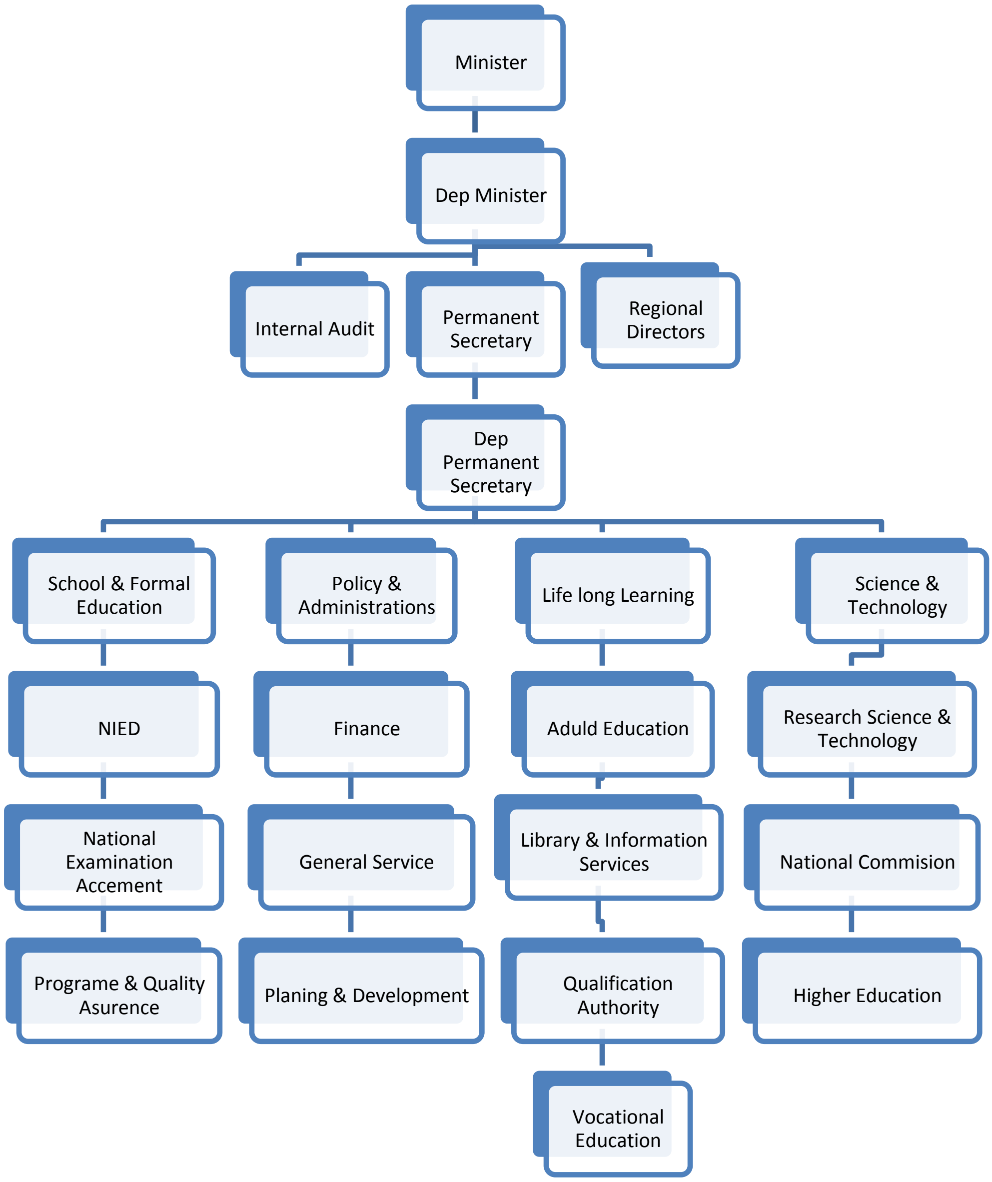
a) Replacement of pre-independence Bantu education with new democratic based pedagogical methods of education;
b) Total reformation of educational issues after independence with focus on "Toward Education for All" (TEFA) as the major objective;
c) Amalgamation of education authorities into a unified body;
d) The establishment of two Ministries for the Namibia Education sector: Ministry of Basic Education (MBESC) and Ministry of Higher Education Vocational Training Science and Technology (MHEVTST) (The two ministries re-combined, March, 2005);
e) Free and Compulsory Primary education for all Namibians regardless of any social, economic or ethnic back ground (Implemented in 2013);
f) Introduction of semi-automatic policy in 1996, whereby learners are allowed to repeat only once in the school phase, except in Grade 10;
g) Establishment of Namibia College of Open Learning (NAMCOL) to cater for Grade 10 and 12 drop outs on a distance level;
h) Use of Continuous Assessment (CA) as criterion-based estimates of learners' progress;
i) Establishment of National Inspectorate as a watch dog to guarantee quality education in the school system; and
j) Establishment of non-formal education through lifelong learning, which is targeted at adults and out-of-school youths, with literacy as focal point.

All these initiatives have been enhanced by the recently held National Education Conference which came up with the following recommendations and objectives (National Education Conference document, 2011: 2):

a) provide an in-depth analysis of the current state of the Namibian education and training system at all levels (pre-primary, primary, secondary, vocational, higher education);
b) identify deficiencies in the current education and training system;
c) seek consensus on major and large areas in need of improvement in order to deliver quality education and training at all levels;
d) develop resolutions from the conference proceedings which form the basis for developing a road map towards comprehensive reforms of the Namibian education and training system.

The Ministry of Education, in an effort to decentralise education structures and bring offices close to the regions, created four main departments: School and Formal Education; Policy and Administration; Life Long Learning; and Tertiary Education, Science, and Technology. These departments are further structured in different directorates as shown in the Ministry of Education organogram in Figure 3.1 below:

Figure 3.1 The organogram of Ministry of Education (Namibia)



Apart from these new structures for educational improvements, there are other bodies that help with the improvement of education, e.g., NIED (National Institute for Educational Development) for developing curriculums of subjects and ETSIP (Educational Training Sector Improvement Programme) for planning and implementing government strategic plans and policies. NIED aim at the improvement of educational quality, with four main functions:

- Curriculum development for schools and colleges;
- Pre-service/in service professional development for teachers;
- Material development, and
- Research primarily related to curriculum monitoring and evaluation.

Situated in Okahandja the capital city of Otjozondjupa Region, NIED is structured to link with national and regional teachers' professional development committees, teacher advisers, and teacher recourse centres, once per year (NIED, 2003: 3). Through the meetings of these committees, policies and documents are discussed with regard to NIED's responsibly and roles that it plays in educational development. In 2005, the Ministry of Education launched what it called its key initiative to educational improvement called Educational Training Sector Improvement Programme (ETSIP). The main aim was to increase the efficiency of the education and training system (MCA Compact, 2008: 7). This programme is intended to increase the number of skilled and trained Namibians through focus on improving educational qualities. ETSIP is subdivided into the following sub-components: Early Childhood development and Pre-Primary education, General education, Vocational education and Training, Knowledge and innovation, Information and Communication Technology in Education, HIV/AIDS, and Capacity Building.

Providing education in rural schools is one of the greatest challenges faced by the Namibian government. According to FAQ, (2005: 2) the majority of the world population in developing countries lives in rural areas with Agriculture as the major source of income. The major challenges facing rural schools are: lack of buildings for classrooms, lack of electricity and lack of textbooks. For example, less than 50% of schools in northern Namibia do not have electricity (MCA Compact, 2008: 17). According to the report, such shortages limit the teaching of subjects like science and IT which need electricity and materials. There is also a severe shortage of qualified teachers in these regions that hinders the effective teaching and limits development of skills in Science (MCA Compact, 2008: 21). Signs of improvement in the education sector are there, even in remote areas e.g.:

- Compulsory school attendance up to the age of 16 years or up to end of Grade 10 has been to a large extent, achieved;
- Equal access to education regardless of tribe, colour, economic or past educational background has been well addressed;
- 95% enrolment in primary schools has been attained by 2011;
- 82% of learners reach the end of primary school (free education);
- More schools and classrooms have been built between 2008 and 2011;
- More qualified teachers have been employed in rural school since 2009; and
- Learner teacher ratio remains a problem with some schools reaching 45 learners per teacher.

Despite all these efforts by the Ministry of Education to improve education in Namibia, the education system in Namibia still faces serious challenges, e.g.:

- Coverage and provision of quality education in all the 13 regions of the country;
- Adequate provision of educational resources through decentralisation to all schools;
- Provision of sufficient number of text books to all schools; and
- Improvement of Grades 10 and 12 results (Heita, 2012: 2).

3.3.1 Namibian Science Curriculum/Syllabi

The Namibian Physical Science curriculum has put great emphasis on learner-centred education and practical work investigations (Kachinda & Ajayi, 2009: 6). The curriculum has further differentiated between general objectives and specific objectives (Kachinda & Ajayi, 2009: 5). The responsibilities rest on the teacher, to translate these objectives in-to meaningful reality to the learners. These objectives can only be meaningful if they are measured, meaning the teacher should be able to observe that learners have attained the objectives through the use of assessment in a form of a test or examination and/or by learners conducting an experiment or other practical observable tasks that demonstrate understanding. According to Kachinda & Ajaji (2009: 6), the Namibian Physical Science Syllabi put strong emphasis on the learners' existing knowledge, skills, interest and understanding of phenomenon.

These previous knowledge skills and experience serve as the foundation for learning new knowledge and skills by building up on what they know.

The Namibia Senior Secondary Certificate syllabus for Physical Science, therefore, intends to:

- develop values and attitudes, as well as knowledge and skills among learners;
- promote self-awareness and an understanding of the attitudes, values and beliefs of others in a multilingual and multicultural society;
- encourage respect for human rights and freedom of speech;
- provide insight and understanding of crucial global issues in a rapidly changing world which affect the quality of life such as the HIV/AIDS pandemic, global warming, environmental degradation, distribution of wealth, expanding and increasing conflicts, the technological explosion and increased connectivity;
- recognise that as information in its various forms becomes more accessible, allowing learners to develop higher cognitive skills of analysis, interpretation and evaluation in order to use information effectively; and
- seek to challenge and motivate learners to reach their full potential and contribute positively to the society, economy and environment, (Kachinda & Ajayi, 2009: 7).

The syllabus also intends to encourage learners to develop the following skills, (NSSCH Physical Science Syllabus, NIED, 2005: 1):

- communication skills;
- numeracy skills;
- problem-solving skills;
- self-management and competitive skills;
- work and study skills;
- critical and creative thinking skills;
- investigative skills; and
- organisational and analytical skills.

With regards to practical work in Chemistry, the Broad Curriculum and the Physical Science Syllabi require the following objectives to be attained by learners, (NSSCH Physical Science Syllabus, NIED, 2005: 2):

I. follow a sequence of instructions, use appropriate techniques, handle apparatus/material competently and have due regard for safety;
II. make and record accurate measurements, observations and estimates;
III. handle and process experimental observations and data, including dealing with anomalous or inconsistent results;
IV. apply scientific knowledge and understanding to make interpretations and to draw appropriate conclusions from practical observations and data; and
V. plan, design and carry out investigations (based on concepts familiar to learners) and suggest modifications appropriate to the level and experience.

According to the NSSCH Physical Science Syllabus, (NIED, 2005: 1), the overall aim of the syllabi is to equip learners with the necessary knowledge, skills and attitudes that will enable them to successfully enter tertiary education, or the labour market. The syllabi aim at accomplishing these by increasing the learners' knowledge and understating of Physics and Chemistry as part of the syllabi. The learners have to understand how the people use the natural environment for survival and how the environment changes as a result of human activities on earth. According to NSSCH Physical Science Syllabus, (NIED, 2005: 2) critical thinking, investigating phenomena, interpreting data, and applying knowledge to practical (experimental and investigative) skills and abilities are essential for understanding the value and limitations of natural scientific knowledge and methods and their application to daily life. This is why in the (NSSCH Physical Science Syllabus) the Chemistry practical part of the syllabi requires learners to carry out exercises involving:

- quantitative experiments requiring the use of a pipette, burette and an indicator such as methyl orange or screened methyl orange; if titrations other than acid/alkali are set where full instructions and other necessary information will be given;
- rates of reaction;
- measurement of temperature based on a thermometer with 1ºC graduations;

- problems of an investigatory nature, possibly including suitable organic compounds;
- simple paper chromatography;
- filtration; and
- identification of ions and gases as specified in Sections 5.4 and 5.5. (The question paper will include Notes for use in Qualitative Analysis for the use of learners in the examination; see Annexure 4). (NIED, 2005: 56).

Learners are not required to carry out weight measurements for the Practical test. These practical exercises are assessed and awarded marks according to these levels, considering the following:

- Marks (1-6) are being awarded for each of the experimental skills in terms of the Performance Criteria Descriptors;
- Each skill is assessed on a 6-point scale, level 6 being the highest level of achievement;
- Each of the skills are defined in terms of three levels of achievement at scores 2, 4 and 6. A score of 0 is available if there is no evidence of positive achievement for a skill (i.e. no work is submitted);
- For learners who do not meet the criteria for a score of 2, a score of 1 is available if there is some evidence of positive achievement;
- A score of 3 is awarded for learners who go beyond the level defined for 2, but who do not meet fully the criteria for 4; and
- Similarly, a score of 5 is awarded for those who go beyond the level defined for 4, but do not meet fully the criteria for 6. (NIED, 2005: 57).

It is worth noting that the assessments are based on the principle of positive achievement, which means learners should be given opportunities to demonstrate what they understand and can do. It is expected that learners will have had opportunities to acquire a given skill before assessment takes place.

3.4 Learner Centred Education (LCE)

Although, the origin of Learner Centred Education (LCE) can be traced back from 551 B.C. to 479 B.C by some well-known philosophers like Confucius, Pestalozzi, Jean-Jacques Rousseau and Colonel Francis Parker (Henson, 2003: 3) the concept of Learners-Centred Education has only been practised recently in Namibia, (Kapenda, 2007: 191). Although several studies from 1997 to 2002, e.g.: Learner-centred education in Namibia: A case study (Chaka, 1997: 33); Beginning teachers' perceptions of learners-centred approach to teaching in Namibia (Sibuku, 1997: 22); Learner-cantered education: Development of teachers' concepts and practice of teaching in the context of Namibia school reform (Shinyemba, 1999: 48); Learner-centred education: equal group work? Findings from Namibian classroom (van Graan, 1999: 125); Learner-centeredness and group work in Second Language teaching: A shattered dream (Shaalukeni, 2002: 19) and In-Service education and classroom practice: Geography teaching in Namibia (Mutwa, 2002: 35), their focus was on primary education and basic education in general, with no specific focus to science education. The bold policy document phrases learner-cantered education in such a way that all should understand it and follow it in achieving the Namibian education goal:

"As we made the transition from educating the elite to education for all we are also making another shift, from teacher-centred to learner centred education … What teachers do must be guided both by their knowledge of the concepts and skills to be mastered and by the experiences, interest and learning strategies of their learners. Our challenge is to harness the curiosity of learners and the excitement of learning rather than stifling them …" (Ministry of Education and Culture, Namibia, 1993: 10).

Learner-Centred Education is defined by McCombs and Whisler (1997: 9) as: "The perspective that couples a focus on individual learners (their heredity, experiences, perspectives, backgrounds, talents, interests, capacities, and needs) with a focus on learning (the best available knowledge about learning and how it occurs and about teaching practices that are most effective in promoting the highest levels of motivation, learning, and achievement for all learners.)". In general the term LCE embraces terms like: active learning, exploration, self-responsibility, learners' prior knowledge and skills as well as the fundamental construction of knowledge rather than passive participation of learners in the teaching and learning process (Woelfel, 2004: 1). It, therefore, places the responsibility for learning on the learner, while the instructor assumes responsibility for facilitating the learner's education. This approach strives to be individualistic, flexible, competency-based, varied in methodology and not always constrained by time or place, (Gunderman, Williamson, Frank, Heitkamp and Kipfer, 2003: 16; Henson, 2003: 5; Mahendra, Bayles, Tomoeda and Kim, 2005: 8).

In Namibia LCE was introduced as a foundation policy of the new education system in 1991, (Swarts, 2002: 2). Although during its infant stage, LCE was met by many inconsistencies like: lack of clarity about what the underlying principle and theories of LCE are; overcrowded classrooms; non-conducive physical environments and insufficient teaching and learning materials especially in science practical lessons (Swarts, 2002: 2), much of these short comings are overcome through in-service training and workshops. Thekwane (2001: 1) regards LCE as a means of achieving the goals of the Ministry of Education in Namibia. Due to the ever increasing scientific and technological world, the changing demands from Namibian society and the continual development in the field of technology and education around the world, the need for innovative science curriculum in Namibia after independence is overdue.

3.4.1 The need for Chemistry teachers to use learner-centred approaches in their teaching

Strong, evidence from research exists to support the implementation of learner-centred approaches instead of teacher-centred approaches (Kapenda, 2007: 192). Knowledge of learner-centred education helps teachers to defend their teaching methods to their learners. Chemistry is known to be a practical subject, and using a learner-centred approach to teach and explain phenomena will be an added advantage. This can be done through demonstrations, projects, group work and explorations, as phenomena that support learners-centred education. A few years back, a task force of the American Psychological Association integrated the learner-centred education into six Learner-Centred Psychological Principles which can be summarized through the following five domains (Alexander & Murphy, 2000: 25 and Lambert & McCombs, 2000: 4):

I. *The knowledge base.* The conclusive result of decades of research on knowledge base is that what a person already knows largely determines what new information he attends to, how he organises and represents new information, and how he filters new experiences, and even what he determines to be important or relevant (Alexander & Murphy, 2000: 32). This is true for Chemistry practical activities;

II. *Strategic processing and executive control*. The ability to reflect on and regulate one's thoughts and behaviours is an essential aspect of learning. Successful learners are actively involved in their own learning during practical activities, monitor their thinking, think about their learning, and assume responsibility for their own learning (Lambert & McCombs, 2000: 5);

III. *Motivation and effect*. The benefits of learner-cantered education include increased motivation for learning and greater satisfaction with the school; both these outcomes lead to greater achievement. Research shows that personal involvement, intrinsic motivation, personal commitment, confidence in one's abilities to succeed in doing experiment, and a perception of control over learning lead to more learning and higher achievement in school science (Alexander & Murphy, 2000: 47);

IV. *Development and individual differences*. Individuals' progress through various common stages of development is influenced by both inherited and environmental factors. Depending on the context or task, changes on how people think, believe, or behave are dependent on a combination of factors such as one's inherited abilities, stages of development, individual differences, capabilities, experiences, and environmental conditions (Alexander & Murphy, 2000: 49);

V. *Situation or context*. Theories of learning that highlight the roles of active engagement and social interaction during practical investigation in the learners' own construction of knowledge (Kafai & Resnick, 1996: 67) strongly support this learner-cantered paradigm; and

VI. *Learning is a social process*. Many environmental factors including how the teaching is done, and how actively engaged the learners are in the learning process, positively or negatively influence how much and what learners learn (Lambert & McCombs, 2000: 9).

The new Grades 11 and 12 syllabi also insist that students should be actively involved in learner-centred practical work that emphasizes the process skills of using and organizing techniques, apparatus and materials, observing, measuring and recording, handling experimental observations and data and planning investigations

(NIED, 2005: 51). These skills transcend every topic in the syllabus and are to be assessed throughout the course teaching and examined in the final practical examinations. It is, therefore, assumed that students will need these skills wherever they go, whether in science fields, technology, industry or as common citizens.
The following four notions were central to learner-centred education theories:

- education should meet the needs of those being educated;
- these needs would be best met if identified with the interests of children;
- the curriculum should be based on experience and discovery; and
- rather than being subject or content based educational programmes should focus on activities.

While these notions are not to be discarded and indeed do have great value within and for learning, they have also let to distortions, misconceptions and myths that have 'infiltrated' the learner centred-classroom. Among the most pervasive of these are the beliefs that:

- teachers do less work than the learners;
- factual recall of any sort is of no worth;
- as long as learners are busy they are learning;
- all transmission teaching is poor teaching;
- children only develop at their own pace and that they have definite and fixed stages of development;
- only certain types of learning experiences are suitable for certain age groups;
- learners know what is best for them.

Learner-centred education not only caters for the abovementioned notions but according to (Barends, 2004: 3) disciplines are strengthened in class. When learners are actively involved in decision making and sharing responsibilities, they tend to co-operate, become more enthusiastic about their work and at times also enforce discipline among themselves. These aspects imply that the learner-centred approach in teaching Physical Science which entails Chemistry will help learners apply knowledge and skills by listening critically, organise and summarise information, investigate, interpreted and communicate information in a form of answering examination questions and doing practical investigations.

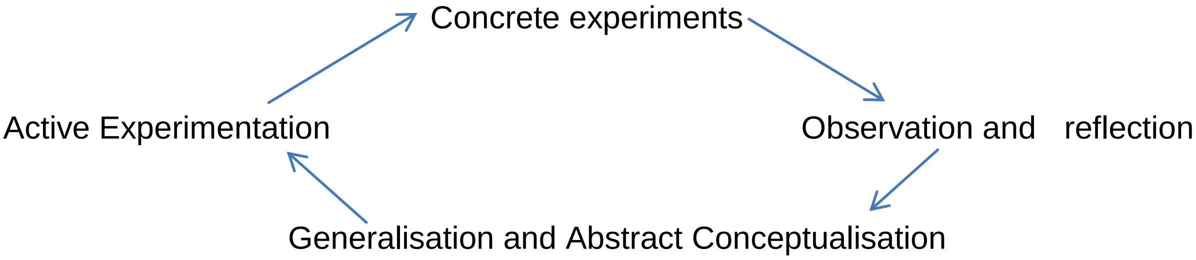
Furthermore, learner-cantered education allows learners in laboratories to become more responsible in shaping and administering positive learning environments due to the role of being seen as co-workers or co-experimenters with their teachers (Stears & Malcolm, 2005: 23). This is due to the understanding that the failure or success of experiments does not entirely rest on the shoulder of the teacher but to all who participate. Learning Chemistry through practical work is therefore important but it is not necessarily the best way because if the results of the experiments are wrong, it usually confuses learners, and learners tend to see the teacher as a failure or not knowing the subject. In situations like these, some teacher usually explain "the supposed to be" correct results and processes with some justifications on why the results might be wrong. The understanding of learners in this regard become one of being accepted as human error, respected, trusted, and most importantly partners with the teacher doing the experiment.

3.5 Teaching and learning

Although the emphasis in the Namibian education system after independence was on learner-centred approach to be implemented at all schools, it does not mean that it was implemented at all schools (Ministry of Education, 1993). As Namibia is focussing on *education for all* by the year 2015 (Barrow, Leu & Van Graan, 2006: 1), it has become imperative for Namibia to simultaneously introduce complex reforms in teaching and learning especially in the Science curriculum. The syllabi and curriculum developers have focused on understanding of complex interactions that take place in the classroom (ADEA, 2005; USAID/EQUIP2, 2006, and UNESCO, 2006).

The teaching process that allows learners-centred education put its emphasis on the fact that if learners are able to bring theories in to practice, they will easily grasp the concept and apply it to their own lives. This phenomenon is strongly supported by Kolb's learning theory (Kolb, 1984: 30):

Figure 3.2. Kolb's learning theory



As this theory explains, it all starts with concrete experience that learners possess either from past experiences or learning. As the learners participate and experience these events, they must constantly reflect upon the issues that they are doing in class (Reflective observation). As they are doing project work, practical and group work these learners must constantly formulate ideas on how the world works for them, or at the very least, how the world works for someone else (abstract conceptualisation). Consequently these learners will take these ideas and apply them to experience that they have or might have in the future (active experimentation). When these types of teaching and learning approaches occur, the issue of learners-centred education happens. These types of teaching and learning can only occur if the teacher encouraged interactions among learners, which enhance their communication skills, leadership skills teamwork skills, and management skills. Active learning supported by learners-centred education, therefore, occurs when:

- learners are intending to understand materials for themselves;
- learners are vigorously and critically interacting with content;
- learners are relating ideas to previous knowledge and experience;
- learners are using and organising principles to integrate ideas;
- learners are relating evidence of their findings to integrate ideas; and
- when what they have experienced and learned can be examined in theoretical examination.

Perceptual psychology suggests that through learner-centred approach teaching and learning can nurture the development of positive self-concepts by (a) assigning problems that challenge learners to think and reason within their abilities, (b) encouraging them to succeed in their learning and (c) recognising learners' success through marking and awards (Henson, 2003: 5). According to Kapenda (2008: 17) the term learner-centred education and learner-centred teaching can be used interchangeably because both terms describe learning that has the learner at its centre.

3.5.1 Science teaching in Namibia

On the onset it is worth mentioning that there is a vast difference between knowing about a topic (content knowledge), and knowing about the teaching and learning of that topic (pedagogical content knowledge). Some knowledge about teaching and learning Chemistry is specific to the particular subject matter, the skills of teaching stereoChemistry, for example, are different from those of teaching thermodynamics and these vary from grade level to grade level. According to the implications of science education research modern pedagogy should encourage:

(a) Active and constructivist teaching and learning;

(b) Meaningful and conceptual understanding;

(c) The development in students of practical abilities;

(d) The connection of science with everyday life;

(e) A spiral curriculum;

(f) The cultivation of higher-order cognitive skills, such as critical thinking.

(Tsaparlis, Tsoulos & Kampourakis, 2011: 3)

Deriving from the past political dispensation, the teaching of Science and Mathematics in Namibia was only for the minority whites (Mkandawire, 2009: 1). These inequalities were also in the science teacher training programme at tertiary level where in 1988 statistics shows that 70-90 % of black teachers in Namibia were unqualified, while 99-100% of the white teachers were qualified (Ottevanger, Macfarlane & Clegg, 2005: 37). These untrained teachers resulted in poor learners' achievement in the black communities, and according to Ottevanger et al (2005: 37), the Namibia situation of Mathematics and Science was so desperate that the government implemented the In-service Training and Assistance for Namibian Teachers (INSTANT) Project to remedy the dire situation.

According to one report called, Office of the President (2004: 64), the government is committed to the implementation of effective Science teaching in all schools in the

country. The aim is to motivate and increase the enrolment figures in the field of science both at school and tertiary level. This initiative was followed by the introduction of (MASTEP) Mathematics and Science Teacher Diploma (Fischer, 2010: 5) at the University of Namibia. Through this process Science teachers were given a two year post diploma training at the cost of the government and donor organisations like EU, USAID, the Bank of Luxembourgian Development Aid (Fischer, 2010: 1). The teaching of Science in Namibia is of outmost importance to the government and that is why it was gazetted in the overall government Vision 2030 (Office of the President, 2004: 63). The government envisages a prosperous industrialised Namibia, developed by its human resources, enjoying peace, harmony and political stability by the year 2030. In order to achieve this vision it is imperative for the government to train and develop the science sector in order to have enough engineers, scientist and professionally qualified work force that will carry the vision.
With the Physical Science curriculum in Namibia, Science has become a subject that should be taught with great emphasis on practical activities. There are two underlying reasons for this belief: First, science is considered to be more than a body of knowledge to be acquired. This infers that science process skills are considered equally important and that the teaching and learning of science should cater for the development of practical skills during practical investigations. Secondly, the current constructivist views of learning, consider learning as active participation on the part of the learner.

The learner is considered as an individual who actively constructs his/her knowledge based by engaging in learning activities (Al-Naqbi & Tairab, 2005: 20). Therefore, practical work in Namibian schools is expected to provide learners with the opportunity to construct scientific knowledge based on personal involvement in designing experiments that will solve real life problems, collecting data from observations and analysing data by drawing conclusions. This is why the Ministry of Education has put much effort in the development of exemplary teacher support materials, which provide Science teachers with detailed lesson plans and suggestions on how to put the curriculum topics in to practical work in the classroom (Ottevanger et al, 2005: 41).

With the introduction of teaching and learning through practical work in the schools in Namibia, it seems that the Ministry of Education has come to realise the role and extent of practical work to the development of learners' scientific literacy in Namibia. According to Al-Naqbi & Tairab (2005: 21), practical work is one perspective that could lead to learners engagement and active participation in daily learning process and hence to authentic knowledge constructions.

The Physical Science Syllabi for Grade 12 on the Chemistry section put emphasis on hierarchy of Basic Science process skills and Intergraded Science Process Skills. The reason being that the basic science process skills, provide the foundation for the acquisition of intergraded science process skills. The Basic skills are: Measuring, inferring, observing, classifying, communicating and predicting. While integrated Science Process Skills include: defining, identifying and controlling variables, constructing tables and graphs, collecting and transforming data, interpreting data, experimenting, making hypothesis and drawing conclusions (Rambuda & Fraser, 2004:14, 16).

Given the above, it is therefore required that Chemistry teachers should have a good understanding of these skills in order for them to make their Chemistry teaching a success. Teachers should distinguish between the different types of practical work, e.g., inquiry practical work, skills practical work, illustrative practical work, investigative practical work and observation practical work. Knowing the difference between these different types of practical work will help them in making proper preparation based on the aim and objective of the practical investigation. This is why Al-Naqbi & Tairab (2005: 32) concluded that for the technological and industrial practical work to succeed in science teaching, science teachers should work hard to close the gap between classroom science and its application in the daily life of learners, by emphasising the impact that practical work could have in raising leaners' varied intellectual procedural skills that can benefit them in future careers. Reiss (2000: 5) has concluded that school science education can only succeed when learners believe that the science they are being taught is of personal worth to themselves.

3.5.2 Textbooks in Namibian schools

The schools in Namibia are facing a serious shortage of books according to Honey (2005:1). On average three learners have to share one textbook and in some remote regions the number goes up to five people for one book, especially in subjects like Science and Mathematics (Staff, 2008: 1). In trying to address these problems, the Ministry of Education has made a goal to have the ratio of textbooks to learners of 1:1 by the year 2013 (Kisting, 2001: 1).

The Ministry of Education in its effort to provide all Namibian schools with needed textbook has come up with a textbook policy which was passed by Parliament on 18 March 2008 (Staff, 2008: 1). The aim of the policy is to guide the production of inexpensive, but good quality textbooks for schools, publishing of textbooks and the regulation thereof, procurement of textbooks, budgetary provision of textbooks, and the dispersion of books to schools at equal basis (Staff, 2008: 1).

Although there is a shortage of text books in most Namibian schools, it has become imperative that teachers should use other methods of teaching to cater for the lack of textbooks in schools. For this reason Katonyala (2000: 1) emphasises the need for teachers to move away from textbook dependency teaching to becoming creative, and innovative by producing appropriate materials that they can share with learners, and in so doing meeting the national goal of expanding the written Namibia knowledge base materials. This will help teachers from following textbook slavishly, by developing their skills in interpreting syllabus objectives and adapting practical materials in subjects like Chemistry (Katonyala, 2000: 1).

3.5.3. Physical Science examination in Namibia

The Physical Science examination at the end of the year for Grade 12 consists of three components, Paper 1 which accounts for 20%, Paper 2 which is 50% and Paper 3 (Practical) which carries 30% (Physical Science Syllabi Grade 12, 2007: 36). For Namibia, the assessment of what has been learned must closely be matched to the purposes of the Physical Science curriculum. These papers are set externally by the Ministry of Education and the result has been highly criticised due to the high failure rates. These external examinations usually have greater impact than the internal ones because of the high stakes attached to the results, being used as measure of school standards. Various researches in external and internal examination have identified many serious problems with external examinations, these include:

- The excessive burden of assessments especially on the practical paper;
- Failure to assess the full range of skills and competencies that should be assessed according to the syllabi;
- The evaluation of teachers and schools with labelling of poor to good performing school and teachers; and
- Psychological fear which learners undergo when faced with these external papers.

  (Black, Harrison, Marshall, & Wiliam, 2003: 17 and Black, Harrison, Osborne, & Duschl, 2004: 15).

Practical work examination in some Namibian schools proves problematic due to lack of basic Science equipment (Mkandawire, 2009: 7). In order to overcome this problem, the Ministry of Education has opted for an ordinary level paper called Alternative to Practical Work which is a practical paper but does not require learners to do practical or do experiments. The Alternative paper to practical work simply requires learners to have internalised experimental skills and results and therefore should remember the outcome (Mkandawire, 2009: 7).

3.6 Conclusion

Despite the dark past of Namibian education system, much progress has been made in addressing inequality in education. The government has embarked upon the formulation of policies, bills, regulations and training that will help develop the standard of education in the country. Most of these policies and training are supported by other educational bodies like the NIED, UNICEF, ETSIP and MCA that have helped in providing experts and funding. There is a growing concern about the need for Mathematics and Science trained work force that need to be produced by the education system in Namibia, with the aim of achieving vision 2030. Due to these needs, much funding and training have gone in to Science training and in the provision of materials for practical investigations. The important task of providing materials to schools to do practical examinations and assessments is much supported by government. These tasks require good trained educators who have good knowledge of practical activities and how these benefit the learners.

Chemistry is a practical subject, which can be easily taught through learner centred methods by using demonstrations, practical investigations and group work activities. The teaching of Chemistry in Namibian schools with limited resources requires the teacher to improvise demonstrations and investigations. The science curriculum puts much emphasis on the teaching and learning of practical skills because these skills are assessed in Physical Science Paper 3 at the end of Grade 12.

The aim of education in Namibia is to produce well trained responsible, qualified and highly motivated graduates who will steer the country towards the achievement of Vision 2030. The next chapter will focus on the methodology used in this study.

Chapter 4

4.1 Research Methodology

4.1.1 Introduction

This chapter describes the research methodology, the instruments used to gather data, the approach used in this study and the methods used to statistically analyse data.

As highlighted in Chapter 1 the aim of this study was to determine the relationship between teacher-learner interaction and laboratory learning environment during Chemistry practicals in Namibia.

The following research questions where addressed:

1. What underlying relationship exists between the laboratory learning environment and learners' attitudes to Chemistry practicals?
2. How do learners perceive their learning environment in Chemistry laboratory?
3. How does teacher-learner interaction influence the learners' attitudes in Chemistry practicals?
4. How does the learner-learner interaction influence the learners' attitudes to Chemistry practicals?
5. How do learners perceive the interaction between them and their teachers during Chemistry practical work?
6. What are the characteristics of Chemistry practicals and the nature of the current laboratories in Namibian schools?
7. Is the Namibianised version of the QTI and SLEI suitable and valid instrument for use in Namibia?

The research methodology consists of three phases; the *preparation phase*, the *data collection* phase and the data *analysis phase*.

4.1.2 Definition and Purpose of Research

Due to lack of research in Namibia in the field of Chemistry practical work at school level, coupled with poor performance in Grades 10 and 12 in Physical Science Paper 3 which is a practical paper that contains Physics and Chemistry, the study was deemed necessary. The study further explains the relationship between learners' perceptions and teacher-learners interactions; learning environments and learners' attitudes; as well as learner-learner interaction during their Chemistry practical which will help in providing primary information that will improve these classes in future practical work. The study aims at elucidating the area of Chemistry practicals work by providing new conceptual insight through the use of three internationally recognised questionnaires (Questionnaire on Teacher Interactions; Attitudes to Chemistry Practical Questionnaire and the Science Laboratory Environment Inventory) that are modified to fit the Namibian situation.

4.1.3 Quantitative Method

Quantitative research methods refer to the systematic empirical investigations of large scale survey of social issues through the use of statistical, mathematical and computational technics (Dawson, 2007: 16). In quantitative data, the researcher asks a specific narrowed question that could be answered in terms of choice of value (numbers) and collects a sample of numerical data to answer the question in terms of quantity that can be later generalised to the whole population. The acceptable sample size for the survey is calculated by statisticians using formulas to determine how large a sample size will be needed from a given population in order for the result to be generalised or to achieve findings with an acceptable degree of accuracy. Usually a sample size that yields findings with at least a 95% confidence interval is acceptable, this means if another researcher repeats the same survey 100 times, he/she will most likely get the same results at least 95 times out of the 100. Quantitative research is viewed as being realistic and sometimes as positivist because it uncovers the existing realities underlying social phenomena. Quantitative research has its strong point in that the researcher is detached from the research as much as possible and this helps maximised objectivity and minimises the involvement/influence of the researcher in the results. Another strong point in quantitative research that fits well with the current study of Chemistry laboratories in Namibian schools is the fact that quantitative research seeks to answer empirical statement or descriptive statements about what "is" the case in the "real world" rather than what "ought" to be the case.

4.1.4 Qualitative Method

The main aim of qualitative research method is to answer the "*whys*" and "*hows*" of human behaviours, opinions and experience questions. This is information that is difficult to obtain through quantitative methods of research. Although qualitative research has many definitions, these two underneath are more congruent to this study because they cover the two main areas of Chemistry practical work, "purpose and focus" while the other caters for "epistemological stance."

Qualitative researchers are interested in understanding the meaning people have constructed, that is, how people make sense of their world and the experiences they have in the world. (Merriam, 2009: 13)

Others emphasize an epistemological stance:

(Qualitative research is) research using methods such as participant observation or case studies which result in a narrative, descriptive account of a setting or practice. Sociologists using these methods typically reject positivism and adopt a form of interpretive sociology. (Parkinson & Drislane, 2011: 14).

Qualitative research studies things in their natural settings, attempting to make sense of, or to interpret phenomena in terms of meaning people bring to them. In this study qualitative research will bring a naturalistic approach to the Chemistry classroom situation by interpreting the meaning behind the behaviour of learners during Chemistry practical lessons from the way they answer the questionnaire. This study supports the "idealism" stand that reality is only knowable through the human mind and socially constructed meaning. The only qualitative method to be used in this study is the interview, mainly to pursue in-depth information around the questionnaire that they have answered.

4.1.5 The chosen method (Mixed Methods Research)

There is now a new trend of researchers that are using the mixed methods approach because they have overlooked the underlying assumptions behind qualitative and quantitative research. Mixed methods research offers great promise for practising and developing researchers who would like to see a breach between qualitative and quantitative research paradigm (Onwuegbuzie & Leech, 2004a: 5). Although the philosophical distinctions between qualitative and quantitative research has become blurred, the difference between the two approaches remains technical. Due to these difference the two methods can be used in complementing each other rather than competing against one another. In this study the interview that took place after the completion of the questionnaire acted as a complement to uncover the reasons why learners answered the questions the way they did.

As de Waal (2001: 18) put it, "Philosophically mixed research makes use of the pragmatic method and system of philosophy that includes logic of inquiry that uses induction (or discovery of patterns), deduction (testing of theories and hypotheses), and abduction (uncovering and relying on the best of a set of explanations for understanding one's results." Mixed methods research is a legitimate way of using multiple approaches by using all necessary input from both methods to answer research questions, rather than restricting or constraining researcher choice to one method. Mixed method research has the advantage of being creative, pluralistic, complementary and it allows researchers to take an eclectic approach in conducting the research. Onwuegbuzie & Leech (2004b: 6) stated that mixed methods research' findings can be corroborated across different approaches, which boost greater confidence in a singular conclusion and expand ones knowledge and understanding. They further described the main features of mixed methods as follows:

- It is useful to study a number of cases in depth;
- Data are based on participants own categories of meanings;
- Useful for describing complex phenomenon;
- Provide individual case information;
- Can conduct cross-case comparisons and analysis;

- Can provide understanding and description of people's personal experience of phenomena and insiders' view points;
- Can describe, in rich detail, phenomena in local contexts;
- It allows the researchers to identify contextual and setting factors as they relate to the phenomenon of interest; and finally
- It allows the researchers to study dynamic processes by documenting sequential patterns and change.

Due to the above advantages that mixed methods entail, the best method of coming to an understanding of learning environment in Chemistry practical work in Namibia is the mixed methods research, because of the nature of the studies.

4.1.6 Why use mixed methods research?

The mixed methods research will be used to answer the above research questions. The mixed methods research has also been called "the third methodological movement" Tashakkori and Teddlie (2003: 5), while Mayring, (2007: 1) calls it 'the new star in the social science sky'. But why does mix-methods research attract superlatives applause? The answer is in what Greene (2007: 20) said, "mix-methods research is multiple ways of seeing and hearing things"; it is a natural outlet for research that seems more accessible to inquiry due to its richness in data gathering and interpretation. Mixed methods research gathers its popularity by incorporating these diverse perspectives to the widening of understanding and corroboration (Johnson, Onwuegbuzie & Turner, 2007: 123). Studies by Collins, Onwuegbuzie, & Sutton, (2006: 68), identified four rationales for conducting mixed methods research: participant enrichment (e.g., mixing quantitative and qualitative research to optimize the sample using techniques that include recruiting participants, engaging in activities such as institutional review, school debriefings, ensuring that each participant selected is appropriate for inclusion in the study); instrument fidelity (e.g., assessing the appropriateness and/or utility of existing instruments, creating new instruments, monitoring performance of human instruments); treatment integrity (i.e., assessing fidelity of intervention); and significance enhancement (e.g., facilitating thickness and richness of data, augmenting interpretation and usefulness of findings).

In this study, mixed methods was regarded as the best way of collecting data because the researcher aims at exploring the reasons; hearing the concern of learners and teachers; map the complexity of the situation; improve instruments; and understand the existing relationship among variables. The use of mixed methods has also created some challenges for the researcher. Apart from developing new skills there was a need for extended research time in order to deal with the large number of instruments used and to consider research design issues (i.e. sampling, participant selection, potential bias in the data integration), logistical issues in conducting the research, demonstrating the rigour of the supplemental data, the integration of findings in to the various methods, and addressing any contradictory findings (Bryman, 2007: 17, Creswell & Plano Clark, 2007: 4; Creswell, Plano Clark & Garrett, 2008:4; Slonim-Nevo & Nevo, 2009: 111). However, the mixed methods approach has enrich the findings with more than what other single approach research methods could have. The richness of the mixed methods research is supported by Teddlie and Tashakkori (2003: 14-15) who give three areas in which mixed methods are superior to single approach designs:

- Mixed methods research can answer research questions that the other methodologies cannot answer;
- Mixed methods research provides better (stronger) inferences; and
- Mixed methods provide the opportunity for presenting a greater diversity of divergent views."

Jones and Summer (2009: 43) could not have put it better when they stated that, "employing mixed methods research allows the researcher to explore and capture, enrich or explain, confirm, contradict or even refute phenomenon," by providing a fuller and richer picture of the research phenomenon. This approach was chosen in order for the study to construct a meaningful proposition about the complex environment of Chemistry practical work in schools in Namibia. Mixed methods research is a research design with philosophical assumptions as well as methods of inquiry that guide the direction of the collection and analysis of data. As a method, it focuses on collecting, analysing, and mixing both quantitative and qualitative data in a single study or series of studies (Creswell, 2003: 208). Its central premise is that the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone. Today, the most frequently used name for this method is "mixed methods research," which acknowledges that the approach is actually a combination of methods, it has been called "hybrids" all along (Creswell, 2003: 208).

The study has used a multiplicity of knowledge sources including experiential, epistemological and ontological views which are blended with the research questions to shape and direct this study. Although the study opted for mixed methods research, it is clear that the one method (Quantitative) is more prominently used than the other method (Qualitative). The purpose of qualitative data (Interview) was merely to enhance and solicit more information about the answer from the questionnaires. Studying school related matters requires analysis that is informed by multiple and diverse perspectives of philosophy because of its complex and pluralistic social context (Sammons, Siray-Blatchford, Sylvia, Melhuish, Taggard and Elliot, 2005: 221). This is one of many reasons why the researcher has opted for mixed methods research.

4.2. Preparation phase

This study was conducted with Grades 10 and 12 learners in Secondary schools in Namibia. Data was collected from 5 out of 13 regions in Namibia from both boys and girls who are doing Physical Science as a subject, as well as the teachers who are teaching them. The visited regions were the Khomas, Otjozondjupa, Hardap, Karas, Erongo and Omaheke regions. These regions are diverse in terms of ethnicity, population and culture and it is, therefore, assumed that they represent varied academic, cultural, social and environmental education sectors in Namibia.

4.2.1 Permission to conduct research

With reference to the Ministry of education organogram in chapter 3, the highest administrative office in the ministry is the permanent secretary, because the office of the minister and deputy minister do not deal with administrative tasks but more of political orientation. For this reason, permission was requested from the permanent secretary in the Ministry of Education, Mr Alfred Ilukena, and with his response letter (see Appendix E) the researcher requested further permission from the 9 regional education directors of the regions selected for the study. With the letters from the permanent secretary and the regional directors attached the researcher further asked permission from varies school principals and teachers. After receiving permission from principals, the final permission letter was sought from the parents of participating learners.

4.2.2 Voluntary participation

The exercise of answering questionnaires and taking part in interviews was purely voluntary and no force, threat or incentive was involved. Learners were also informed of their right to privacy, withdrawal or discontinuation should they so desire during the process. All participants were informed about the anonymity of their responses and were not required to enter their names on any of the questionnaires or in the interviews. Participants were only requested to enter their region, school and gender on their questionnaire for the purpose of analysis.

4.2.3 Ethical considerations

High ethical level was maintained throughout the data collection and interpretation process. Participants' names were not entered on the response sheets and the information gathered was solely used for the studies alone. Participants were guaranteed of their right to privacy, protection from harm and that they would be treated with all dignity and respect as (McMillan & Schumacher, 2001: 196) stated. They were also informed of their right to withdrawal should they so desire at any point during the research.

4.2.4 Confidentiality

The information gathered was presented such that no schools' name or information that might easily be identified as belonging to a particular school could be disclosed publicly. The participants were provided with needed information and explanations on what the meaning and limit of confidentiality were in relation to each particular research instrument as McMillan & Schumacher (2001: 422) stated. The research instruments (questionnaires) did not require learners and teachers to enter their names but only the region, school and gender for analysis purposes.

4.2.5. Informed consent

Permission from the permanent secretary in the Ministry of education, regional education directors, parents and principals was solicited prior to data collection. The participants were thoroughly informed of the purpose of the investigation and interviews as recommended by (McMillan & Schumacher, 2001: 422). This process was repeated at each section of data analysis.

4.2 Data Collection phase

4.3.1 Selection of instrument and sampling procedure

This section is designed to present the rationale behind the instruments used in this study in order to assess the relationship between learners' and teachers' interactions, perceptions and attitudes of the learners with regards to learning environments during Chemistry practicals in Namibia. The main purpose of the different instruments was to answer the corresponding research questions as stated in chapter one.

This study employs a mixed methods approach to encompass such a variety of data sources and research methods. The complexity of this research calls for answers beyond either simple numbers obtained in using quantitative sense or words in a qualitative approach only. The study has placed numbers in the contexts of participants' words and also frames the words of participants with numbers, trends, and statistical results.

The study has employed two broad approaches, the quantitative method (using questionnaires) and qualitative method (using interviews). This is because the use of variety of methods provides a strategy by which the researcher will make more sense of the data collected (Mathison, 1988: 15). The three quantitative instruments used were QTI for assessing teacher-learners' interactions' SLEI for measuring learners' and teachers perceptions of their Chemistry laboratory environment and the *Attitudes on Chemistry Practical Questionnaire* (ACPQ) for measuring learners' attitudes during Chemistry practical.

On the qualitative level interviews were used to refine the questionnaires, to seek explanations on why learners answered the questionnaires the way they did, and to explain in-depth understanding of the typical Chemistry practical learning environment. Permission to use and alter these instruments was granted by the original author, Professor B.T Fraser (see Appendix A).

It is worth mentioning that the three instruments have been derived from other studies, for example, SLEI from Fraser, McRobbie, and Giddings (1993), the QTI from Wubbels, Crẻton, Levy, and Hooymayas (1993) and the ASC from Fisher, Henderson, and Fraser (1997). All these instruments are modified from the original ones to meet the level and standards of the Namibian education system and Chemistry practicals situations.

4.3.2 Sampling techniques

The total random sample selected from various regions ware 1383 learners and 12 Science teachers (male = 9 and female = 3). These learners completed the Science Laboratory Environment Inventory (SLEI), Attitudes on Chemistry Practical questionnaire (ACPQ) as well as the Questionnaire on teachers' Interactions (QTI) and a few were interviewed. Learners registered their perceptions on response sheets that used the five point Likert-Scale provided for each instrument. After the completion of the questionnaire there was a random selection of 1 or 2 participants per group who were subjected to interviews that were recorded after each section for the purpose of the getting the story behind the participant's experience. Although there were marked out questions for the interview there was still room for open-ended questions to help in getting in-depth information around the perceptions of learners with regards to learning environments and teacher-learner interactions.

Data was collected from samples of Grades 10 and 12 learners who were doing Physical Science as a subject. These samples were from 73 out of 566 secondary schools in Namibia distributed in 5 out of 13 regions in the country. They were randomly selected on the base of population, size, distance, accessibility and availability of secondary schools per radius (to cut cost). The selected schools represent 4.2% of the total secondary schools in Namibia and 38.5% of the political regions of Namibia. The population variability in these regions was not so high because most people in these regions live in the same conditions in terms of behaviour, attitudes, culture and economic status. The selection of the sample was calculated using a modified version of simple random sampling called "Stratified random sampling" that is best at producing a more accurate sample that represents the total population (Berg, 2001: 12). A sampling fraction of the possible participating (Grades 10 and 12) learners were randomly selected based on gender i.e., if a Chemistry class consisted of *X number* of learners and *M* are male and *F* are female, where ($M+F=X$), then the relative size of the two samples ($X1=M/K$ males. $X2=F/K$ Female) reflected the correct proportions. This means a random sample from male and female learners were selected in numbers proportionate to the stratum's size of the total male and female learners.

Table 4.1

Number of participants per region in terms of male and female.

Region	Female	Male
Hardap Region	197	101
Karas Region	72	41
Omaheke Region	88	39
Khomas Region	510	237
Erongo Region	55	43
Total	**922**	**461**

4.3.3 Validity, reliability and pilot study

Although these three instruments have been used in studies in other countries with good validity and reliability score, altering some questions in the instrument to the Namibian situation might change the score. The validity and reliability was enhanced during the pilot study in two secondary schools, to fit to the Namibian situation under the following questions:

- Does the instrument allow all type of learners to fully express their views with ease and as fast as possible?
- Is the English used clear and unambiguous to all learners?
- Does the item measure the content of Chemistry practicals?
- Does the pilot study result correlate with the original result of the instrument?
- Does the score serve a useful purpose and have positive consequences when used?

A pilot study was done with three secondary schools in Windhoek that did not take part in the real study in order to refine the length, structure and wording of the questions before using them for the research (Dawson, 2007: 99). Two of the instruments QTI and ACPQ were given to educators to validate. These instruments were selected because they were widely used in America, Australia and the Netherlands with a reliability coefficient as high as 0.90. During the pilot study the reliability coefficient of 0. 86 closely correlated with the original score at 0. 87 reliability of other studies. Learners in the pilot study were interviewed to clarify ambiguity of the questionnaire items that they found difficult to understand or answer. Subsequently, relevant adjustment was made to the instruments before they were used.

4.3.4. The questionnaire on teacher interactions (QTI)

To assess learners-teacher interactions the questionnaire on teacher-student interactions was used. The widely used QTI instrument with great reliabilities record of 0.90 for the 7 items out of 9, when used in the USA and the Netherland was found to be the most effective instrument. A distinctive feature of this classroom environment questionnaire is that it has the ability to measure perceptions of actual classroom environment, as well as the perceptions of preferred classroom environment. The preferred, or ideal, form is concerned with goals and value orientations and measures perceptions of the classroom environment ideally liked or preferred. More importantly, for this study, because this learning environment research has adopted a person-environment perspective, it is hoped that a similarity between the actual environment and that preferred by learners will lead to improved learners' achievement and attitudes.

During the initial state, some items of the 128 Leary's Interpersonal Adjective Checklist (ICL) were found to be not applicable to teachers' behaviours (Wubbels, Creton and Hooymayers, 1985). Based on this discovery and the model for Interpersonal Teacher Behaviour, Wubbels, Creton and Hooymayers (1985), developed the questionnaire for Interactional Teacher Behaviour in the early 1980s. Later Wubbels & Levy (1993:6), developed the Questionnaire on Teacher Interactions, which is regarded as the original version of the QTI in the Dutch language consisting of 77 items. This questionnaire was designed to measure secondary students' and teachers' perceptions of teacher interpersonal behaviours. After an extensive analysis, items found not to be correlated to the respective scales were deleted from the 77 items Dutch version and later a 64 items version was developed and administered in the USA (Wubbels & Levy, 1991: 15). Later still an Australian version of the QTI containing 48 items was used, using a five point Likert scale response. This version was found to be more accurate and economical in terms of time and analysis. It is also reported that the QTI showed internal consistency reliabilities in other studies ranging from 0.76 to 0.84 for learners' responses and 0.74 to 0.84 for teachers' responses.

As a result of these good consistencies over range of studies, research with the QTI has been subsequently conducted at various grades and levels in the USA. (Wubbels & Levy, 1993) and Australia (Fisher, Henderson & Fraser, 1995). In the middle east the QTI was used in Israel, (Kremer-Hayon & Wubbels, 1992), in Asia it was used in Singapore (Goh & Fraser 2000 and Goh, Young & Fraser, 1995), Korea (Kim, Fisher & Fraser, 2000, Lee & Fraser, 2001a, 2001b; Lee, Fraser & Fisher, 2003), Indonesia (Soerjaningsih, Fraser & Aldridge, 2001) and Brunei (Scott & Fraser, 2004; Khine & Fisher, 2003) and in Europe, the Netherlands (den Brok, Wubbels, van Tartwijk, Vednan & Jong, 2004). The 48 item version of the Questionnaire on Teacher Interaction (QTI) has provided useful feedback to teachers to allow improvements in instruction and the overall learning environment

(Koul & Fisher, 2004). The other reason why the QTI has gained such popularity is the easy way of completion due to the fact that responses are given on the same questionnaire and not on a separate sheet. This method of giving response to each question on the same sheet facilitates faster completion of the questionnaire. The questionnaire could be easily administered and the respondents can complete it easily and faster.

In this study, the QTI is a five point scale with 48 items which are scored from 0 (Never) to 5 (Always) on the questionnaire itself. The 48 items of the original QTI as it was developed by Wubbels & Levy, 1991 was used, but 22 of the items where changed to fit practical work in the Namibian context. The changes were such that the original meaning was not altered; but focused more on the learners' attention to the practical work in class. Below see the Table 4.2 containing the 22 items that were changed including reasons for change.

Table 4.2 QTI items change and reason for change

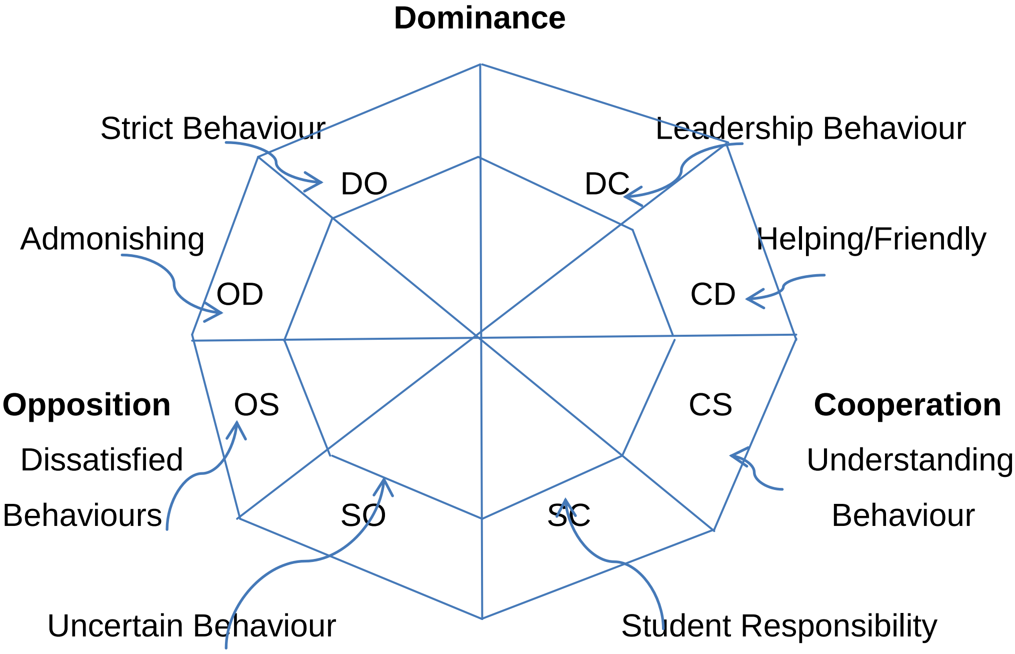
Original item of QTI	**Change to:**	**Reason for change**
1) This teacher talks enthusiastically about his/her subject.	1) This teacher talks enthusiastically about practical work.	1) To narrow it down to practical lessons rather that the whole subjects' lessons.
2) This teacher trusts us.	2) This teacher trusts us with handling equipment.	2) To focus learner's attention to teacher's trust on equipment
3) This teacher is uncertain	3) This teacher seems uncertain about practical work.	3) To focus attention to teacher's uncertainty on practical work.
4) This teacher gets angry unexpectedly.	4) This teacher gets angry if things go wrong in practical work.	4) To focus learners attention only to anger during practical work.
7) This teacher is hesitant.	7) This teacher is hesitating when doing practical work.	7) To focus learners attention only to hesitation doing practical work.
15) This teacher let us boss her/him around.	15) We can boss this teacher around easily during experiments.	15) To focus the bossing around only to experiments that they are doing and to class teaching.

21) This teacher act confidently.	21) This teacher act confidently when doing practical work.	21) To focus the confidence only to experiments that they doing and to class teaching.
22) This teacher is patient.	22) This teacher is patient with us during experiments.	21) To focus the patient only to experiments that they are doing and to class teaching
23) It's easy to make full out of this teacher.	23) This teacher allows learners to tease her/him during practical.	23) To see the level of control that the teacher has during practical work.
25) This teacher helps us with work.	25) This teacher helps us if we get stuck doing experiments.	25) To see if teacher helps learners during practical work.
27) This teacher thinks we cheat.	27) This teacher thinks we cheat in our experiments.	27) To find out about the trust level during practical work.
28) This teacher is strict.	28) This teacher is strict with experimental procedures.	28) To find out how learners see how strict the teacher is with regards to experimental procedures.
30) We can influence this teacher.	30) We can influence this teacher in doing the practical that we like.	30) To see the level of influence from learners in terms of choice of experimental topic.
31) This teacher thinks that we don't know anything.	31) This teacher thinks we don't know any practical procedure.	31) To say learners don't know anything is too vague narrow it to practical work.
32) We have to be silent in this teacher's class.	32) We have to be silent during practical demonstrations.	32) To find out the level of silence required by teacher during practical work.
35) This teacher put us down.	35) This teacher put us down during practical work.	35) To be specific on what the teacher put learners down.
36) This teacher's tests are hard.	36) This teacher's practical tests are difficult.	36) To be specific on which type of test the learners experience difficulties.
38) This teacher let us get away with a lot in class.	38) This teacher doesn't mind how we behave.	38) To be specific on behaviour rather than a lot in class.
39) This teacher thinks we can't do things well.	39) This teacher thinks that we can conduct experiments well.	39) To move from things well to experiments well. The

		statement is now positive.
43) This teacher seems dissatisfied.	43) This teacher seems dissatisfied with our practical.	43) To focus the dissatisfaction to practical work and not just general.
45) This teacher's class is pleasant.	45) I enjoy this teacher's practical demonstration.	45) To focus the enjoyment specifically to practical demonstrations.
47) This teacher is suspicious.	47) This teacher blames us for everything that goes wrong in class.	47) To show what the teacher is suspicious about.

The interesting Leary model, which was adapted and developed into a Model for Interpersonal Teacher Behaviour by Wubbels, Creton, Levy, & Hooymayers (1993), has two dimensions: one for Proximity (Cooperation-Opposition); and the other dimension for Influence (Dominance-Submission). The Proximity dimension describes the level of cooperation or closeness between the teacher and the learners in their communication. The influence dimension indicates who is controlling or directing the communication between learners and teacher and how often this occurs. In the Leary Model the term Dominance-Submission is used to represent the various behaviours in the influential dimension. Figure 4.1 shows the Leary model on the coordinate system with the different types of interpersonal behaviour from the teacher's side. In Figure 4.1 the letters D=Dominance, C= Cooperation, S= Submission and O= Opposition, in each section of the eight interrelated sections of teacher behaviour the sections are combined and the one that come first is regarded as having higher dominance than the one that follows e.g. DC meaning the element of (D) dominance is higher than the element of (C) cooperation etc.

Figure 4.1 The Leary Model and Coordinate System.



Wubbels, Creton, Levy, & Hooymayers (1993: 16)

In this study items are arranged into eight scales corresponding to the eight interrelated sections of the model for interpersonal teacher behaviour. Table 4.3 provides the name of each scale, its description, and a sample item as appears on the questionnaire.

Table 4.3 Description and Examples Items for each Scale in the QTI

Scale	**Descriptions**	**Items**
Leadership [DC]	Extent to which teacher provides leads, organises, provides orders, determines procedures and structures the classroom situations.	This teacher explains things clearly and enthusiastically about practical work.
Helping/Friendly [CD]	Extent to which teacher is friendly, helpful and shows considerate manners that aspire confidence and trust from learners	This teacher is friendly and helpful.
Understanding [CS]	Extent to which teacher shows understanding/concern/care and openness to students.	If we don't agree with this teacher, we can talk about it, because there is trust.
Student	Extent to which students are given	We can influence this teacher

Responsibility/Freedom [SC]	opportunities to assume responsibilities for their own activities by encouraging independent work.	by taking decisions in class.
Uncertain [SO]	Extent to which the teacher exhibits her/his uncertainty by showing a low profile.	It is easy to make a fool out of this teacher.
Dissatisfaction [OS]	Extent to which the teacher shows unhappiness/dissatisfaction/criticise/ learners.	This teacher thinks that we don't know anything, we just cheat in test.
Admonishing [OD]	Extent to which the teacher shows anger/temper/impatient/irritation/ punishments in class.	The teacher is impatient/unexpected anger.
Strict [DO]	Extent to which teacher is strict/enforce rules with demands to learners.	We are afraid of this teacher, the teacher is strict.

4.3.5. Attitudes to Chemistry Practical Questionnaires (ACPQ)

The Test of Science Related Attitudes (TOSRA), which was developed by Fraser in 1978, was designed to assess secondary school students' science attitudes. It had seven attitudes scale, which are: Social implications; Normality of Science; Attitudes of Scientific Inquiry, Adoption of Scientific Attitudes; Enjoyment of Science Lessons; Leisure Interest in Science; and Career Interest in Science. The seven scales are suitable for group administration and all can be administered within a single lesson. The TOSRA has been carefully designed and extensively field tested with high reliability in many countries (Fraser, 1981: 1). In early studies, Fraser calculated the reliability and validity of the TOSRA with a survey to secondary students. The values of the α reliability coefficient ranged from "0.66 to 0.93 with a mean of 0.82 for the Year 7 sample, from 0.64 to 0.93 with a mean of 0.81 for the Year 9 sample, and from 0.67 to 0.93 with a mean of 0.84 for the Year 10 sample" (Fraser, 1981: 4). The inter-correlations of the TOSRA scales were calculated as indices of discriminate validity. The inter-correlation was low and ranged from 0.10 to 0.59 with a mean of 0.33 (Fraser, 1981: 4).

Fraser's research on the TOSRA was again conducted with students in Australia in 1987. The main purpose of the study was to investigate the cross-cultural validity of the TOSRA when used with American high school students (Khalili,1987: 6). In the study, 336 grade 11 and 12 learners in suburb area Chicago high schools took the test. The researcher showed that the TOSRA did have a high degree of internal consistency when used with American students (Khalili, 1987: 133).

The work of Fraser was based on earlier studies by Klopfer in 1971, who examined the manifestation of favourable attitudes towards science and scientists. The *Social Implications of Science scale* measures the "manifestation of favourable (by excluding the non-favourable) attitudes towards science" (Fraser, 1981: 2). This includes attitude towards the social, academicals benefits and problems associated with scientific progress and research that learners have to do in science.

The *Normality of Scientists* scale measures the attitude toward scientists as normal people rather than eccentrics. This scale measures how students perceive scientists as individuals and their perceptions of scientists as having a normal lifestyle. This include the type of career and lifestyle that scientist live.

The *Attitude of Scientific Inquiry* scale measures attitude toward scientific experimentation and inquiry as methods of obtaining information about the natural world. This scale measures the acceptance of scientific inquiry as a way of thought. The focus is on how learners master the science process, skills and methods of inquiry that are most of the times needed in practical investigations.

The *Adoption of Scientific Attitudes* scales measures open-mindedness, openness to follow rules and regulations that are related to scientific investigation and inquiry. This scale measures the probability of learners to adopt their way of seeing the world to be based on scientific evidence and not mere human reasoning.

The *Enjoyment of Science Lessons* scale measures the level of enjoyment of science learning experiences. This includes participating in Science practical work as well as attending science fairs and projects.

The *Leisure Interest in Science* scale measures the development of interest in science and science-related activities.

The *Career Interest and Science* scale aims at measuring the level of interest those learners have in Science related studies, especially after completing their school and moving to tertiary institutions.

The TOSRA in this study is renamed to Attitudes to Chemistry Practical Questionnaire (ACPQ) due to the nature and the scope of this study. The original content of the TOSRA is not changed apart from lowering the different scales from the original seven scales to five scales. Due to the fact that the focus of the study is on Senior Secondary Chemistry practical work the researcher found it relevant to focus on the following scales: Social Implications of Chemistry; Attitudes towards inquiry; Enjoyment of Chemistry lesson; Leisure interest in Chemistry; and Career interest in Chemistry. Each of these five scales has five statements. Students are asked to indicate whether they strongly agree (SA), agree (A), undecided or neutral (N), disagree (DA), or strongly disagree (SD) with each of the 25 statements.

The 25 statements are divided in the 5 sections as follows: Social implications of Chemistry is number 13, 17, 21, 23 and 24; Attitudes towards inquiry is number 3, 4, 6, 18 and 25; Enjoyment of Chemistry lessons is number 1, 2, 5, 8 and 14; Leisure interest in Chemistry 7, 9, 12, 16 and 19; and Career interest in Chemistry in 10, 11, 15, 20 22.

4.3.6. Science Laboratory Environment Inventory (SLEI)

The initial version of the SLEI contained 72 items altogether, with 9 items in each of the eight scales (Fraser, Giddings & McRobbie, 1992: 432). However, extensive field-testing and instrument validation later led to a more economical and valid final version with 35 items, with 7 items in each five of the original scales (Fraser et al, 1992: 4). The five scales' criteria were:

1. *Consistency with the literature on laboratory teaching.* Earlier literature review identified dimensions considered important in the unique environment of the science laboratory class (Hofstein & Lunetta, 1982; Woolnough, 1991).

2. *Consistency with instruments for non-laboratory settings.* Evidential data was obtained by examining all scales in existing classroom environment instruments for non-laboratory settings in this regard (Fraser, 1986).

3. *Coverage of Moos' general categories.* One of the prerequisites on the development of SLEI was that it should provide coverage of the three general categories of dimensions identified by Moos (1974) for conceptualizing all human environments. These are “Relationship Dimensions” (the nature and intensity of personal relationships), “Personal Development Dimensions” (directions of personal growth and self-enhancement), and “System Maintenance and System Change Dimensions” (the extent to which the environment is orderly, clear in expectation, maintains control, and is responsive to change). The SLEI included scales in each of these categories.

4. *Salience to teachers and learners.* Interviews with science teachers and learners at the upper secondary and university levels showed that SLEI's dimensions and individual items were salient.

5. *Economy.* To achieve economy in terms of the time needed for answering and scoring, the SLEI had a relatively small number of reliable scales, each containing a small number of items, which will cover all areas needed without boring the candidates or taking much of their time. Initially, the above criteria led to the formation of an instrument containing eight scales, although only the following five scales survived field-testing and item/factor analyses and appear in the final version. *Student Cohesiveness* assesses the extent to which students know, help, and are supportive of one another; *Open-Endedness* assesses the extent to which laboratory activities emphasize an open-ended, divergent approach to experimentation; *Integration* assesses the extent to which laboratory activities are integrated with non-laboratory and theory classes; *Rule Clarity* assesses the extent to which behaviour in the laboratory is guided by formal rules; and *Material Environment* assesses the extent to which laboratory equipment and materials are adequate.

Each item's response alternatives are Almost Never, Seldom, Sometimes, Often, and Very Often. With learners that have to choose between the five choices. In earlier studies the SLEI was field tested and validated simultaneously across different countries with a sample of 5447 learners in 269 classes in more than five countries (USA, Canada, England, Australia, Nigeria, Israel and cross-validation with Australia) (Fisher, Henderson & Fraser, 1997: 25; Fraser & McRobbie, 1995: 301).

A typical item in the actual form of the Student Cohesiveness scale is: "We can break rules in the laboratory and nothing will happen." The wording of the preferred version is almost identical except for the use of words such as "class" is change to "laboratory". For example, the item "I got little chance to get to know other students in class" in the actual version is reworded in the preferred version to read "I got little chance to get to know other learners in the laboratory". Almost all items are altered to a lesser degree in order to fit the Chemistry laboratory and practical work from classroom perception to a laboratory perception. Strong emphasis is given to validity and reliability so that the altering of the statements could not influence the original validity and reliability of the instrument. Considering the fact that Namibian learners who have to answer this questionnaire were studying English as a Second Language the issue of language use was also considered during the pilot study, e.g., "*It takes me a long time to get to know everybody by his/her first name in this laboratory*"; is shorten to read "*I know everybody in this laboratory by name*". The sentence "*My regular Biology class work is intergraded with Biology laboratory activities*", was misinterpreted in the pilot study as meaning practical work lessons were done with content lesson. Therefore, it was changed to ". *We have practical experiment for each topic we do in Chemistry class*".

In Asia, the SLEI has been cross-validated and found useful in research involving both its original English form and translated versions. The validity of the English version of the SLEI has been established in Singapore by Wong and Fraser's (1995:908, 1996: 93) study of 1592 Grade 10 Chemistry students in 56 classes in 28 schools, and by Quek, Fraser and Wong (2001: 18) study of 497 gifted and non-gifted Chemistry students. Also, Riah and Fraser (1998: 23) cross-validated the English version of the SLEI with 644 Grade 10 Chemistry students in Brunei Darussalem.

Another noteworthy programme of research involving a Korean-language version of the SLEI has been conducted by Kim and built upon by Lee (Kim & Kim, 1995:163, 1996: 213; Kim & Lee, 1997: 213; Lee & Fraser, 2001:12, 2002: 22). For example, Lee and Fraser reported strong factorial validity for a Korean version of the SLEI and replicated several patterns from previous research in Western countries (e.g., low Open-Endedness scores and significant associations with students' attitudes).

The SLEI consists of negative and positive statement. The statements are constructed mainly to avoid monotony. It is worth mentioning that the scoring on the negative statements is reversed e.g. our laboratory is crowed when we are doing experiments. This statement will score 1 for ***very often*** and it will increase to 5 for ***almost never***. Table 4.4 shows the positive and negative scoring statements of the SLEI. The table further shows the diversion from the original version in terms of number of items per scale due to the nature of the topic under investigation.

Table 4.4 SLEI items and scales

Scale	**Items Numbers**		**Total Items**
	Positive Numbers	**Negative Numbers**	
Learners Cohesiveness(SC)	1,11,16,21,32,26	6,22,33	9
Open Endedness (OE)	2,7,12,17	27,8,34	7
Integration (I)	13,18,3	23,28	5
Rule Clarity (RC)	4,19,29,24	9	5
Material Environment (ME)	10,30;14,15,25	5,20,31,35	9

4.3.7. Interview

The interview conducted formed the qualitative part of this study. The main aim of the interview was to help the researcher understand the environment in which the learners lived and find deeper answers to statements in the questionnaires like:

- Why learners interact with their teacher and among themselves the way they do;

- How does the behaviour of the teacher influence his/her learners' behaviour towards practical activities in the subject;
- How does the event that goes on in the practical classroom affect them in mastering concept in the class room;
- Why classroom culture is the way it is today in their practical classroom and;
- It also seeks to get answers on the experience, opinion and feelings of individual learners with regards to practical work and the questionnaire they answered.

The interview has provided a direct encounter with the individual learners and it has encouraged learners to express their views at length, and make direct comments on the questionnaire's statements.

A small group of learners was interviewed and the responses were recorded and analysed qualitatively. The interview serves to provide insight into the way the learners answered the questionnaire and clarify issues that cannot be answered through ticking (Creswell 2003: 16). During the interview, the researcher took notes from the learners responses. Follow up questions were used to encourage learners to freely speak out about their own ideas, feelings, insight, expectations, attitudes and to say what they think (Richardson, 2008: 22). The extent of reliability and trustworthiness of any interview can be measured on the cooperativeness, consistency and confidence of participants' responses to the questions asked (Richardson, 2008: 18). All interviews were conducted right after the administration of questionnaire while everything was still fresh in the learner's mind. The interview consisted of open ended questions in order to elicit richer and deeper responses from learners without fear or favour. The interview was prepared such that it addressed the following issues with regards to the questionnaires:

- Are the statements in these questionnaires clear and logical to understand?
- Does the QTI address relevant issues with regard to teacher-learner interactions; should other statements be added or removed?
- With regards to the learning environment in your laboratory does the SLEI access all aspects of what is happening in your laboratory?
- What other attitudinal problems do you experience in your laboratories that are not addressed by the ACPQ?

The study explores the relationship between teacher-learner interaction and learning environment; and teacher-learner interactions and the learners' attitudes during Chemistry practicals. Through interviews the researcher could compare teacher-learner interaction to learning environment and learners' attitudes; and the characteristics of the type of Chemistry practicals in the classroom (Miller & Brewer, 2003: 17).

Usually in qualitative studies, classroom observation is carried out over quite limited time (short period) and it does not reflect the usual situation to the maximum extent. In contrast, using a questionnaire means that learners' perceptions of their learning environments take into account previous experiences as well as their current situation in the classroom which is far more comprehensive than just doing observation. Quantitative studies also allow for the pooling of data from a large number of learners.

The credibility of qualitative data was enhanced and assured by:

- Rigorous techniques and methods for gathering high-quality data through interviews that are carefully analysed, with attention to issues of validity, reliability and triangulation; (Creswell, 2003: 195)
- The credibility of the researcher, which depends on training, experience, track record, ethical status and presentation of self during interviews (Creswell, 2008: 411) and
- The researcher's fundamental appreciation of naturalistic inquiry, qualitative methods, inductive analysis, purposeful sampling and holistic thinking during interviews (Creswell, 2008: 412).

4.4 Implementation phase

4.4.1 Data collected

The data collected by the use of QTI, SLEI and ACPQ was entered on Microsoft Excel Spread sheet to make statistical analysis easy. The analysis was based on the research questions. The following was applied to analyse data: Cronbach alpha coefficient, Pearson’s coefficient (*r*), Regression coefficient (β) and multiple correlation (R).The Cronbach's alpha was used to assess the reliability of rating by summarizing the survey answers which measure the underlying factors McMillan and Schumacher (2001: 247). The Pearson’s alpha coefficient is usually best in investigating the relationship between two quantitative, continuous variables, for example teacher interaction and learners participation in Chemistry practicals (McMillan and Schumacher, 2001: 612). Due to the nature of the study, the above mentioned statistical analysis was found suitable in finding the correlation coefficient between what other studies in the same field has found and the findings of this study.

The qualitative data from interview recorded on tape was transcribed by using spread sheet and qualitative computer programme called *Atlas.ti*. This programme helped the researcher to organised text, graphic, audio and visual notes in to a data base that is easily retrievable (Creswell, 208: 249).

4.4.2 Nature of schools visited

So far we have discussed various instruments used to collect data, but did not go in to details on how the instruments were used to collect data in various regions. This section aims at explaining how data was collected in the different schools including rural schools.
As stated in section one the schools were randomly selected based on varies factors like:

- Grades 10 and 12 academic performance from 2009-2011;
- Accessibility of schools by car;
- Urban and remoteness of school;
- Total number of learners in that school;
- Social cultural factors like traditions and beliefs; and
- Economic status of school and community.

The schools were visited by means of a 4×4 vehicle that enabled travel to even the most remote schools that were not easily assessable with non-four wheel drive vehicles. The greatest challenge during the travelling was that February and March are the predominantly raining month in Namibia and most of the time rain was posing a serious threat to driving.

Due to the remoteness of some of the schools and the fact that strict rules from the permanent secretary in the Ministry of Education should be adhered to like no interruption to school programmes and class teaching, the best option was not to require teachers to do experimental/practical work for observation purposes. The best options was to give the questionnaire during break, after school or during off periods for the learners/teacher to complete. It was assumed that the information provided by the learners/teacher was a true reflection of what was happening in their laboratory practical work.

Upon arrival in the different regions, it was easy to connect with relevant people because prior arrangements had been with the regional Director and school principals and parents had equally been informed. The use of GPRS on the mobile phone in terms of locating the different schools was very helpful. Previous arrangements, with the directors, principals and teachers greatly helped the process. The arrival and location of the various schools to be visited in every town was done the previous day. Nearly 55% of the schools visited in the regions had already selected the teachers and class groups that the researcher was to work with and provision was make for time, classroom and logistic support.

Most remote schools in these regions did not have laboratories at all and learners were complaining in the interview that they barely did any experiments. The majority of the schools in remote regions use the class in which they are teaching Science as a laboratory although no equipment, electricity or running water is available in these class rooms. On inquiry from the teachers about the learners' complaints, teachers referred to lack of chemicals, equipment and in-service training from the ministry as the main stumbling block in offering practical work. Urban schools' laboratories in this region seemed to be more equipped with the necessary chemicals and equipment compared to the rural schools.

The procedure in class was as follows: The researcher was introduced by the teacher or principal to the class. The researcher then explained the reasons for his visits and the need for them to help in answering the questionnaire. Willing participation, anonymity, right of withdrawal and protection from any harm or victimisation by teachers or the ministry was guaranteed to the participants. After handing out the questionnaire the researcher explained how to fill the questionnaire, e.g., that there is no wrong or right answer, it is not a test, they should mark/shade one block in each statement according to the level of agreement. The teachers' version of the questionnaire was also given to the teachers at the same time. A total of 34 teachers completed the teachers' version, while around 21 teachers refuse to answer the questionnaire citing busy schedules and not having time to go through the questionnaire.

4.5 Preparation and data analysis phase

Description of the data collection procedure was given in the previous sections. In this section the process of analysing data was explained. Data were collected by researcher using the three quantitative instruments and the interview. To minimise none return of questionnaire through mail the researcher had travel to various regions in person. Although there were modifications made to some items of the instruments to fit the need of practical work in school in Namibia, this modification was minimal, and the validity of the modified questions rested largely on the original instrument validity established by the previous studies. Data was entered region by region in Excel spread sheet and later transferred to SPSS. Statistical analyses were done by using SPSS. The data obtained from the study was analysed in terms of both descriptive statistics and inferential statistics in order to answer the various research questions.

4.5.1 Descriptive statistics

The researcher's aim to use descriptive statistics was to describe, organise and present raw data in the form of numbers, charts and tables, mainly to show measures of central tendency, dispersion, skew and kurtosis of the collected data.

4.5.2 Inferential statistics

Through inferential statistics the researcher drew conclusions that were beyond the immediate data alone, the aim was to test the reliability of the findings and infer the characteristics from sample to the population. In order to answer the research questions, the reliability of the original QTI and the Namibian modified version of QTI were analysed using the Cronbach's alpha coefficient for each scale, by using the individual learners and regional mean as a unit of analysis. The alpha validity coefficient can vary from .000 to 1.00; the value of 0.00 indicates no reliability at all while 1.00 is indicating a perfect reliability. Although there are different reports about the acceptable values of alpha validity coefficient, ranging from 0.70 to 0.95, for this study the acceptable value for both the QTI and SLEI is ≥ 0.60 and the unacceptable value is ≤ 0.40 as explain by Clark and Watson (1995: 315). Another statistical method used was the analyses of Variance (ANOVA). This was applied to examine the main effect of gender and region of various schools level of interest on both learners' attitudes toward science and classroom environment. Using the ANOVA, students' mean score resulted from TOSRA were compared based on their region, gender, and school. The interactions frequency of gender and grade level was examined to analyse the magnitude of interdependency level of the two variables in contributing to the attitude differences. In addition, the main effects of each gender, region and grade level were also investigated. The correlation between the original version of QTI and the actual one has been entered on a spread sheet for calculation using the Pearson's coefficient (*r*) for QTI and SLEI scales. The acceptable range area for Pearson Coefficient was between -1 and +1 with Lutz's (1983) example of acceptable value of 0,65; 0,40 and 0,15 which he called 0.65 = strong; 0.40 = moderate and 0,15 = weak. The negative and positive sign in front of the correlation indicate the direction of the movement of the relationship, and do not have any mathematical value. The ability of the SLEI to differentiate between schools level of practical activities was achieved by performing for each SLEI scale, a one way ANOVA, with the mean of each school as the main effect, and using individual learners as the unit of analysis. Using the same method and the procedure, the results of the ACPQ questionnaire were also analysed to examine gender and grade level differences on students' perceptions towards classroom climate. The SLEI are divided in five categories for the purpose of analysis in this study, the five sections are the Student cohesiveness (SC); Open endedness (OE); Integration (I); Rule clarity (RC) and Material environment (ME).

To discover how learners perceive the interactions between them and the teacher as well as among them during Chemistry practical work, the mean and standard deviation of the original QTI and the modified QTI were processed and calculated. The effect size in this study refers to the difference between variables of the original QTI and the modified QTI. The effective size was then calculated using the difference between the two groups' means and using the pool standard deviation. For effect sizes 0.10; 0, 25 and 0.4 then the difference is considered small, medium and large respectively. The same steps were followed to investigate students' perceptions of their learning environment using the SLEI.

Simple and multiple correlation analysis were used to investigate the association between the different SLEI scale and QTI scales. Pearson correlation coefficient (r) was used to investigate the strength of association between the mean score of the SLEI and QTI. The regression coefficient (β) was used to predict one variable from another. The result of the three questionnaires QTI, ACPQ and SLEI were compared to determine the characteristic of the type of Chemistry practical work in Namibia.

4.6 Conclusion

Analysing data in a mixed methods research study is potentially the most complex step because the researcher has to be skilful at analysing both the quantitative and qualitative data that have been collected, as well as integrating the results that stem from both the quantitative and qualitative analysis in a coherent and meaningful way that yields strong meta-inferences (i.e., inferences from qualitative and quantitative findings being integrated into either a coherent whole or two distinct sets of coherent wholes). This chapter has discussed the methodology followed by the researcher to collect and analyse data. It began with the preparation phase, followed by implementation and analysis phase. Descriptive and inferential statistics where used in this studies for analysis. Data from the QTI, SLEI and ACPQ was tabulated on the Excel spread sheet and later calculated using the SPSS software.

In chapter 5 detailed analysis of all the collected data will be done with focus on answering the research questions stated in chapter one. Each questionnaire will be dealt with separately with each question showing all its statistical outcomes.

Chapter 5

5.1. Introduction

Data collected from 1383 learners from various secondary schools in central, western and southern Namibia was analysed using the SPSS statistical package. Each of these 1383 learners completed three questionnaires namely the QTI, SLEI and the ACPQ, while 28 of the learners who completed the questionnaires also participated in the interview. Twelve Physical Science teachers also took part in the interview process.

The study posed several research questions, namely:

i. What underlying relationship exists between the laboratory learning environment and learners' attitudes to Chemistry practical?
ii. How do learners perceive their learning environment in a Chemistry laboratory?
iii. How does teacher-learner interaction influence the learners' attitudes in Chemistry practicals?
iv. How does the learner-learner interaction influence the learners' attitudes to Chemistry practicals?
v. How do learners perceive the interaction between them and their teachers during Chemistry practical work?
vi. What are the characteristics of Chemistry practicals in Namibia?
vii. What is the nature of the current laboratories in Namibian schools?
viii. Are the Namibianised versions of the QTI and SLEI suitable and valid instruments for the use in Namibia? (Comparing results with other studies)

After all the questionnaires were collected from the field, they were analysed for reliability and validity of all their items. The next section will deal with the descriptive in-depth analysis of all the items dealt with in the questionnaires.

5.2. Attitudes to Chemistry Practical Questionnaire (ACPQ) data analysis

The ACPQ was designed to assess secondary school learners' attitudes towards Chemistry. It stemmed from the Test of Science related Attitudes (TOSRA) developed by Fraser in 1978, but it was modernised and changed to fit the current Namibian Chemistry class situations. The original TOSRA consisted of seven scales:

Social implications; Normality of Science; Attitudes of Scientific Inquiry; Adoption of Scientific attitudes; Enjoyment of Science lesson; Leisure interest in Science; and career interest in Science. With the modernisation and renaming of the TOSRA to ACPQ the seven original scales were also reduced to five scales, namely: Social implication of Chemistry; Attitudes towards inquiry; Enjoyment of Chemistry lessons; Leisure interest in Chemistry; and Career interest in Chemistry.

Data collected from the sample of 1383 learners across five regions was analysed using the SPSS statistical programme. Table 5.1 shows the results of the ACPQ. The results are divided in the following sections, *Items* showing all the questions asked, *Kruskal Wallis Test* showing the results of comparison between the five regions visited. When interpreting the value for the test, it was important to note that if the value was less than .05 then the test was significant at the 5% level (5% meant that less than 1 in 20 chances of being wrong) and if the value was less than .10 but greater than .05 then the test was not significant. It is worth noting that if the SPSS value is .000 it is usually reported as < .001. The lower the value e.g. .000 the more significant the results, meaning that there are no significant differences between regions and the way learners answered this question and it can also be interpreted as “the mean dependent variable are the same throughout the regions”. The higher the value e.g. .557 the more insignificant the results of that specific question meaning that the dependent variable are not the same throughout the regions or the way learners answered this question differed significantly from region to region.

The Pearson Chi-square test shows the level of association between the region and the various categories e.g. Pz = .690 >.050 then there is no statistical differences and there will be no association between the region and the category. If the p-value .010 < .050 then the result is statistically significant which means that there is an association between the region and the category. The issue of an item being statistically significant refer to strong evidence that the interesting effect seen in the sample (in this case the relationship between the region and the category) also exists in the population.

The Confident interval at 5% shows the range were the mean results will be significant and it is calculated as follows: If the Standard error is .038 and the mean statistic is 3.66, then the calculation will be 3.66 ±1.96 × .038 the answer for this at 95% ≈ {3.59; 3.73}. The Standard Deviation shows how far or how close the results are from the average mean. A low standard deviation indicates that the data points tend to be very close to the mean, while a high standard deviation indicates that the data points are spread out over a range of values far from the mean. The smaller or lower the value of standard deviation preferably ≤ 2.00 the more realistic the results are to the mean. For the purpose of this study any standard deviation values that are one standard deviation above (+2) or below (-2) the mean are considered as unrealistic because they lie outside the 95% confident limit for probabilities. This means that any deviation within the data did not occur by chance alone, but something was going on that affected the normal distribution of data.

The scale that is used in the questionnaire is a 5 point scale which represents various opinions of the learners representing the following: 1 = Almost Never, 2 = Seldom, 3 Sometimes, 4 = Often and 5 = Very often, with standard deviation of 1.339. Furthermore, each item in the table and its results are discussed in detail below.

Table 5.1: Descriptive Statistics

	Item	Nr of respondent	Independent Sample	Pearson Chi-square Test	Confidence interval	Statistics		Std. Deviation
		Statistic	Kruskal-Wallis Test		CV at 5%	Mean	Std. Error	
1	Looking forward to experiments	1357	.000	.003	3.59~3.733	3.66	.038	1.386
2	Practical work is fun	1333	.000	.155	3.82~3.95	3.88	.033	1.190
3	Dislike doing practical investigations	1339	.001	.001	1.872~3.048	2.46	.030	1.110
4	Practical Work makes me bored	1380	.093	.000	2.145~2.275	2.21	.033	1.238

5	I find it interesting doing practical work	1382	.384	.000	3.923~4.037	3.98	.029	1.076
6	I enjoy practical lessons	1345	.001	.000	3.623~3.757	3.69	.034	1.242
7	Practical work is a waist of time	1369	.001	.002	1.232~2.408	1.82	.030	1.106
8	I love Chemistry more than any other subject.	1379	.001	.000	2.933~3.047	2.99	.029	1.092
9	Chemistry is not important in comparison with other subjects.	1378	.000	.000	2.878~2.002	2.96	.042	1.576
10	My Chemistry teacher is my role model.	1382	.190	.027	2.205~2.335	2.27	.033	1.235
11	I will study Chemistry at University level.	1381	.306	.003	2.466~2.569	2.50	.035	1.296
12	Chemistry is one of the easiest courses for me.	1381	.066	.011	3.137~3.283	3.21	.037	1.361
13	We never use equipment in Chemistry practical.	1378	.225	.011	2.951~3.089	3.02	.035	1.294
14	I would love to have Chemistry classes more often.	1244	.005	.000	2.899~3.041	2.97	.036	1.280
15	Chemistry knowledge is vital for my future career.	1370	.000	.000	3.246~3.358	3.32	.038	1.419
16	My Chemistry teacher makes practical work fun.	1327	.003	.107	3.109~3.216	3.18	.036	1.297
17	I have difficulties to understand Chemistry.	1369	.033	.000	3.537~3.635	3.57	.033	1.239
18	I know the names of most equipment we use.	1367	.033	.826	2.927~3.025	2.74	.033	1.232
19	I hate Chemistry lessons.	1371	.000	.000	3.177~3.272	3.24	.032	1.199
20	I would like to work in a laboratory in future.	1353	.002	.002	2.089~2.211	2.15	.031	1.133
21	I don’t need Chemistry knowledge.	1346	.000	.000	2.460~2.620	2.54	.041	1.492
22	I like my Chemistry teacher.	1303	.000	.002	2.664~2.794	2.75	.044	1.574

23	Chemistry calculations give me hectic (Difficulty).	1339	.038	.005	3.136~3.285	3.21	.038	1.405
24	Most of our school's equipment are out date.	1349	.000	.000	3.476~3.285	3.51	.034	1.231
25	Safety comes first in our laboratory.	1277	.036	.040	3.369~3.511	3.44	.036	1.273

In Table 5.1 the confident interval is equal to two margins of errors and a margin of error is equal to about 2 standard errors (for 95% confidence). A standard error is the standard deviation divided by the square root of the sample size. The standard error is standard deviation of the sampling distribution of the mean, or in English, it is basically the amount we expect the sample mean to fluctuate for a given sample size due to random sampling error.

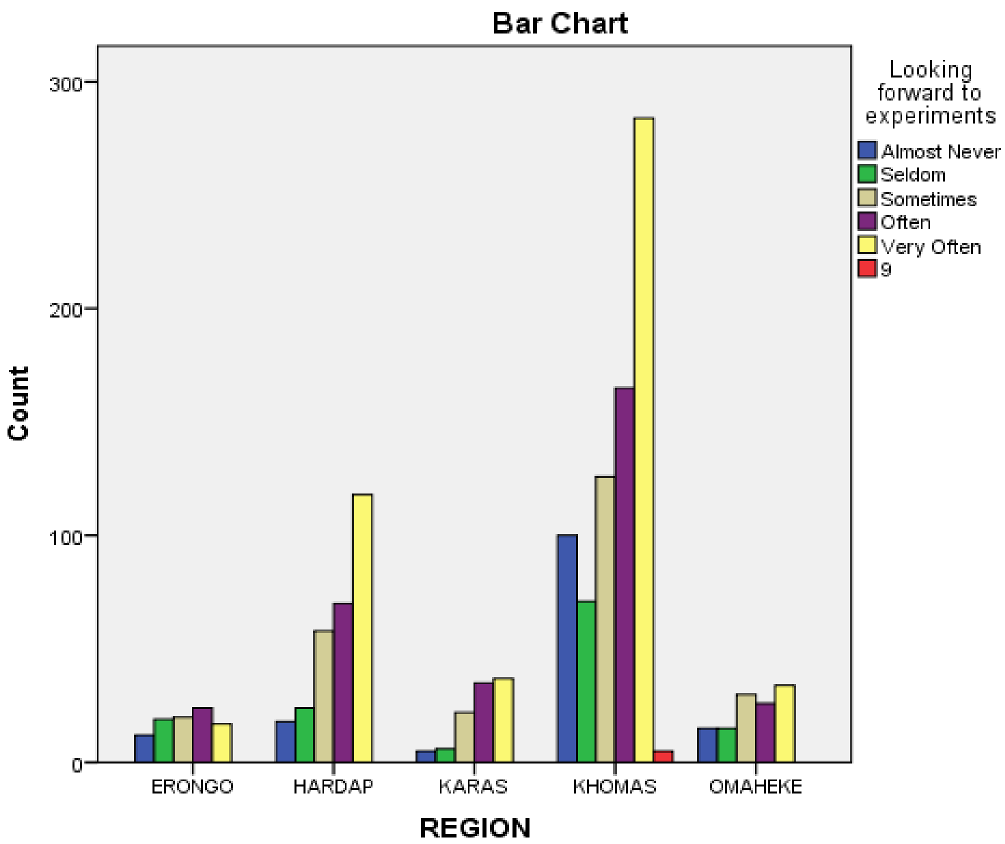
Item 1. Looking forward to doing experiments

Table 5.2: Answers for "looking forward to doing experiments"

REGIONS	Looking forward to experiments						Total
	Almost Never	Seldom	Sometimes	Often	Very Often	Missing	
ERONGO	12	19	20	24	17	6	92
HARDAP	18	24	58	75	118	3	288
KARAS	5	6	22	40	37	7	105
KHOMAS	100	71	126	160	284	10	751
OMAHEKE	15	15	30	26	34	1	120
Total	150	135	256	325	490	27	1356

The mean score for this statement across the visited regions is 3.66 on the scale of 1-5. The Kruskal-Wallis Test shows a significant value of .001 which can be interpreted as there is no substantial differences in the way learners answered the item ;"look forward to doing experiments" in their Chemistry laboratories throughout the visited regions in Namibia. This means that the dependent variables (learners) are the same across all levels of a factor across the regions in the way they answered this question. The confidence interval for this statement at 95% ≈ {3.59; 3.73}. Chi-square of .003 for this item suggests that there is a significant association between the regions and their opinion on this item. On the statement “looking forward to experiments” in terms of percentage the majority of learners fall in these two categories, often (23.7%) and very often (36.1%). This indicates that there is a positive underlining relationship between the prevailing learning environment and the learners’ attitudes in doing experiments in the visited regions, because the majority of learners show high interest in doing experiments. Rodd, (2003:3) suggests that attractive physical learning environments are associated with improved learners attitudes, behaviour and performance. The first research question is somehow addressed by this item suggesting that a positive underlying relationship exists in Chemistry laboratories in the visited regions. This has resulted in positive attitudes among learners towards Chemistry practical work. This was also emphasised by NESTA, (2005: 5). The aim of the interview was to establish the underlying reason why learners have so much interest in practical investigations. *The majority of the interviewed learners suggested that, they like practical investigation because it is fun. Teachers who were interviewed also reported a high demand from learners for practical lessons, but some associate the demand with lack of understanding of the purpose of practical work, learners enjoying practical activities and learners not interested in theoretical lessons.* The general expectation was that learners enjoy practical investigations because they make concepts clearer and understandable. Schools in the Hardap and Khomas regions have shown the highest score in terms of looking forward to doing practical work which can possibly be attributed to the availability of chemicals and equipment in these two regions, as observed the laboratories in these two regions were more advanced in terms of the availability of equipments and chemicals. See the Chart below on how the regions performed in terms of this item:

Figure 5.1. Looking forward to doing experiments.



Item 2. Practical Work is fun.

Table 5.3 Practical work is fun

REGION	Practical work is fun						Total
	Almost Never	Seldom	Sometimes	Often	Very Often	Missing	
ERONGO	9	11	13	27	28	12	88
HARDAP	18	22	56	97	95	15	288
KARAS	3	4	23	33	40	9	103
KHOMAS	50	46	108	238	293	14	736
OMAHEKE	8	9	19	36	45	1	117
Total	88	92	219	431	501	51	1332

The mean score for this statement is 3.88, with a standard deviation of 1.19. This standard deviation suggests that the data is slightly clustered closely around the mean with ±1.19 above or below the mean. This item provides an answer to research question one with regards to positive underlying relationships that support a harmonious learning environment in Chemistry classes in the visited schools. When learners' regards Chemistry practical as fun they tend to perceive their learning environment as positive, enjoyable and fun. This item also provides answers to research question two as it gives an idea on the way learners perceive their learning environment in the laboratory. The Kruskal-Wallis Test shows an insignificant value of .088 which is ≥ .05 this can be interpreted that there is a significant difference in the way learners "regard practical work as fun" in their Chemistry laboratories throughout the visited regions. In some schools the learners do not regard practical work as fun; this factor is related to gender as more females than male learners do not regard practical work as fun. This means that the dependent variables are not the same across all levels of the factor. The Pearson Chi-Square of .155 is not statistically significant and there is no association between the region and the category practical work is fun. The confidence interval for this statement is at 95% ≈ {3.82; 3.95}. The high percentage of 32.4% (often) and 37.6% (very often) suggests that the majority of learners regard practical work as fun. In the interview conducted most of the teachers agreed that learners often requested them to conduct practical work and teachers were always confronted with questions like, "Sir, are we going to do practical work today?" Although some learners in the interview could not explain why they regarded doing practical work as fun, it was not clear whether or not this enthusiasm to practical work is attributed to the experimental chemical reactions, empirical collection of data or merely a dislike of theoretical lessons and tests. Further reasons in to course of these excitements remain to be study. The small percentage of learners who opted for (Almost Never) 6.6% and (Seldom) 6.9%, *reported in the interview that the reason why they disliked practical work was because they found practical work as time consuming, intellectually challenging and too dangerous to human beings. Generally teachers in the interview were of the opinion that learners enjoyed practical work because they found it fun.* Toplis and Allen (2012:7) stated that "learners do not enjoy a practical lesson if it requires them to write and submit reports." This issue needs to be studied further to find the reasons behind the small percentage of learners' dislike of practical experiments in the Namibian context. The cross tabulation table for this item below shows how the learners in the different regions answered this item.

Item 3. I dislike doing practical investigations.

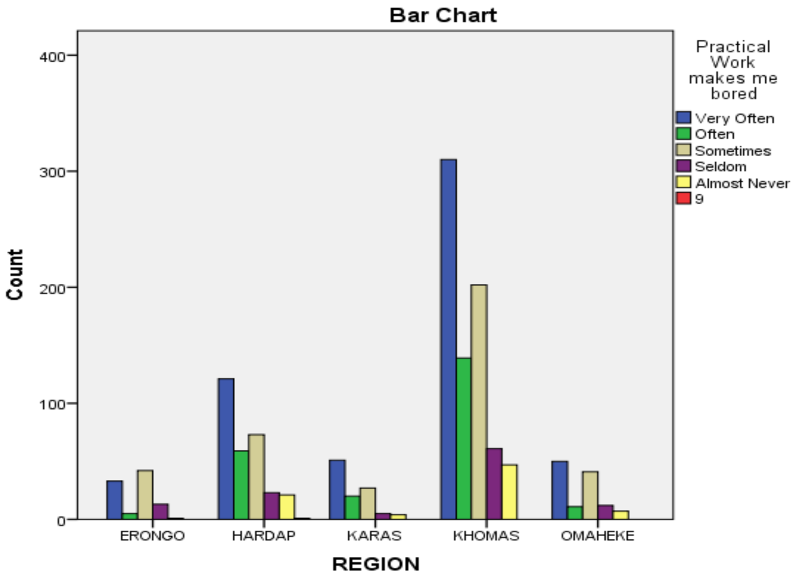
Table 5.4. Results for Item 3

REGION	Dislike doing practical investigations						Total
	Very Often	Often	Sometimes	Seldom	Almost Never	Missing	
ERONGO	12	13	46	19	9	1	90
HARDAP	80	66	95	42	10	9	293
KARAS	34	23	33	14	2	11	105
KHOMAS	213	139	260	107	17	5	736
OMAHEKE	22	19	51	19	6	18	115
Total	361	260	485	201	44	44	1339

This item was stated negatively and the scores were reversed. The aim of this item was to find out the type of attitudes learners had with regards to doing practical work. This will help in finding answers to question one. The mean score for this statement across the visited regions is 2.46 which represented seldom in the Likert-scale of 1-5. The standard deviation of 1.110 suggests that the result of learners around the visited region is slightly clustered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤.05 and it can be interpreted as there is no significant differences in the way learners answered the item; "I dislike Chemistry investigations" in their Chemistry laboratories throughout the visited regions. This means that the dependent variables are the same across all levels of a factor, and generally learners have the same positive attitudes towards practical work across all schools. The confident interval for this statement at 95% ≈ {1. 872; 3.048}. Chi-square of .001 for this item suggests that there is a strong significant association between the regions and their opinion on this item. A high percentage of learners opted for (sometimes) 36.2%, (seldom) 19.4% and (very often) 27.0%. This indicates the high interest that learners have in practical investigations; which also highlight a positive leaning environment that exists between learners and teachers; learners and practical investigations. The majority of the schools chose (sometimes and almost never) as a dominant option in their five choices with an exception of Hochland High school in Khomas region which showed a very high percentage of "very often". This item is in agreement with what Cerini et al (2003: 10) suggested that the majority of the learners enjoyed doing practical work.

Item 4. Practical works make me bored

Figure 5.2. Results for item 4



This item was stated negatively and the scores were reversed before analysis. The objective of this statement was to find out the type of attitudes the learners had with regards to practical work. The aim was to provide an answer to the research question 6, which aimed to find out "What the characteristics of Chemistry practicals in Namibia are?" The international trend according to Williams, Stanisstreet, Spall, Boyes and Dickson, (2003: 329) is that learners tend to perceive Biology as interesting while Physics and Chemistry were regarded as boring. This is mainly due to the fact that Biology is more associated with every day's life events that they experience like changes to their bodies, nature and wild life, while Physics and Chemistry are associated with Mathematics which is regarded as complicated, according to (Williams at el 2003:329). The mean for the reversed score of this statement across the visited regions is 2, 21 on the Likert-scale of 0-5, which represented seldom in the questionnaire with a standard deviation of 1,238. This standard deviation suggests that the data are slightly scattered around the mean. The Kruskal-Wallis Test shows an insignificant value of .093 which is ≥ .05 at 5% significant level, this can be interpreted that there is significant differences in the way learners regarded "practical work as boring" in their Chemistry laboratories throughout the visited regions. In some schools the learners do not regard practical work as boring while others regard practical work as boring (Figure 5.2). The confidence interval for this statement is at 95% ≈ {2.145; 2. 275}. Chi-square of .001 for this item suggests that there is a strong evidence of association between the regions and their opinion on this item. During the interview some learners suggested that practical investigations made them curious to want to know more about phenomena. Past research has provided convincing evidence that the quality of classroom environment and the type of experiments conducted in class were a mayor role player in stimulating learning (Webster & Fisher 2004; Temons, 2005 and Claiborne & Ellett, 2005). These suggest that positive learning environments prevail in some visited regions like Erongo and learners are not necessarily bored by doing practical investigations. This item can also be linked to item number 2 that scored highly in terms of learners seeing practical work as fun, meaning there was no way that learners would regard practical work as fun and on the other hand regard it as boring. In the end, both items can be linked to prevailing positive learning environments and in answering question number six.

Item 5. I find it interesting doing practical work

Table 5.5 Results per region for item 5

REGION	I find it interesting doing practical work						Total
	Almost Never	Seldom	Sometimes	Often	Very Often	Missing	
ERONGO	1	1	35	21	34	0	92
HARDAP	11	17	53	96	120	0	297
KARAS	1	7	19	27	53	0	107
KHOMAS	35	37	180	191	321	1	764
OMAHEKE	1	3	34	35	48	1	121
TOTALS	49	65	321	370	576	2	1381

The mean score for this statement across the visited regions is 3.98 on the Likert-scale of 0-5, with standard deviation of 1,076. The confident interval for this statement is at 95% ≈ {3.923; 4.037}. The intention of this statement was to measure the extent to which learners enjoyed practical work. The Kruskal-Wallis Test shows an insignificant value of .384 which is ≥ .05 and can be interpreted as there is significant difference in the way learners answered the item "I find it interesting in doing practical work" in their Chemistry laboratories throughout the visited regions. This means that the dependent variables are not the same across all levels of factors and in some schools' learners find practical work less interesting. The examples by two regions in Bar-Char 5.3 below show that learners in Erongo region opted for "Sometimes" compare to "Very Often" in the Karas Region. It is also interesting to notes that according to the 2011 and 2012 NSSC (Grade 12 National and Regional Ranking, http://www.dnea.gov.na/stats) the Karas Region had 34 A symbol and 81 B symbol while Erongo had 22 A and 46 B in the Physical Science end of year examination. Williams at el (2003: 325) narrated the issues that provoke interest of learners in practical work as handiness of equipment, motivation from educators and relating practical investigations to every day's life. This might be the various items that are needed in schools were learners show poor interest in practical work. The issue of motivation from educators might have influence on the learners' attitudes to Chemistry in some of these schools. *During the interview some learners blaming educators for lack of subject knowledge, poor planning and lack of interest.* This item provided answers to the third research question about teacher-learners interactions because motivation can only come through proper teacher-learners interactions. The results from some schools shows lack of interest in doing practical work, especially from female learners, while, other schools show an average to above every interest from female learners in doing practical work. The results for this item are not generally speaking the same thing as far as learners' interest in doing practical work is concerned, but it differs from school to school.

Figure 5.3 Results from Erongo region

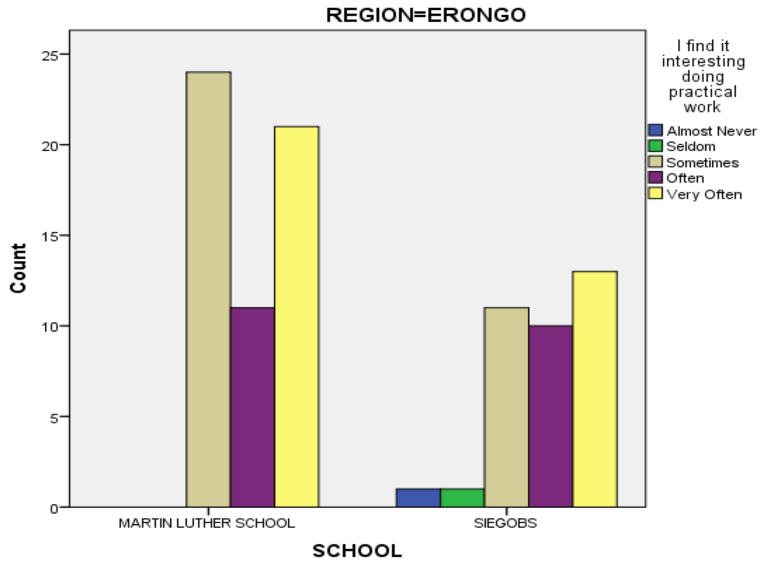
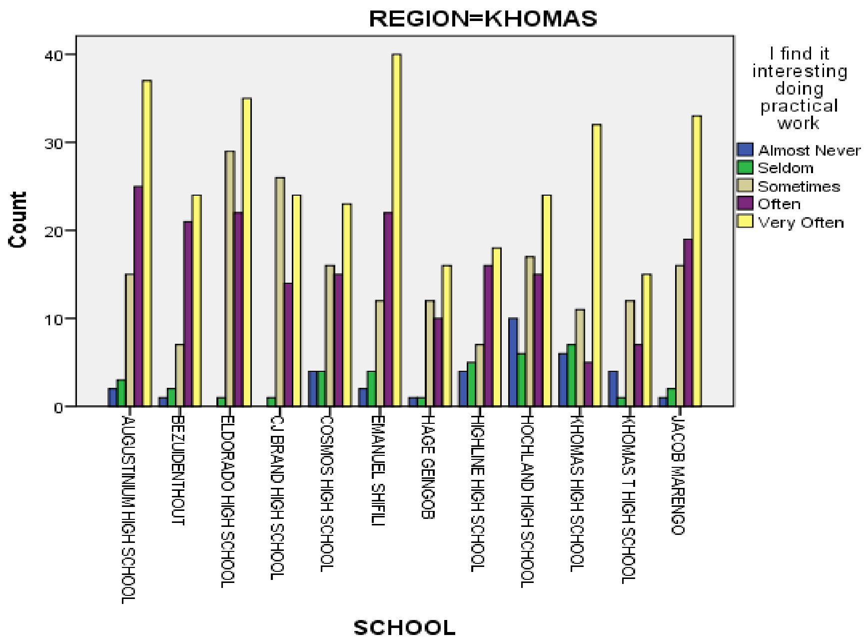
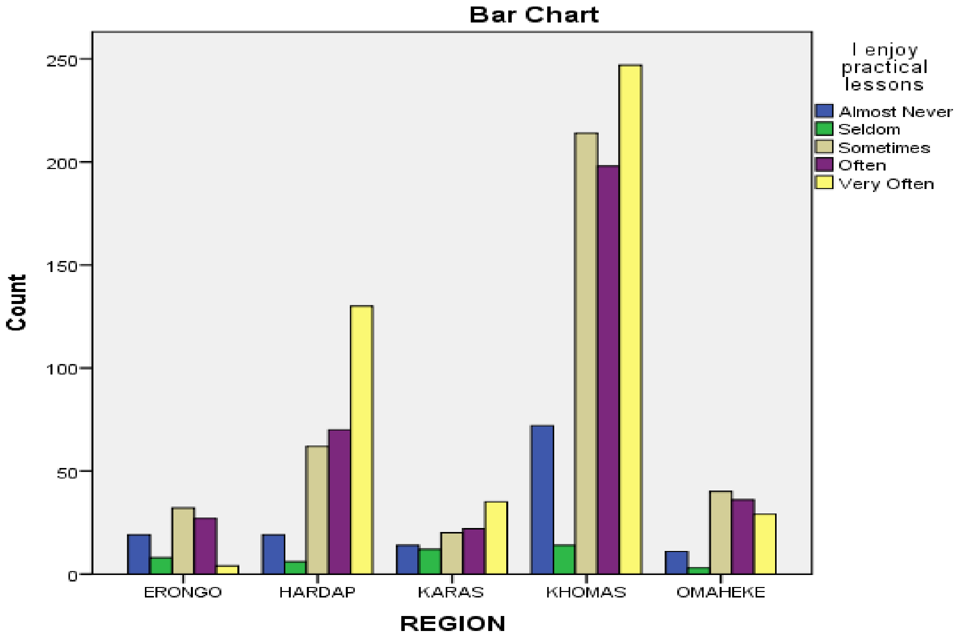


Figure 5.4 Results from Khomas Region



Item 6. I enjoy practical lessons

Figure 5.5 Results for item 6



The aim was to find out the attitudes of learners with regards to practical lessons enjoyment. (NFER, 2010:09) highlighted the need for teachers to make science practical lessons fun and enjoyable, this increases learners' interest to become stronger and learners tend to regard practical work as fun and enjoyable rather than difficult and boring. The (NFER, 2010:09) further highlighted that young people will be more engaged in science practical work if:

i) Practical work is more relevant to their contemporary every days life;

ii) There is positive influence from science teachers;

iii) Learners link science practical work to future career opportunities;

iv) The science practical work is linked to fun and is an enjoyable aspect of activities outside the classroom.

The sixth research question aimed at finding out the characteristics of practical work in Namibian schools. The results show that the majority of learners do enjoy practical work. This indicates positive Chemistry practicals in the visited regions. The mean score for this statement across the visited regions is 3.69 which represented often in the questionnaire. The standard deviation of 1.242 suggests that the result of learners around the visited region is clustered around the mean. The confident interval for this statement is at 95% ≈ {3.62; 3.76}. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as, there are no significant differences in the way learners “Enjoy practical lessons” in their Chemistry laboratories throughout the visited regions. This means that the dependent variables are the same across all levels of factor, and generally learners enjoy practical work in their lessons. Figure 5.5 above shows three regions opting for “Very Often” and only two regions with few learners opting for “Sometimes”. Due to these reasons, the learner’s enjoyment of practical work could also be linked to the teacher-learner interactions and positive learning environments prevailing in the visited regions.

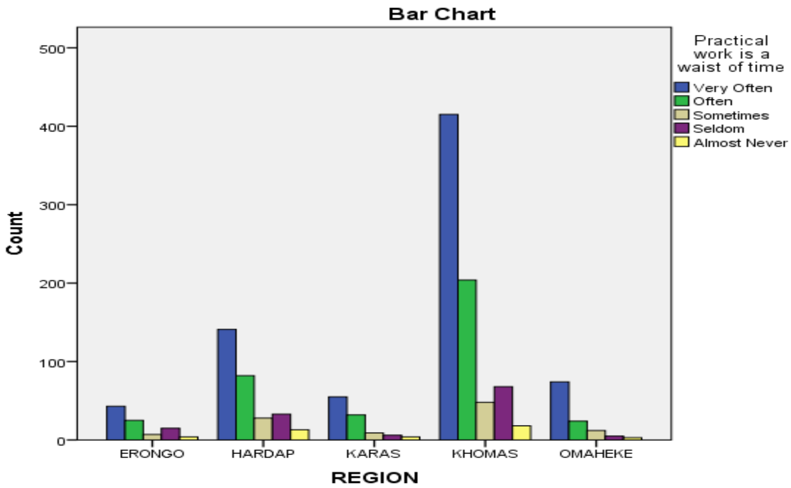
Table 5.6. Results for Item 6

REGION		I enjoy practical lessons						Total
		Almost Never	Seldom	Sometimes	Often	Very Often	Missing	
	ERONGO	19	8	32	27	4	6	90
	HARDAP	19	6	62	70	130	5	287
	KARAS	14	12	20	22	35	9	103
	KHOMAS	72	14	214	198	247	8	745
	OMAHEKE	11	3	40	36	29	11	119
Total		135	43	368	353	445	39	1344

Item 7. Practical work is a waste of time

This item was stated negatively and the score were reversed. The aim was to find out the ease that learners have with regards to practical work. According to the House of Lords (2006: 33) there should be a link between practical work in the classroom and what is happening outside the classroom, this link will entice learners to want to learn more during practical investigations. The overwhelming number of learners in the visited regions shows the type of characteristics of practical work, as a waste of time as suggested by item 7. This item gives answers to research question six, about the prevailing characteristics in the library in the visited regions. The mean score for this statement across the visited regions is 1.82 which represented seldom in the questionnaire. The confident interval for this statement at 95% ≈ {1. 232; 2.408}, which means any value below or above this value will be deemed insignificant. The standard deviation of 1.106 suggests that the result of learners around the visited region is slightly clustered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as there are no significant differences in the way learners responded to the item "Practical work is a waste of time" in their Chemistry laboratories throughout the visited regions. This means that the dependent variables are the same across all levels of a factor, and generally learners regard practical work as waste of time the majority of learners opted for "very often". A high percentage of 80, 1 % of the learners regard practical work as a waste of time. *During the interview some responses mentioned inappropriate and poorly planned practical work as a waste of time and lack of resources because in the end it does not benefit the learners.* Successful experiments seem to encourage learners to want to do more practical investigations and find out new things. When asked about the reasons why they see practical work as a waste of time some responses were: "*There are always no chemicals or tools to use in the experiment; our teacher is not well prepared during practical demonstrations; I do not see the need for practical work."* Practical work is an effective way of learning and reinforcing theoretical concepts in science. Teachers who make effective use of practical work and experiments often find that learners learn better. *During the interview most teachers referred to lack of equipment and chemicals as the major problem that causes teachers not to plan or do practical work.* Through practical work, teaching is enhanced and becomes more interesting both for the learner and the teacher. Chi-square of .002 is ≤ .050 and it can be interpreted as statistically significant and this further suggests that there is no strong significant association between the regions and their opinion on this item.

Figure 5.6. Results for item 7



Item 8. I love Chemistry more than any other subject

The aim of this statement was to find out how learners regarded Chemistry in comparison with other subjects. The mean score for this statement across the visited regions is 2.99 which represented sometimes in the questionnaire. The confident interval for this statement is at 95% ≈ {2.93; 3.05}. The standard deviation of 1.092 suggests that the result of learners in the visited region is nearly clustered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as there are no significant differences in the way learners answered the item "I love Chemistry more than other subjects", throughout the visited regions. This means that the dependent variables are the same across all levels of a factor, and generally learners are showing a significant 50% love towards Chemistry. The remaining 50% are not sure if their love for Chemistry is above or below the other subject. This item can also be linked to whether the learners have a future career or plans in Chemistry or not. This item provides answers to item number 6 about the nature of current laboratories in Namibia. The assumption is that if learners love the subject they will put more effort in understanding it. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item, therefore the researcher can be 95% confident that this relationship between the regions and the learners' opinion on this item is not due to chance.

Table 5.7 Answers for Item 8

REGION	I love Chemistry more than any other subject.						Total
	Very Often	Often	Sometimes	Seldom	Almost Never	Missing	
ERONGO	9	9	34	27	14	0	93
HARDAP	29	69	133	40	25	1	296
KARAS	17	20	37	20	12	2	106
KHOMAS	77	146	327	136	76	1	762
OMAHEKE	10	14	55	28	14	1	121
Total	142	258	586	251	141	5	1378

Item 9. Chemistry is not important in comparison to other subjects

This statement was stated negatively and the scores where reversed. The aim was to find out the leisure interest of learners in Chemistry. This item can be linked to the previous item number 9 and the results shows a close association. This item can help in providing answers to research question one, because it shows the underlying attitudes among learners towards the subject. The mean score for this statement across the visited regions is 2.96 which represented some times in the questionnaire. The confident interval for this statement is at 95% ≈ {2.88; 2.02}. This suggests that not all learners agreed with the importance of Chemistry in comparison with other subjects. The standard deviation of 1.576 suggests that the result of learners around the visited region is spread out 1.576 units below or above the mean, which means that this item the standard deviation is within the 95% confident intervals. There is generally a mixed feeling on the importance of Chemistry in comparison with other subjects. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as; there are no significant differences in the way learners "compare Chemistry to other subject" throughout Namibia. During the interview the issue of Chemistry being difficult and complicated was raised by various learners, who suggested that they rather do other subjects that seem easier for them: "*Should you choose between Chemistry and any other subject like Business Studies or History what will you choose and why?" I will* *rather choose other subject because Chemistry is too complicated and difficult to understand; I do not see a future with Chemistry".* This means that the dependent variables are the same across all levels of factor. Chi-square of .001 for this item suggests that there is a strong and significant association between the regions and their opinion on this item.

Table 5.8 Results of Item 9

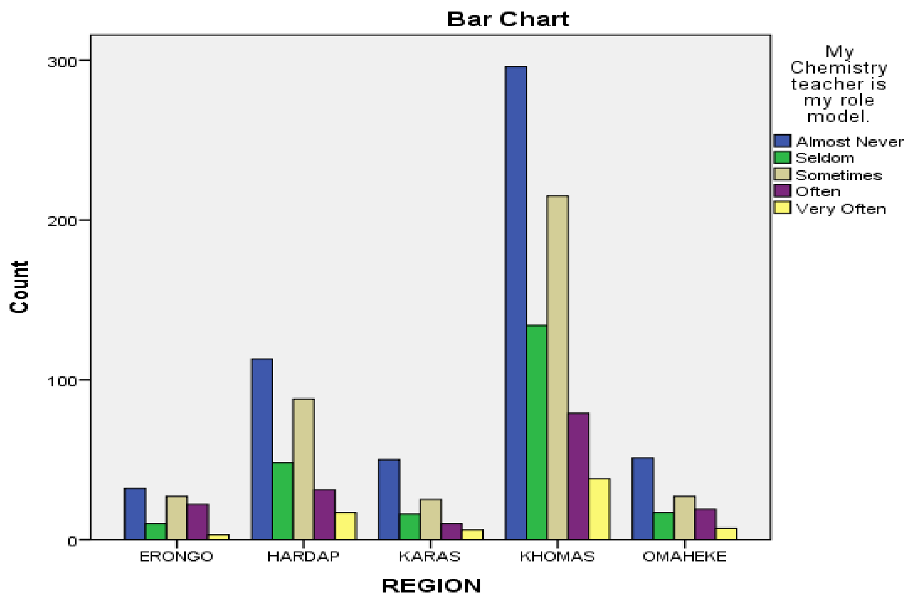
REGION	Chemistry is not important in comparison with other subjects.						Total
	Very Often	Often	Sometimes	Seldom	Almost Never	Missing	
ERONGO	8	2	14	20	48	0	92
HARDAP	88	31	50	57	71	1	297
KARAS	28	16	20	20	23	0	107
KHOMAS	252	102	142	95	171	1	762
OMAHEKE	34	8	18	19	40	4	119
Total	410	159	244	211	353	6	1377

Item 10. My Chemistry teacher is my role model

The objective of this statement was to find out if there is any career influence from the science teachers towards their learners in the visited regions. (NSTA, 2006: 55) suggested that science educators play central roles in educating, inspiring, and guiding learners to become responsible and scientifically literate citizens. They help learners reflect and use skills of inquiry to become effective problem solvers in the future. The opposite can also be true that negative teacher's role model could influence learners negatively in science fields (Wynarczyk & Hale, 2009:7). A lack of science and engineering role models has been cited by authors in the field as a potential problem particularly when referring to making science classroom relevant to pupils everyday life experiences (Roberts, 2002: 17, Rasekoala, 2001: 38).This statement further aims at elucidating the relationship between teacher-learner interactions and learning environment, which is covered by research question four. The mean score for this statement across the visited regions is 2.27 on the scale of 0-5, which represented seldom in the questionnaire with a standard deviation of

1,235. This standard deviation suggests that the data are closely scattered around the mean. The confident interval for this statement is at 95% ≈ {2.21; 2.34}. The mean of 2.27 also suggests that the majority of the learners do not regard their Chemistry teachers as their role model. The Kruskal-Wallis Test shows an insignificant value of .190 which is ≥ .05, this can be interpreted that there is a significant differences in the way learners regards their teachers as role model throughout the visited region. Some schools regard their Chemistry teachers as role model while other schools do not regards them as role models. During the interview, some learners referred to other celebrities as their role models e.g. musicians, politicians, and sports men and women: *Who is your role model and why? Frankie Fredericks, Former President Sam Nujoma, Harry Simon, Gazza and the Dogg.* These were the prominent answers during the interview. Chi-square of .027 for this item suggests that there is a strong and significant association between the regions and their opinion on this item. It can be said that the relationship between the regions and this item is 95% not due to sampling error.

Figure 5.7 Results for item 10



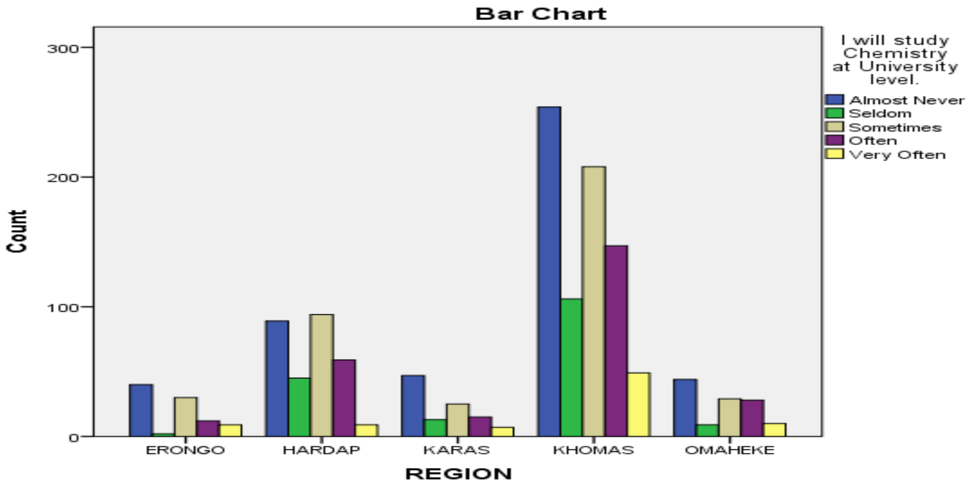
Item 11. I will study Chemistry at University level

Table 5.9. Results for item 11

REGION	I will study Chemistry at University level.						Total
	Almost Never	Seldom	Sometimes	Often	Very Often	Missing	
ERONGO	40	2	30	12	9	1	93
HARDAP	89	45	94	59	9	0	296
KARAS	47	13	25	15	7	0	107
KHOMAS	254	106	208	147	49	2	764
OMAHEKE	44	9	29	28	10	0	120
Total	474	175	386	261	84	3	1380

The mean score for this statement across the visited regions is 2.50 on the scale of 0-5 which represents sometimes, with standard deviation of 1.296. The confident interval for this statement is at 95% ≈ {2.47; 2.57}. The intention of this statement was to measure the extent to which learners see their career progress in the field of Chemistry. The overall result shows a mixed feeling among learners because some learners (47%) do not see themselves as studying Chemistry at university level. If learners do not associate with Chemistry as a subject for their future career, their interest in studying a subject that they do not need for a future career becomes sluggish. This statement is narrated by Bennett and O' Neale (1998: 58) who stated that "Only a minority of Chemistry students make direct use of their Chemistry knowledge and skills in their work, and it seems increasingly true that many Chemistry students have no intention of pursuing Chemistry as a career." The Kruskal-Wallis Test shows insignificant value of .306 which can be interpreted that there is a significant difference with regards to learners' interest in pursuing Chemistry in their future career. A high percentage of learners 47% shows that they will not want a future career in Chemistry and 28% are unsure if they will have a future career in Chemistry as seen in the graph below. The .306 value means that the dependent variables are not the same across all levels of a factor. Learners vary significantly in their opinions with regards to this item. Looking at Table 5.8 below it is clear that a significant number of learners in all regions suggested that they would not pursue Chemistry career at tertiary level. Chi-square of .003 for this item suggests that there is a significant association between the regions and their opinion on this item.

Figure 5.8. Results for item 11



Item 12. Chemistry is one of the easiest courses for me

Table 5.10. Results for item 12

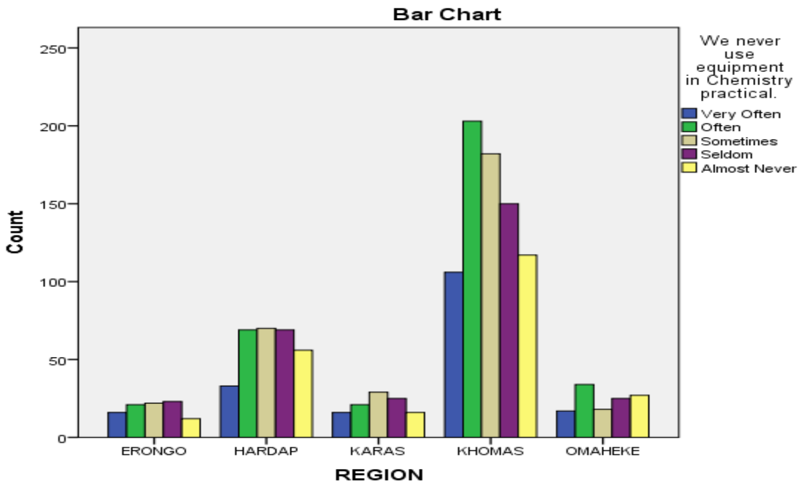
REGION	Chemistry is one of the easiest courses for me.						Total
	Almost Never	Seldom	Sometimes	Often	Very Often	Missing	
ERONGO	20	5	27	27	15	0	94
HARDAP	33	37	70	89	66	1	295
KARAS	21	12	26	24	24	1	107
KHOMAS	126	130	153	191	164	0	764
OMAHEKE	26	15	32	29	18	1	120
Total	226	199	308	360	287	3	1380

Chemistry knowledge is learned at three levels: “sub-microscopic,” “macroscopic “and “symbolic”, and the link between these levels should be explicitly taught (Treagust *et al*., 2003:1355). Chemistry, by its very nature, is highly conceptual. While much can be acquired by rote learning (this often being reflected by efficient recall in examination questions), real understanding demands the bringing together of conceptual understanding in a meaningful way. Once this scenario is practised by both learners and educators, Chemistry becomes one of the easiest subjects to understand.

However, Chemistry is regarded by most learners as challenging especially the calculations that require some Mathematical skills. The mean score for this statement across the visited regions is 3.21 on the scale of 0-5, which represents sometimes and the standard deviation of 1.361. The confident interval for this statement is at 95% ≈ {3.14; 3.28}. The purpose of this statement was to measure the extent to which learners regard Chemistry as an easy or difficult subject. The Kruskal-Wallis Test shows an insignificant value of .066 which is just above the significant value of .05 at 5%, this can be interpreted that there is slightly a significant differences with regards to the way learners perceive Chemistry in terms of level of difficulties throughout Namibia. This means that the dependent variables are slightly different across all levels of a factor. Some schools show a significant high level regarding Chemistry as easy while others regard it as difficult. During the interview, learners emphasized the difficulties they found in understanding Chemistry formulae and calculations: *Some people regard Chemistry as a difficult subject while others do not see it in that way. What is your opinion on this issue? Chemistry is too complicated especially the formulae and calculations, I would rather do subjects that demand less cognitive thinking and calculations*. *When asked about how learners perceived Chemistry in terms of difficulties, most teachers suggested that learners had a negative mental connotation to Chemistry which psychologically hampers their understanding of Chemistry.* This item helped in answering research question six, by showing the nature of current laboratories in Namibia. From the results, there is a significant number of learners who opted for "sometimes" while a huge number also opted for "Almost Never". This shows that the nature of laboratories in Namibia varies with some learners having high understanding while others are showing low understanding in Chemistry. Chi-square .011 for this item suggests that there is a 95% significant association between the regions and their opinion on this item.

Item 13. We never use equipment in Chemistry class

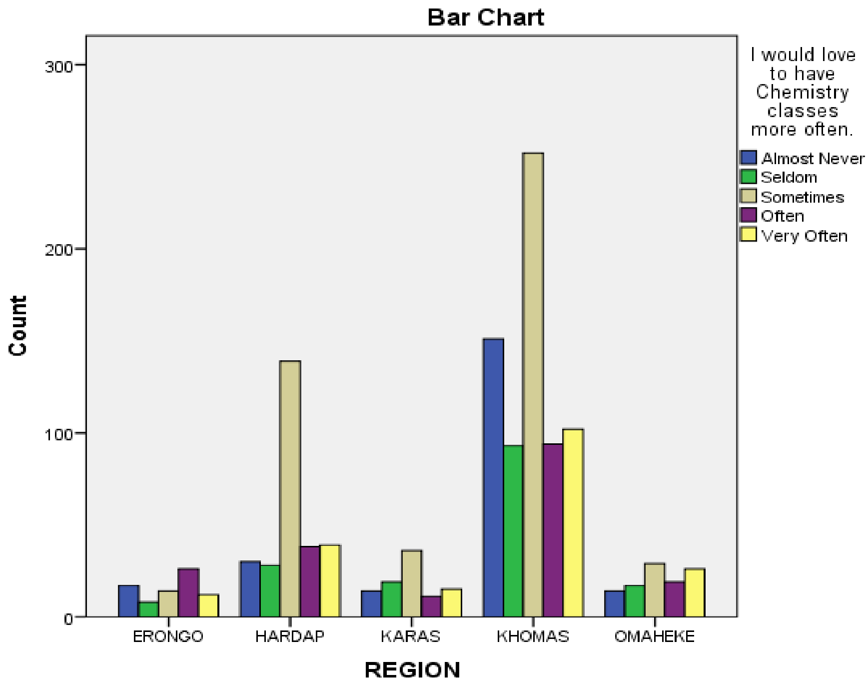
Figure 5.9. Answers for item 13



The study by (Bekalo & Welford, 1999:1305) has been very critical on this issue when they find out that in 80 lessons observed in four secondary schools in Ethiopia, only one lesson was a practical activity lesson and this was only a practical demonstration by the teacher with learners just observing. This issue is strongly supported by Inye (2011: 40) in a study done in Nigeria that learners need to handle equipment during practical investigations. This statement was stated negatively and the scores were reversed. The mean score for this statement across the visited regions is 3.02 on the scale of 0-5, with standard deviation of 1,296. The mean of 3.02 represent sometimes on the Likert scale and highest score in this item were 23.5% (seldom) and 23.3% for (sometimes). In general the scores were scattered all over the scale, which shows that learners have different opinions in the use of equipment in their Chemistry classes. The confident interval for this statement is at 95% ≈ {2.951; 3.09}. The intention of this statement was to measure the extent to which learners used equipment during practical investigation. This item further denotes the class room environment and the teacher-learner interactions during Chemistry practical work by providing insight into the extent to which practical work is done in the laboratory. These also provide answers to research question three in terms of leaner-teacher interactions, the extent to which learners are allowed to use equipment indicates the characteristics of learners-teacher interactions. The Kruskal-Wallis Test shows an insignificant value of .225 which is greater ≥ .05 and it can be interpreted as there being a significant difference with regards to the use of equipment in Chemistry laboratories throughout Namibia. Some schools use equipment more often than others differing from region and school (See Figure 5.9 above). This means that the dependent variables are not the same across all levels of a factor. Chi-square value of .890 is ≥ 0.05 for this item, which suggests that this item has a insignificant association between the regions and their opinion on this item. We cannot be more than 95% sure that the relationship between the region and this item is not due to chance.

Item 14. I will love to have Chemistry classes more often

Figure 5.10. Results for item 14



The aim was to find out the leisure interest of learners in Chemistry lessons. The mean score for this statement across the visited regions is 2.97 which represented some times in the questionnaire. This suggests that not all learners agree with looking forward in attending Chemistry lessons. The aim was to find out if there was interest among learners to addend Chemistry classes. If the learning environment and the teacher-learner interaction are positive (research question three and five) learners will look forward to being in such a class room. The general score in the result is that 37.8% opted for (sometimes) and 18% for (almost never) suggesting that the opinions are scattered and differ from school to school, however, the majority of the learners seem not keen to attend Chemistry lessons. It was however not clear if those who love to attend Chemistry classes often do so due to lack of subject knowledge or due to high interest in Chemistry. *During the interview learners were asked why they liked or did not like attending Chemistry classes and the replies were mixed: I attend because I do not understand and want to understand Chemistry concept; I attend because I understand Chemistry and want to learn more; I do not attend because I do not understand and I hate Chemistry as a subject.* The standard deviation of 1.280 suggests that the result of learners around the visited region is nearly clustered around the mean. *When asked about the attendance of learners in extra classes the teachers' comments showed that learners were not interested in attending extra classes.* The Kruskal-Wallis Test shows a significant value of .005 which is ≤.05 and it can be interpreted as, statistically significant. There is an association between the region and the item "I will love to have Chemistry classes more often". This means that the dependent variables are the same across all levels of factor and that learners across all the regions would mostly love to have Chemistry classes more often. The confident interval for this statement is at 95% ≈ {2.89; 3.04 }. Chi-square of .000 for this item suggests that there is a strong and significant association between the regions and their opinion on this item.

Item 15. Chemistry knowledge is vital for my future career

Table 5.11. Results for item 15

REGION	Chemistry knowledge is vital for my future career.						Total
	Almost Never	Seldom	Sometimes	Often	Very Often	Missing	
ERONGO	35	9	18	20	12	6	94
HARDAP	49	29	46	95	78	2	297
KARAS	19	7	15	32	33	0	106
KHOMAS	134	52	156	236	178	1	757
OMAHEKE	28	3	25	40	19	5	115
Total	265	100	260	423	320	14	1369

The mean score for this statement across the visited regions is 3.32 on the scale of 0-5, with standard deviation of 1.419. The confident interval for this statement is at 95% ≈ {3. 25; 3.36}. The aim was to find out if learners are study Chemistry with the aim of using the Chemistry knowledge they acquire for their future career or not? The average percentage of 30. 9% (Often) and 23. 4% (Very Often) shows that around half of the learners regard Chemistry knowledge as vital for their future career, while the other halves regard it as not crucial. It can be deduced that some learners have an underlying belief that they do not need Chemistry knowledge for their future careers and this might discourage them in studying Chemistry. This position is emphasized by several authors who argue that Chemistry courses are often felt to be irrelevant to learners everyday life and its knowledge does not apply to their intended future careers (Millar, 2006:1513; Bennett, Grasel, Parchmann & Waddington, 2005: 1533; and Aikenhead, 2006:55). The Kruskal-Wallis Test shows a significant value of .001 which can be interpreted as there is no significant difference in the way learners regard "Chemistry knowledge is vital for their future career" throughout the visited regions. This means that the dependent variables are the same across all levels of a factor. It can be deduced from the result that the majority of the learners studied Chemistry to retain knowledge for the future use. It is however not clear whether the future here refers to the examination they have to write or the career. Chi-square of .000 for this item suggests that there is a significant association between the regions and their opinion on this item and this association is not due to chance or sampling error.

Item 16. My Chemistry teacher makes practical work fun

Table 5.12. Results for Item 16

REGION	My Chemistry teacher makes practical work fun.						Total
	Almost Never	Seldom	Sometimes	Often	Very Often	Missing	
ERONGO	14	22	17	19	16	4	88
HARDAP	23	52	86	55	67	16	283
KARAS	17	16	27	18	26	7	104
KHOMAS	89	135	209	138	166	17	737
OMAHEKE	15	32	39	18	10	13	114
Total	158	257	378	248	285	57	1326

The aim was to find out the perception of learners with regards to the teaching style of their Chemistry teachers. This item aimed at answering research questions three on how teacher-learner interactions influenced learners' attitudes in Chemistry. The assumption is that if teachers are offering practical work that is fun and enjoyable, learners will be interested in doing it. The following studies (Hofstein, Mamlok & Ben-Zvi, 2000:33; and Yager & Weld, 2000:178) have shown that unattractive Chemistry practical work can lead to gaps between learners' wishes and teachers teaching. It is for this reason that this item addresses how learners perceive the interaction between them and their teachers during practical Chemistry work. From the table above the result shows the high respond ranging from "Seldom to Very Often". Such responses suggest that in some schools teachers make practical work fun while in other schools practical work is not fun. The mean score for this statement across the visited regions is 3.181 which represented sometimes in the questionnaire. The confident interval for this statement is at 95% ≈ {3.11; 3.25}. The low standard deviation of 1.297 suggests that the result of learners around the visited region is clustered around the mean. The Kruskal-Wallis Test shows a significant value of .003 which is ≤ .05 and it can be interpreted as, there is no significant difference in the way learners "regard their teachers as making Chemistry practicals fun" throughout the visited regions. This means that the dependent variables are the same across all levels of factor, and 28.6% of learners opted for (Sometimes), 18.7% (Often) and 21.5% opted for (very often), however, a large percentage of

11.9% (Almost Never) and 19.4% (Seldom) are of great concern. From the results it can be inferred that the majority of the teachers try to make practical work fun. Chi-square of .107 for this item suggests that there is no association between this item and the visited regions. We cannot be more than 95% sure that this relationship between the region and the learners' opinions are due to chance.

Item 17. I have difficulty to understand Chemistry

Table 5.13. Results of Item 17

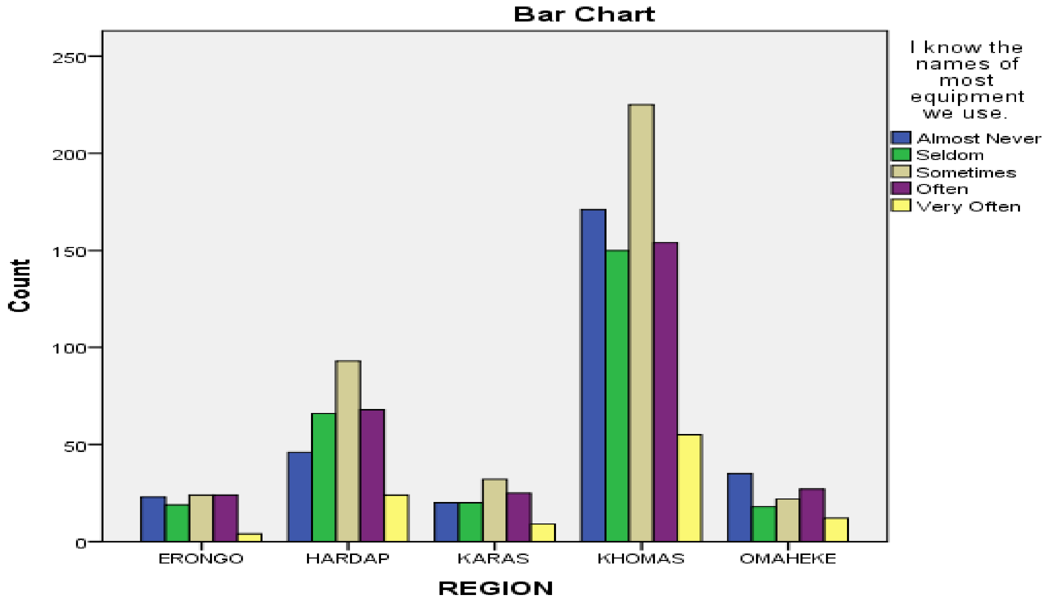
REGION	I have difficulties to understand Chemistry.						Total
	Almost Never	Seldom	Sometimes	Often	Very Often	Missing	
ERONGO	9	1	27	21	31	2	89
HARDAP	13	15	79	84	103	1	294
KARAS	5	7	25	32	37	4	106
KHOMAS	86	69	235	170	200	3	760
OMAHEKE	13	8	44	21	33	5	119
Total	126	100	410	328	404	15	1368

This item was stated negatively and the scores were reversed. The aim was to find out to what extent learners experience difficulties in Chemistry as a subject. Learning Chemistry can become a challenging work for learners of different ages, (Chiu, 2005:1). The mean score for this statement across the visited regions is 3.57 which represented often in the questionnaire. The confident interval for this statement is at 95% ≈ {3. 54; 3. 64}. The percentage of 29.9% (Sometimes), 24% (Often) and 29.5% (Very often) imply that most of the learners do experience problems with understanding Chemistry at different levels. The low standard deviation of 1.239 suggests that the result of learners in the visited region is clustered nearly close to the mean. The Kruskal-Wallis Test shows a significant value of .033 which is ≤ .05 and it can be interpreted as, there is no significant difference in the way learners "understand Chemistry" throughout the visited regions. This means that the dependent variables are the same across all levels of a factor, and generally learners have the same feeling with regards to understanding

Chemistry (See Graph above) Chi-square of .000 for this item suggests that there is a strong and significant association between the regions and their opinion on this item.

Item 18. I know the names of most equipment we use

Figure 5.11. Results of Item 18



Learners should know the names and purpose of equipment that they are using so that they can use it more effectively. Most of the schools visited used micro-scale Chemistry kits in their laboratories. This is mostly due to micro-scale Chemistry kit ability to cut cost, to have all needed Chemicals in small quantities that improve safety and decreases waste. The item aimed at answering research question six by showing the characteristics of Chemistry laboratories in Namibia. The 21.6 % of learners showing Almost Never are of great concern because that shows that quite a number of learners do not know the names of the equipment that they are using. The names of equipment can play a major role during practical examinations because sometimes questions about drawing or using equipment are asked. The mean score for this statement across the visited regions is 2.96 on the scale of 0-5, with standard deviation of 1.232. The confident interval for this statement is at 95% ≈ {2.93; 3.03}. The intention of this statement was to measure the extent to which learners knew the names of the instruments they were using. In terms of percentages 21.6% (Almost Never), 20.0% (Seldom) and 29.0% opted for (seldom), this shows that a significant high amount of learners were not aware of the names of some of the Chemistry equipment they used in Chemistry practical. The Kruskal-Wallis Test shows a significant value of .033 which is ≤ .05 and it can be interpreted that there is no significant difference with regards to learners' knowledge about their equipment' names. This means that the dependent variables are the same across all levels of a factor. Chi-square of .826 for this item suggests that there is no statistical significant association between the regions and their opinion on this item. There might be a relationship error between the regions and the learners' opinions on this item due to sampling or chance.

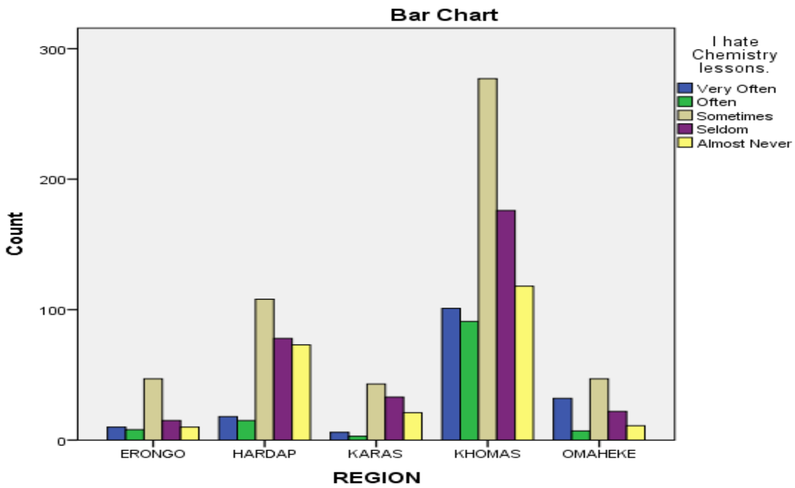
Item 19. I hate Chemistry lessons

Table 5.14. Results for item 19

	I hate Chemistry lessons.						Total
	Very Often	Often	Sometimes	Seldom	Almost Never	Missing	
ERONGO	10	8	47	15	10	0	90
HARDAP	18	15	108	78	73	0	292
KARAS	6	3	43	33	21	6	106
KHOMAS	101	91	277	176	118	3	763
OMAHEKE	32	7	47	22	11	4	119
Total	167	124	522	324	233	13	1370

The aim was to find out the learners' leisure interest in Chemistry lessons. This item provided answers to research question one. The assumption is that if learners' attitudes towards Chemistry lessons are positive then it will yield a positive learning environment. The mean score for this statement across the visited regions is 3.24 which represented sometimes in the questionnaire. The confident interval for this statement at 95% ≈ {3.177; 3.272}. The high standard deviation of 1.199 suggests that the results of learners around the visited region are not clustered around the mean. The dependent variables are not the same through the visited regions. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as there are no significant differences in the way learners “hate Chemistry lessons” in their Chemistry laboratories throughout the visited regions. This means that the dependent variables are the same across all levels of factor, and generally learners are enjoying practical work in their lesson. Most schools in all visited regions opted for (Sometimes) 38.1% followed by 23.6% (Often) and (Very Often) 17.1 %. *During the interview the majority of girls shows lack of interest in Chemistry compared to boys and this confirms what Osborne, Simon and Collins, (2003: 1064) suggested “that there is still prejudice against physical sciences held by girls, suggesting that at an individual level the overwhelming majority of girls still choose not to do physical science in comparison with boys”. Teachers were of the opinion that boys enjoyed practical lessons more than girls.* This opinion seemed to hold truth during the interview as more girls showed resentment towards the subject as opposed to boys. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Figure 5.12. Results for Item 19



Item 20. I would like to work in the laboratory in future

Table 5.15. Results for Item 20

REGION	I would like to work in a laboratory in future.						Total
	Almost Never	Seldom	Sometimes	Often	Very Often	Missing	
ERONGO	36	8	34	8	8	5	94
HARDAP	114	32	119	22	8	8	295
KARAS	48	14	34	7	4	4	107
KHOMAS	316	131	252	20	24	11	743
OMAHEKE	42	19	37	5	10	3	113
Total	556	204	476	62	54	31	1352

The aim was to find out the career interest of learners in Chemistry laboratory. This item hoped to provide answers to research question one by showing what attitudes exited among learners in terms of future careers that involved Chemistry. NFER, (2010:09) highlighted the need for Chemistry practical work to be linked with future career of the learners in order for them to have high interest in Chemistry. The mean score for this statement across the visited regions is 2.15 which represented sometimes in the questionnaire and is in the confident interval margin for this statement at 95% ≈ {2.089; 2.211}. This suggests that not all learners agree or see themselves as working in the laboratory in future. The standard deviation of 1.133 suggests that the result of learners in the visited region is not clustered around the mean and the dependent variable is not the same throughout the visited regions. The two highest choices made by learners were the (Almost Never) 41.1% and (Sometimes) 35.3%. During the interview it was clear that most girls were of the opinion of never to work in a laboratory in future and they might have contributed to the high percentage of all most never. The Kruskal-Wallis Test shows a significant value of .022 which is ≤ .05 and it can be interpreted as, statistically significant. There is an association between the region and the item “I would like to work in the laboratory in future”. This means that the dependent variables are the same across all levels of factor and that generally learners would not want to work in the laboratory in future (See the Table 5.15 above). Chi-square of .002 for this item suggests that there is a significant association between the regions and their opinion on this item and the relationship is not due to chance.

Item 21. I don't need Chemistry knowledge

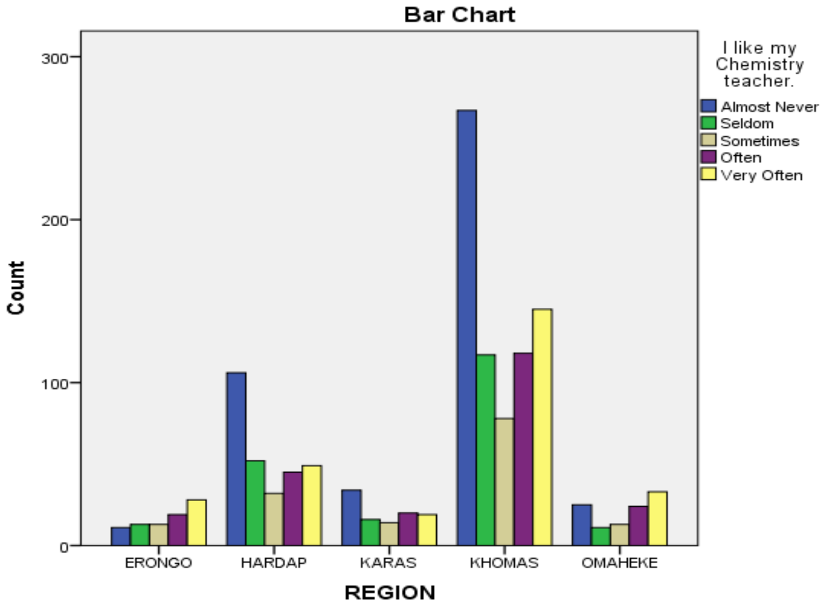
Table 5.16. Results for Item 21

REGION	I don't need Chemistry knowledge.						Total
	Very Often	Often	Sometimes	Seldom	Almost Never	Missing	
ERONGO	49	16	19	4	5	1	93
HARDAP	93	62	34	66	42	0	297
KARAS	42	18	11	24	12	19	107
KHOMAS	257	134	105	108	132	8	737
OMAHEKE	52	20	15	16	8	10	111
Total	493	250	184	218	199	38	1345

This statement was stated negatively and the scores were reversed. The aim was to find out the learners interest in having knowledge of Chemistry. This helped in answering research question one. The assumption is that if learners see the need for Chemistry knowledge, they will have high interest in getting the knowledge and develop positive learning environment and attitudes that is conducive for learning. The mean score for this statement across the visited regions is 2.54 which represented sometimes in the questionnaire. The confident interval for this statement is at 95% ≈ {2.46; 2.62}. This suggests that not all learners agree with the need for Chemistry knowledge. The standard deviation of 1.492 suggests that the result of learners around the visited region is not clustered around the mean. This suggests that the dependent variables are not the same across all regions. The majority of the learners opted for (Almost Never) 36.7% and (Seldom) 18.6%, while 13.7% choose (Sometimes). The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as; there are no significant differences in the way learners "regards Chemistry knowledge as important" throughout the visited regions. This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a strong and significant association between the regions and their opinion on this item.

Item 22. I like my Chemistry teacher

Figure 5.13. Results for Item 22



The aim was to find out the type of relationship that existed between learners and the teacher. This will help in providing answers to research question one and three. The assumption is that if teacher-learner interactions are positive then the social cohesion will also be positive. Good relationship between teacher and learners will foster positive attitudes among learners and towards the subject. The mean score for this statement across the visited regions is 2.75 which represented sometimes in the questionnaire. The confident interval for this statement is at 95% ≈ {2.664; 2.794}. This suggests that not all learners agree with the idea of liking their teacher. The high standard deviation of 1.574 suggests that the result of learners around the visited region is insignificant. This means that the dependent variables are not the same across all levels of factor. In terms of percentages the value is scattered all over the five point scale with no congruent differences, e.g. Almost Never =34.0%, Seldom=16%, Sometimes=11.5%, Often=17,4% and Very often=21.0%. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as, there is no significant differences in the way learners “like their teacher" throughout out the visited regions. The significant of learners in the Khomas and Hardap regions opted for almost never. Chi-square of .002 for this item suggests that there is a 95% strong and significant association between the regions and their opinion on this item and the result is not due to chance or random sampling.

Item 23. Chemistry calculations are difficult (Hectic)

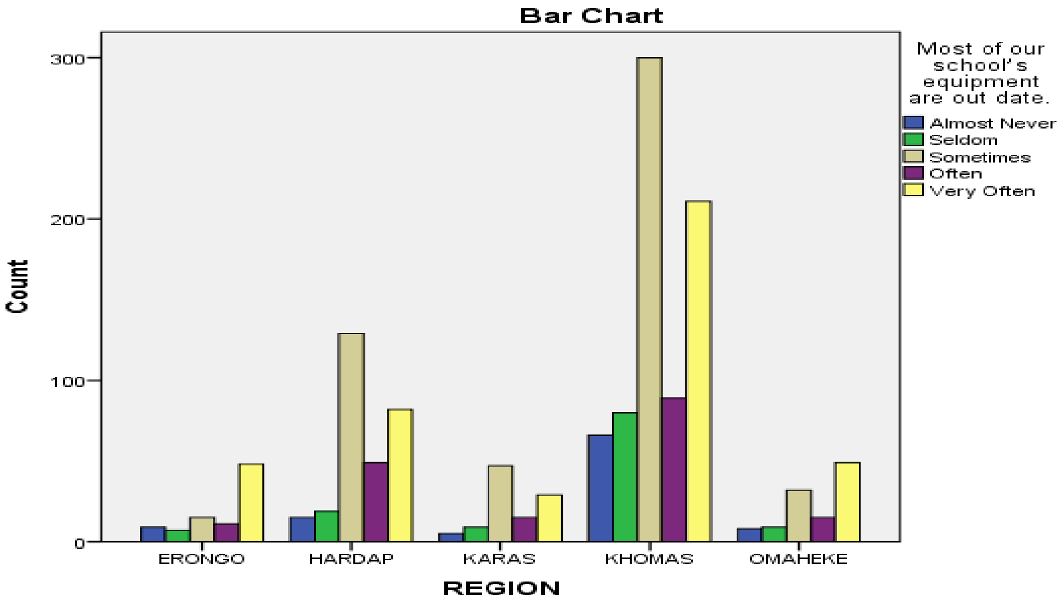
Table 5.17. Results for Item 23

REGION	Chemistry calculations give me hectic (difficult)						Total
	Very Often	Often	Sometimes	Seldom	Almost Never	Missing	
ERONGO	33	11	9	26	12	2	91
HARDAP	50	32	81	76	56	12	295
KARAS	20	9	26	32	19	8	106
KHOMAS	140	60	159	215	161	11	736
OMAHEKE	25	9	17	36	23	12	110
Total	268	121	292	385	271	45	1338

The aim was to find out the social implications of calculations in Chemistry, how learners experience the level of complexity in doing the Chemistry calculations. If the experience is too bad then it will affect the learning environments and the characteristics of Chemistry practicals in Namibia. This answered research questions one and three. The mean score for this statement across the visited regions is 3.21 which represented sometimes in the questionnaire. The confident interval for this statement is at 95% ≈ {3.14; 3.29}. This suggests that not all learners agree or see themselves as having difficulties in doing calculations in Chemistry. The result in terms of percentages is spread all over the five point scale with Almost never= 20.0%, Seldom= 9.0%, Sometimes = 21.8%, Often= 28.8% and Very Often= 20.2% respectively. The standard deviation of 1.405 suggests that the result of learners in the visited region is not squarely scattered around the mean. The Kruskal-Wallis Test shows a significant value of .038 which is ≤ .05 and it can be interpreted as, statistically significant. There is an association between the region and the item "Chemistry calculations give me hectic". This means that the dependent variables are the same across all levels of factor and generally learners in all visited region feel the same way with regards to this item. Chi-square of .005 for this item suggests that there is a significant association between the regions and their opinion on this item.

Item 24. Most of our school equipment's are out dated.

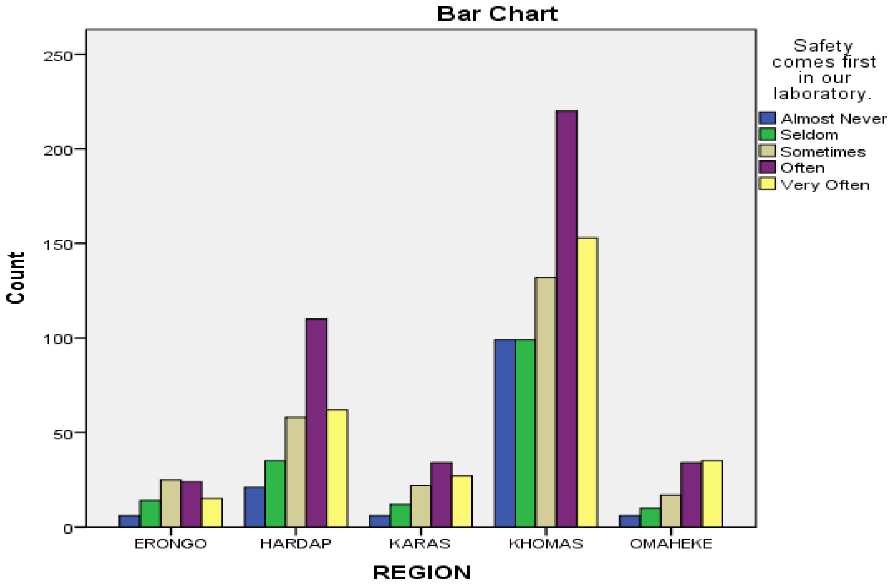
Figure 5.14. Results for Item 24



This statement was stated negatively and the scores were reversed. The aim was to find out the status of the equipment used in the laboratory. This will help in answering research questions one and two. The mean score for this statement across the visited regions is 3.51 which represented often in the questionnaire. The confident interval for this statement at 95% ≈ {3.47; 3.54}. If most equipment are out dated, it can serve as a deterrent to learners perception of the learning environment and learners attitudes to Chemistry practical. The standard deviation of 1.231 suggests that the result of learners around the visited region is clustered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as there is no significant difference in the way learners "see their school equipment as out dated" in their Chemistry laboratories throughout the visited regions. This means that the dependent variables are the same across all levels of factor, and generally the equipment used are out dated. The two dominant categories in this item is (Sometimes) = 38.8% and (Very often) = 31.1%. This suggests a serious lack of new chemical equipment for practical work in the visited regions. Chi-square of .000 for this item suggests that there is a strong insignificant association between the regions and their opinion on this item and the result is not due to sampling error.

Item 25. Safety comes first in our laboratory

Figure 5.15. Results for Item 25



The aim of this statement was to find out how learners regard their safety in their laboratory. Teaching and learning will be effective if a conducive and safe learning environment is created. Research question two is addressed by this item. The mean score for this statement across the visited regions is 3.44 which represented sometimes in the questionnaire. The confident interval for this statement is at 95% ≈ {3.37; 3.51}. This shows a significant amount of learners regarding safety precautions as important in their laboratory. This suggests that the majority of the learners regard their learning environment as safe. Safe laboratories could yield positive learning environment among learners. The standard deviation of 1.273 suggests that the result of learners around the visited region is not clustered around the mean. The Kruskal-Wallis Test shows a significant value of .036 which is ≤ .05 and it can be interpreted as, there are no significant differences in the way learners regard their room' safety as of high importance throughout the visited regions. This means that the dependent variables are the same across all levels of a factor. The scoring on the 5 point scale is scattered all over the scale as follows: Almost

Never=10.8%, Seldom =13.3%, Sometimes=19.9% Often=33.1% and Very often=22.9%. Chi-square of .040 for this item is ≤ .050 which suggests that there is a strong insignificant association between the regions and their opinion on this item.

Table 5.18. Five categories of the questionnaire

Categories	ITEMS	Almost Never	Seldom	Some times	Often	Very Often
Social implications of Science	13,17,21, 23,24	18.34%	11.48%	28.40%	19.48%	22.26%
Attitudes towards inquiry	3, 4, 6, 18, 25	22.06%	14.58%	28.10%	20.90%	14.20%
Enjoyment of science lessons	1, 2, 5, 8,14	9.88%	10.70%	27.18%	23.26%	28.26%
Leisure interest in Science	7, 9, 12, 16, 19	24.70%	16.24%	22.86%	18.62%	17.64%
Career interest in Science	10,11,15, 20, 22	33.58%	13.48%	24.32%	16.68%	11.92%

The percentages may not total 100 exactly due to rounding off. These are the results in percentages in terms of the five different levels of ACPQ. Data were given in percentage on how learners answered various sections of the questionnaire. It is clear from the table that a significant number of learners for the first three categories opted for some times, often and very often, while the last two items were dominated by almost never and seldom. Social implication suggests that most learners have social difficulties in understanding or comprehending Chemistry knowledge e.g. they do not use equipment in practical work, they do not understand Chemistry, equipment are out dated or Chemistry calculations give them problems. The general attitudes of learners toward Chemistry are mixed with half having positive attitudes and the other half having negative attitudes towards Chemistry. The enjoyment of science lessons is particularly favourable among learners in general. However it is noted from the questioners that a great number of female learners are the ones who opted for not enjoying Chemistry practical work. It is also not clear from the male side if the reason behind their enjoyment of Chemistry practical is to avoid content lessons; tests or they simply enjoy the explosions and chemical reactions taking place in the practical lesson.

From the questionnaires responses there is a clear lack of interest in science from the learners' side. Learners' regard Chemistry lessons as a waste of time, boring, difficult and not fun. This suggests that learners will rather do Chemistry practical work than sitting in a Chemistry class and being taught Chemistry lessons. A great deal of learners seem not to have any career interest in science at all. They do not regard Chemistry or its knowledge as important for their future career, the majority indicated that they would not study Chemistry at university level and they did not want to work in laboratories in future.

5.3. Science Laboratory Environment Inventory

Table 5.19. SLEI-Table for all items

Item	N	Independent Sample	Independent Sample	Pearson Chi-square	Confident interval	Mean		Std. Deviation
	Statistic	Kruskal-Wallis Test	Mann-Whitney U Test	Test	CV at 5%	Statistic	Std. Error	Statistic
REGION	1214					3.33	.031	1.070
SCHOOL	1214					10.67	.179	6.240
Learners get on well in the laboratory.	1102	.000	.000	.000	2.95~3.13	3.04	.042	1.379
Learners are given freedom to pursue their own methods in the laboratory.	1093	.000	.000	.000	2.47~2.65	2.56	.043	1.438
The experiments we do are related to topics in the syllabi.	1105	.000	.000	.000	3.50~3.68	3.59	.043	1.445
We follow rules and procedures during practical work.	1069	.000	.000	.000	3.29~3.47	3.38	.044	1.446
Our laboratory is crowed when we are doing experiments.	1072	.000	.000	.000	2.75~2.93	2.84	.045	1.478
I got little chance to get to know other learners in this laboratory.	1121	.000	.000	.000	2.51~2.69	2.60	.044	1.477

In this laboratory I am required to design my own experiments to solve given problems	1090	.000	.000	.000	2.51~2.69	2.23	.042	1.372
In this laboratory everyone is doing experiments on his/her own	1111	.000	.000	.000	2.30~2.47	2.38	.038	1.280
We can break rules in the laboratory if we want and nothing will happen to us.	1126	.000	.000	.000	1.99~2.17	2.07	.040	1.349
The chemicals and equipment that I need for my experiments are readily available.	1086	.000	.000	.000	2.70~2.88	2.79	.042	1.375
Everyone takes part in doing practical work.	1095	.002	.000	.000	3.22~3.43	3.34	.043	1.411
During laboratory sessions other learners collect different data than I do for the same problem.	1080	.000	.000	.000	2.74~2.90	2.82	.041	1.334
We have practical experiment for every topic that we do in Chemistry class.	978	.000	.000	.000	2.58~2.76	2.67	.045	1.422
The wall of the laboratory is decorated with Science related posters.	1016	.000	.000	.000	2.96~3.38	3.17	.107	3.425
We clean and pack the equipments and chemicals after each session.	1041	.000	.000	.000	3.08~3.28	3.18	.051	1.639
We are encouraged to work in groups during practical work.	1036	.000	.000	.000	3.20~3.40	3.30	.048	1.539
We are encouraged to do our own experiments to find out things on our own.	1029	.000	.000	.000	2.71~2.89	2.80	.046	1.490
I apply my theoretical knowledge on Science in my practical work.	1088	.000	.000	.000	3.00~3.18	3.09	.042	1.401
I am always protected (safety) during practical work.	1024	.152	.000	.000	2.97~3.06	3.07	.050	1.588
The laboratory chemicals that we use have expired already.	1049	.000	.000	.000	2.10~2.30	2.20	.049	1.587
I am able to depend on other learners for help in laboratory activities.	1037	.001	.000	.000	3.06~3.30	3.18	.059	1.894

During laboratory session, we can copy answers from one another.	1065	.386	.000	.000	2.10~2.30	2.20	.048	1.559
The teacher only does practical work on topics that he/she likes.	1039	.000	.000	.000	2.51~2.73	2.62	.056	1.517
My teacher tells me the safety rules before I do experiments.	1068	.013	.000	.000	3.32~3.52	3.42	.051	1.674
The laboratory has enough room for me to do my experiments.	1008	.000	.000	.000	3.01~3.25	3.13	.058	1.831
I know everyone in this laboratory by name.	1036	.000	.000	.000	3.42~3.66	3.54	.057	1.850
During laboratory session the teacher only give guidelines to do experiments.	1068	.000	.000	.000	2.89~3.11	3.00	.053	1.719
I love practical lessons more than theoretical lessons.	1011	.023	.000	.000	3.02~3.24	3.13	.056	1.781
We wear protective cloth during laboratory experiments.	1055	.000	.000	.000	2.45~2.69	2.57	.057	1.849
The laboratory atmosphere is so attractive to work in.	1056	.000	.000	.000	2.89~3.11	3.00	.056	1.825
We share equipments during practical work.	1052	.534	.000	.000	2.94~3.18	3.06	.058	1.896
When I got stuck during the experiment I request my teacher's assistant.	1051	.000	.000	.000	3.28~3.54	3.41	.062	2.005
When my experiments fail other learners laugh at me.	1032	.000	.000	.000	2.65~2.89	2.77	.060	1.932
My teacher leaves us alone in the laboratory.	985	.000	.000	.000	2.20~2.46	2.33	.063	1.977
This laboratory is hot and unventilated.	1021	.000	.000	.000	2.39~2.65	2.52	.065	2.069
Valid N (listwise)	227							

Table 5.20 Reliability coefficient for the scale of SLEI

Scale Reliability	Number of Items	Alpha
Learners Cohesiveness (SC)	9	0.80
Open Endedness (OE)	7	0.77
Interpretation (I)	5	0.79
Rule Clarity (RC)	5	0.67
Material Environment (ME)	9	0.71

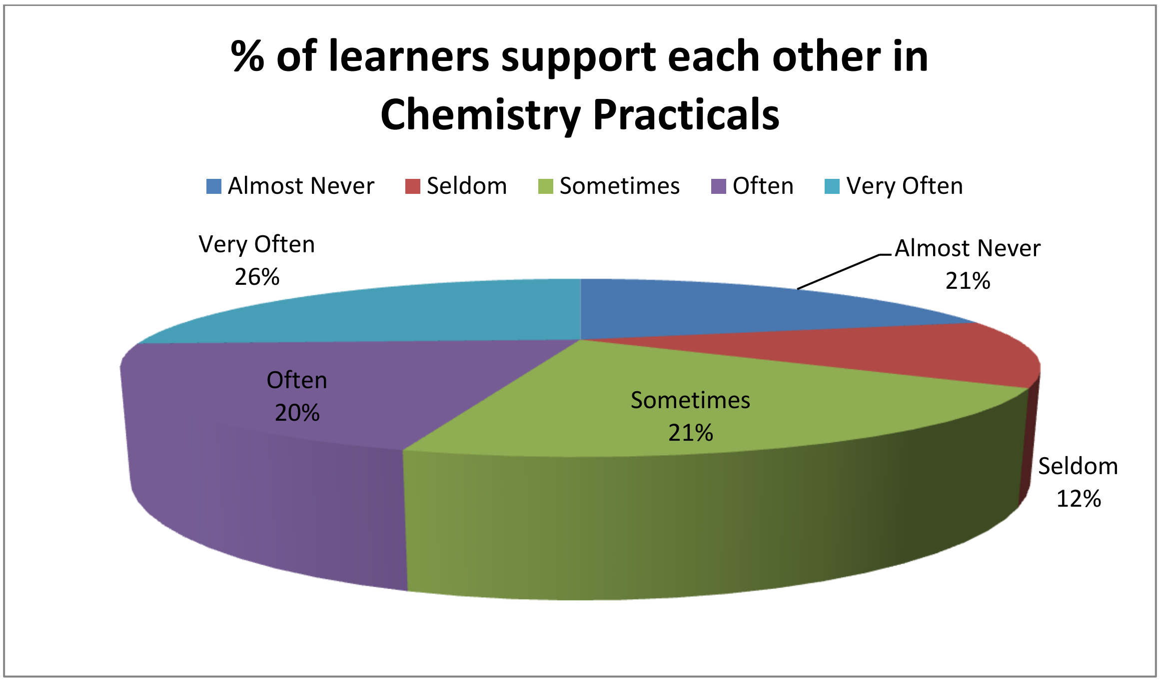
An inspection of the mean scores per school indicates that female learners see their teachers as supportive and discipline implementers more that male learners.

Table 5.21. Learners Cohesiveness (Learners support each other in Chemistry practical work)

	Almost Never	Seldom	Sometimes	Often	Very Often
1. Get on well with others	21.0%	12.1%	27.5%	21.2%	18.2%
6. Know other learners	36.1%	13.0%	20.7%	15.1%	14.9%
11. Take part in practical	15.3%	11.9%	22.7%	24.7%	25.2%
16. Group work encouraged	17.6%	12.3%	23.3%	18.9%	27.8%
21. Help from others	21.6%	13.1%	19.8%	22.8%	22.5%
26. Know name of others	18.9%	10.7%	13.8%	14.2%	42.2%
32. Teacher assistance	18.8%	11.4%	19.1%	20.3%	29.2%
Average percentage	21.3%	12.1%	21.0%	19.6%	25.7%

The percentage may not total 100% due to rounding off. The aim of this section of the questionnaire was to find out if learners cohesiveness in terms of their relationship with each other are positive or negative.

Figure 5.16. Average Percentage of the learners' responds to "Learners' cohesiveness"



Item 1: Learners get on well in the laboratory.

The aim of this item was to find out if learners get on well in the laboratory. The research question that was at the centre of this item is research question number four: How does the learner-learner interaction influence the learners' attitudes towards Chemistry practicals? NESTA (2005: 165) suggested that positive learning environment is fostered by learner-learner interaction which in most cases is encouraged or discouraged by the teacher. This suggests that positive learner-learner interactions in the laboratory are important for the creation of good learning environment. The mean score for this statement across the visited regions is 3.04 which represented sometimes in the questionnaire. The confident interval for this statement is at 95% ≈ {2.95~3.13}. This suggests that not all learners agree or see themselves as getting on well with others in the laboratory. The result in terms of percentages is spread all over the five point scale as shown in Table 5.21 above with the majority of learners opting for sometimes as their choice. The standard deviation of 1.379 suggests that the result of learners in the visited region is not squarely scattered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as statistically significant. There is an association between the region and the item "Learners get on well in the laboratory" throughout the visited regions. This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a significant association between the regions and their opinion on this item. The low value in Mann-Whitney U Test of 0.00 suggests that there is no difference between the regions and schools in terms of the way they answered this item. *During the interview learners were asked if they got on well with each other during practical investigations, but their responses varied from school to school: We have a good working relationship between us; some learners are not serious they tease each other during experiment; we help each other during experiments.*

Item 6: I got little chance to get to know other learners in this laboratory

The aim of this item was to find out if learners get the chance to know each other during laboratory work. This helped in understanding the type of relationship that exists between learners and the type of learning environment that it creates in the laboratory. This item will provide answers to research question four. The mean score for this statement across the visited regions is 2.60 on the scale of 0-5 which represents seldom to some times, with standard deviation of 1,477. The intention of this statement was to measure the extent to which learners knew each other's names or got the chance to know each other in the laboratory. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and can be interpreted as there is no significant difference with regards to the way learners answered this item throughout the visited regions. This means that the dependent variables are the same across all levels of a factor. The confident interval for this statement is at 95% ≈ {2.51~2.69}. Chi-square of .000 for this item suggests that there is a significant association between the regions and their opinion on this item. This means the relationship is not due to sampling error. The results from some schools shows lack of interest from learners in knowing each other, while other schools showed an average to above average interest from learners. The issue of learners knowing each other builds trust and positive as well as supportive learning relationships which result in positive learning environments in the laboratory. The results for this item are not generally speaking the same thing as far as learners' knowing each other is concerned, but it differs from school to school.

Item 11: Everyone takes part in doing practical work

The aim was to find out the level of participation in Chemistry practical work from the learners. The aim was to provide answers to research question four. The mean score for this statement across the visited regions is 3.34 which represented sometimes in the questionnaire. This suggests that not all learners agreed with the statement that “Everyone takes part in doing practical work”. The standard deviation of 1,411 suggests that the result of learners around the visited region is clustered around the mean. This suggests that the dependent variables are the same across all regions. Almost half of the learners opted for (Often) 24.7% (Very Often) 25.2% the other half is scattered among the other three options. *During the interview teachers were of the opinion that there were some learners who were very serious with practical investigation while others were using the opportunity to tease others and to relax.* The Kruskal-Wallis Test shows a significant value of .002 which is ≤ .05 and it can be interpreted as there is no significant difference in the way learners answered this item “Everyone takes part in doing practical work” throughout out the visited regions. This means that the dependent variables are the same across all levels of factor. The confident interval for this statement at 95% ≈ {3.22~3.03}. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item. We can be more than 95% sure that the relationship between the region and the learners’ opinion on this item are not due to sampling error.

Item: 16. We are encouraged to work in groups during practical work.

The aim was to find out if there is was encouragement from the teacher’s side for learners to work in groups during practical investigations. (Hofstein, et al 2000:33) emphasised the need for Chemistry teaching to close gaps between learners to motivate them to work cooperatively. The mean score for this statement across the visited regions is 3.30 which represented sometimes in the questionnaire. The confident interval for this statement at 95% ≈ {3.20~3.40}. The low standard deviation of 1.539 suggests that the result of learners around the visited region is clustered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as, there is no significant difference in the way learners "are encouraged to work together" during practical work throughout the visited regions. This means that the dependent variables are the same across all levels of factor, with the majority of learners opting for (very often) 27.8% and (Sometimes) 23.3%. Chi-square of .000 for this item suggests that there was an association between this item and the visited regions. *When asked during the interview if the teacher encouraged them to work is groups the responses were: We barely do group work; We do not do group work at all; the teacher do not encourage us to does group work; We sometimes do group work.*

Item 21: I am able to depend on other learners for help in laboratory activities.

The aim was to find out if learners were allowed to depend on others' help during laboratory activities. This will show the level of learner-learners relationship that exists. The mean score for this statement across the visited regions is 3.18 which represented sometimes in the questionnaire. The confident interval for this statement at 95% ≈ {3.06~3.30}. The standard deviation of 1.894 suggests that the result of learners around the visited region is nearly clustered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as there is no significant difference throughout the visited regions in the way learners "depend on other learners for help in the laboratory". This means that the dependent variables are the same across all levels of a factor, and generally learners depend on or help each other in the laboratory, e.g. 19.8% of learners opted for (Sometimes), 20.3% (Often) and 29.2 (Very Often). *During the interview some responses mentioned that learners helped each other but some schools reported teasing, being laughed at if their experiments failed and dominance by gifted/male learners.* Knowing that you can depend on your peers for the success of your experiment can be a motivating factor for learners to want to do more practicals. Through cooperation and support from peers, teaching is enhanced and becomes more interesting both for the learner and the teacher. Chi-square of .000 is statistically significant and this further suggests that there is a strong significant association between the regions and their opinion on this item.

Item 26: I know everyone in this laboratory by name.

The aim was to find out if learners knew each other in the laboratory by name or were strangers to one another. The mean score for this statement across the visited regions is 3.54 which represented some times in the questionnaire. The confident interval for this statement is at 95% ≈ {2.899~3.041}. This suggests that not all learners knew the names of the other learners. This item gave more information on how learner-learner interactions contributed to the learning environment and attitudes in the class. The aim was to find out if there was interest among learners to know each other or if there were friendships or partnership among learners that would encourage positive learning environment, therefore it provided answers to research question four. If the learning environment and the learner-learner interaction are positive learners will look forward to working together and helping each other. The overall highest score for this item in terms of percentage is 42.2% (Very Often) although this differs from school to school and region to region. The standard deviation of 1.850 suggests that the result of learners around the visited region is nearly clustered around the mean. It can be therefore concluded that the majority of the learners knew each other by name in the laboratory. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as, statistically significant. There is an association between the region and the item "I know everyone in this laboratory by name". This means that the dependent variables are the same across all levels of factor. The Mann Whiney U Test also records a low value of 0.000. The Chi-square of .000 for this item suggests that there is a strong significant association between the regions and the learners' opinion on this item.

Item 32. When I got stuck during the experiment I request my teacher's assistant

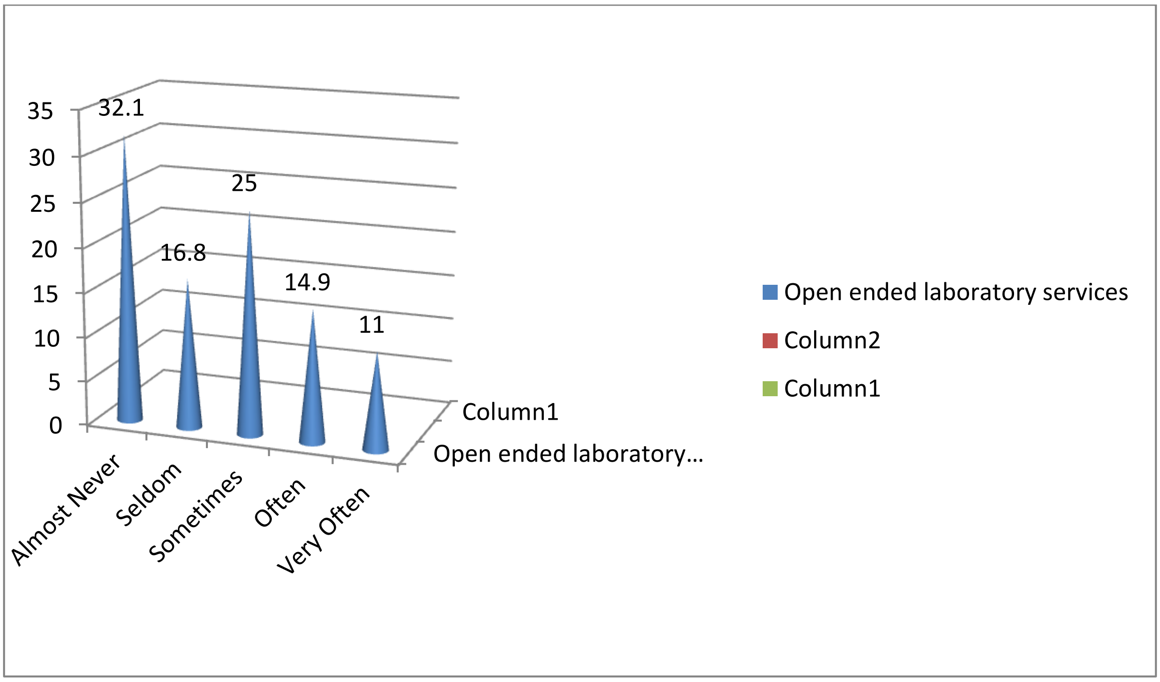
The mean score for this statement across the visited regions is 3.41 on the scale of 0-5, with standard deviation of 1,932. The confident interval for this statement at 95% ≈ {3.28~3.54}. The intention of this statement was to measure the extent to which learners enjoyed support and assistance from their Chemistry teacher during practical work. This helped in providing answers to research question five, "How do learners perceive the interaction between them and their teachers during Chemistry practical work?" Abrahams and Millar (2008,28 forthcoming) argue that 'teachers need to devote a greater proportion of the lesson time to helping students use ideas associated with the phenomena they have produced in practical work, rather than seeing the successful production of the phenomenon as an end in itself.' It is expected that the majority of the leaners will show a high percentage of support from teacher if they are stuck during experiments. The Kruskal-Wallis Test shows a significant value of .001 which is ≥ .05 and can be interpreted as there is no significant difference with regards to the way learners answered this item of getting assistance from their teachers if they get stuck during practical investigations throughout the visited regions. This means that the dependent variables are the same across all levels of a factor. Chi-square of .000 for this item suggests that there is a significant association between the regions and their opinion on this item. This means the result showed more than 95% of confidences that it is not due to chance or error. The results from some schools, shows lack of support from teachers, especially from rural schools learners, while other schools show an average to above average support from teachers during practical work. *During the interview when the teachers were asked the type of assistance they usually offered to learners they said: We offer individual advice, guidance, help and any other assistance if learners ask for it although in most cases learners do not ask.*

Table 5.22. Open-endedness (Open ended laboratory activities)

	Almost Never	**Seldom**	**Sometimes**	**Often**	**Very Often**
2. Freedom own method	34.5%	18.5%	16.6%	17.5%	13.0%
7. Design own experiments	43.0%	18.8%	19.4%	12.7%	5.40%
8. Experiment on your own	35.6%	16.3%	29.9%	11.2%	6.8%
12. Different data	19.6%	20.6%	33.0%	13.2%	13.4%
17. Encourage own experiments	26.0%	13.7%	30.0%	16.8%	13.2%
27. Teacher give guidelines	22.1%	13.8%	25.8%	22.4%	15.7%
34. Learners alone laboratory	43.9%	15.7%	20.2%	10.2%	9.80%
Average percentage	32.1%	16.8%	25.0%	14.9%	11.0%

The percentage may not total 100% due to rounding off. The aim of this section of the questionnaire was to find out if there was an open-ended relationship in terms of laboratory activities. This section helped in understanding the type of relationship that exists in laboratory and how it contributes to the learning environment in the laboratory.

Figure 5.17. Open ended laboratory activities



Item 2: Learners are given freedom to pursue their own methods in the laboratory

The aim of this item was to find out if learners were given the freedom to pursue their own method in doing practical work or whether they were under strict rules and procedures that they had to follow in order for them to complete their laboratory tasks. According to QCA, (2007: 17) learners should be given freedom to pursue an independent enquiry into aspect of Science of personal interest. This item aimed at answering research question five. Moreover, NESTA (2005: 165) commented that practical work *"allows science education to become something that learners participate in freely, rather than something they are subject to by the teacher".* The degree of freedom to pursue owns methods are imperative in creating independent thinkers. The mean score for this statement across the visited regions is 2.56 which represented sometimes in the questionnaire. This suggests that not all learners agree with the level of freedom given in the laboratory. The confident interval for this statement at 95% ≈ {2.47~3.65}. The standard deviation of 1.438 suggests that the result of learners around the visited region is nearly clustered around the mean. There is generally a mixed feeling on the freedom experience in the laboratory by learners. Some schools expressed a high degree of freedom while others reported a low degree of freedom. *During the interview, the majority of learners were of the opinion that the teachers did everything and they merely observed the demonstrations of the teachers. Are you sometimes allowed by your teacher to come up with your own project, experiments or topics that you want to investigate or is it the teacher alone who usually suggest what to study or investigate: The teacher always suggests what topic we should investigate or do practice from; I think the teacher follows the syllabi and always suggests which topic to be covered according to the syllabi*. *The teachers on the other hand suggested that learners did not take the responsibility of doing experiments by themselves seriously and often required teachers' constant supervision.* This can negatively affect the degree of innovative freedom among learners. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as there is no significant difference in the way learners "are given freedom to pursue their own methods in the laboratory" throughout Namibia. This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a strong insignificant association between the regions and their opinion on this item.

Item 7: In this laboratory I am required to design my own experiments to solve given problems

According to Davis (2013: 2) "it is important that learners of Chemistry do experiments in the laboratory in order for them to understand the theories they study in lectures and in their textbooks". This helped them to develop the critical evaluation of experimental data. The laboratory experiments can also aid the learners in the study of science by clearly illustrating the principles and concepts involved. Finally, laboratory experimentation allows learners the opportunity to develop techniques and other manipulative skills that learners of science must master. The expectations from this item are that they provided answers to research questions five and six. The mean score for this statement is 2.23, with standard deviation of 1.372. The confident interval for this statement is at 95% ≈ {2.51~2.69}. This low standard deviation suggests that the data is clustered closely around the mean. This suggests that the majority of the learners 43.0% (Almost Never) and (18.8%) (Seldom) see their laboratory experiments as limited in terms of designing and solving given problems on their own. In rehearsal with the second item it becomes evident that the majority of the learners in the visited region do not have the freedom to do their own experiments but they simply rely on teachers' demonstrations and suggestions. The Kruskal-Wallis Test shows a significant value of .001 which is ≥ .05 this can be interpreted that there is no significant differences in the way learners "enjoy the freedom to design experiments and solve problems" in their Chemistry laboratories throughout the visited regions. The Pearson Chi-Square of .000 is statistically significant and there is an association between the region and the learners' opinion on category "design own experiments and solves problems".

Item 8: In this laboratory everyone is doing experiments on his/her own

The aim was to find out if learners were doing individual experiments or group work. This item can be linked to the previous item number 7 and the results shows close association. The mean score for this statement across the visited regions is 2.38 which represented some times in the questionnaire. The confident interval for this statement is at 95% ≈ {2.30~2.47}. This suggests that not all learners agreed with the statement that everyone is doing individual experiment. The standard deviation of 1.280 suggests that the result of learners around the visited region is nearly clustered around the mean. Generally there is a feeling that everyone does not do experiments on their own among the visited schools. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as there is no significant difference in the way learners regards this item throughout Namibia. This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Item 12: During laboratory sessions other learners collect different data than I do for the same problem

The aim was to find out if the results or data collected in the laboratory were the same or it differed with other learners. The aim was to answer research question number four. Variety in answers showed what types of learner-learner interaction existed in laboratory classes. The mean score for this statement across the visited regions is 2.82 which represented some times in the questionnaire. The confident interval for this statement at 95% ≈ {2.74~2.90}. This suggests that not all learners agreed that their collected data differed for the same problem. The general score in the result is that 33.0% opted for (sometimes) and 20.6% for (Seldom) while 19.6% chose (Almost Never). These types of responses suggest that the opinions were scattered and differed from school to school. The standard deviation of 1.334 suggests that the result of learners around the visited region is nearly clustered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as statistically significant. There is an association between the region and the way learners answered this item. This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a strong and significant association between the regions their opinion on this item.

Item 17: We are encouraged to do our own experiments to find out things on our own

The objective of this statement was to find out if there was any encouragement for individual work from the teachers' side. This item answered research question three by showing what teacher-learner interactions existed in laboratories in the visited regions. (NSTA, 2006: 55) suggested that science educators play central roles in educating, inspiring, and guiding learners to become responsible scientifically literate citizens. Teachers should help and encourage learners to plan, execute and present creatable results from their experiments by motivating, helping and guiding learners in the correct way. Help learners reflect and use skills of inquiry to become effective problem solvers in the future. 'Well planned and effectively implemented, science education laboratory and simulation experiences situate learners' learning in varying levels of inquiry requiring learners to be both mentally and physically engaged on individual level will embolden positive results and experiences among learners' (Lunetta et al., 2007: 405). The mean score for this statement across the visited regions is 2.28 on the scale of 0-5, which represented seldom in the questionnaire. The confident interval for this statement at 95% ≈ {2.71~2.89}.The low standard deviation 1.490 suggests that the data are closely scattered around the mean. The mean of 2.27 also suggests that the majority of the learners are no encouraged to do their own experiment and find out things for themselves. The lack of motivation from the teacher also suggests poor teacher-learner relationship. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 at 5% level, this can be interpreted that there is no significant difference in the way learners perceive this item throughout the visited region. Chi-square of .000 for this item suggests that there is a strong and significant association between the regions and their opinion on this item.

Item 27: During laboratory session the teacher only give guidelines to do experiments

This item was stated negatively and the score were reversed. The objective of this statement was to find out if the teacher gave guidelines only to do experiment or he gave other assistance to learners. This item provided answers to item three in terms of teacher-learner interactions. The mean score for this statement across the visited regions is 3.00 on the scale of 0-5, which represented sometimes in the questionnaire. The confident interval for this statement is at 95% ≈ {2.89~3.11}. This low standard deviation of 1.719 suggests that data are closely scattered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05, this can be interpreted that there is no significant difference in the way learners answered this item. Chi-square of .00 for this item suggests that there is a strong significant association between the regions and their opinion on this item. During the interview some learners suggested that during practical investigations the teacher helped with investigations, while other schools were required to follow rules on paper to complete their investigations. Lack of support from the learners in practical work can create a poor learning relationship or environment.

Item 34: My teacher leaves us alone in the laboratory

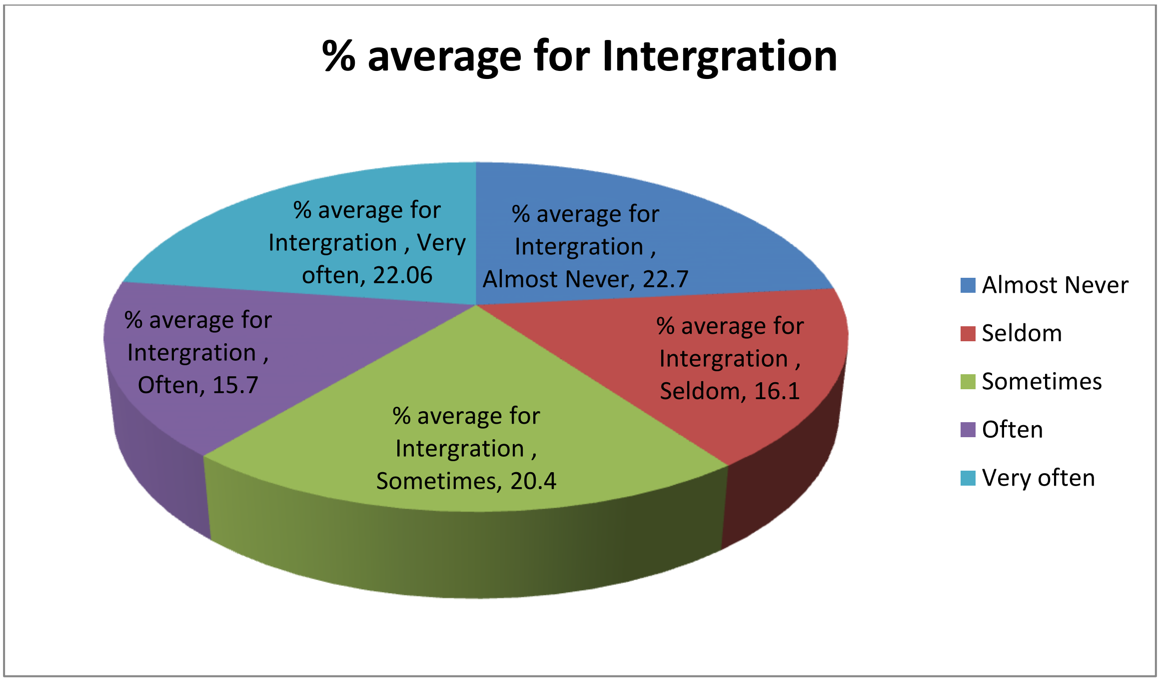
Leaving learners in the laboratory unattended can be irresponsible and dangerous. The mean score for this statement across the visited regions is 2.33 on the scale of 0-5, with standard deviation of 1.977. The confident interval for this statement is at 95% ≈ {2.20~2.46}. The mean score of 2.33 is regarded as sometime on the scale used, which means that in some schools learners do stay in laboratories unattended. The average percentage of 43.9 % (Almost Never) and 15.7% (Seldom) shows that more than half of the learners were of the opinion that they were never alone or without a teacher in the laboratory. This is a good sign that teachers in the visited region remained in laboratories and this can boost the teacher-learner interaction during practical investigations and avoid unnecessary accidents. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 at 5% level and it can be interpreted as there is no significant difference in the way learners answered this item throughout the visited regions. This means that the dependent variables are the same across all levels of a factor and learners' opinions are the same across the visited regions. Chi-square of .000 for this item suggests that there is a significant association between the regions and their opinion on this item. We can be more than 95% sure that the relationship between region and learners' opinion are not due to chance.

Table 5.23. Integration (between laboratory activities and non-laboratory activities)

	Almost Never	Seldom	Sometimes	Often	Very Often
3. Experiment and syllabi	14.7%	9.0%	8.0%	9.0%	39.4%
13. Experiment per topic	26.6%	22.1%	23.1%	16.0%	12.1%
14. Science poster wall	24.3%	18.3%	12.8%	16.3%	28.0%
18. Theoretical Knowledge	15.4%	14.0%	33.5%	22.6%	14.3%
23. Practical on likes topics	37.9%	16.6%	15.1%	9.40%	20.8%
28. Practical than theoretical	18.1%	16.6%	26.8%	15.7%	22.6%
30. Atmosphere attractive	22.2%	16.4%	23.3%	20.7%	17.2%
Average percentage	22.7%	16.1%	20.4%	15.7%	22.06%

The percentage may not total 100% due to rounding off. The aim of this section of the questionnaire was to find out if there was an open-ended relationship in terms of laboratory activities. This section helped in help understanding the type of relationship that exists in a laboratory and how it contributes to the learning environment in the laboratory.

Figure 5.18. Average % for Integration (between laboratory activities and non-laboratory activities)



Item 3: The experiments we do are related to topics in the syllabi.

The aim of this item was to find out if there was a relationship between the topics in the syllabi and the practical work that learners did. The theoretical knowledge that learners acquire through normal teaching classes should be enhanced by practical activities. There is a growing body of research that shows the effectiveness of 'hands-on' and 'brains-on' activities in school science inside and outside the laboratory as an effective way of learning science (Lunetta et al., 2007:413). The aim was to answer research question seven about the nature of Chemistry laboratories in Namibia. The mean score for this statement across the visited regions is 3.38 on the scale of 0-5 which represent sometimes, with standard deviation of 1.446. The confident interval for this statement is at 95% ≈ {3.38~3.50}. The intention of this statement was to measure the extent to which topics covered in practical investigations are truly related to the content of the syllabi or whether learners learn other topics and do different topics in practical investigations. The Kruskal-Wallis Test shows an significant value of .001 which is ≤ .05 and can be interpreted as there are no significant differences with regards to the way learners answered this item through the visited regions. This means that the dependent variables are the same across all levels of factors. The Chi-square of .000 for this item suggests that there is a significant association between the regions and their opinion on this item. The 14.7 % of learners opting for (Almost Never) is worrisome because that shows that a small percentage of teachers do practical investigations that are not related to the syllabi topics. This may have a negative impact to the type of laboratory that we have in Namibia. The purpose of the laboratory is to link theory to practice. The results for this item are not generally speaking the same thing as far as the different schools are concerned, meaning that some schools linked their practical investigations with syllabi requirements while others did not. *During the interview session questions were asked: Are your practical investigations related to your theoretical topics and if not what type of topics do you do practical work for? We do not know because we don't have the syllabi to compare; we are doing according to the syllabi topics. Why do you think your teacher did other topics apart from the syllabi requirements? He wants us to know beyond the syllabi and school activities.*

Item 13: We have practical experiment for every topic that we do in Chemistry class

The aim was to find out whether teachers were following every topic with practical investigations as the science curriculum in Namibia required. This helped in answering research question seven about the nature of practical class in Namibia. According to Millar (2004: 6) effective practical activities should enable learners to breach between what they can see and handle (hand-on) and what they can observe brain-on) because these connections will make understanding and retaining of knowledge possible.

A resounding 26.6% (Almost Never) and 22.1% (Seldom) showed that most Chemistry topics that teachers dealt with were not followed by practical investigations. This scenario was echoed in the interview by most learners that not all topics they do theoretically are backed by practical investigations. *During the interview questions were raised: Does your class do practical work for every topic taught?: We barely do practical investigations because our teacher always complains of lack of equipment, lack of time and the class misbehaviour during practical investigations; We do not do practical investigations because some topics* *are too simple to do practical investigation on.* The mean score for this statement across the visited regions is 2.67 which represented sometimes in the questionnaire. The confident interval for this statement at 95% ≈ {2.58~2.76}. This suggests that not all learners agree that all topics are followed by practical investigations. The standard deviation of 1.422 suggests that the result of learners in the visited region is clustered around the mean and the dependent variable is the same throughout the visited regions. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as statistically significant. There is an association between the region and the way learners answered this item. This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a significant association between the regions and their opinion on this item.

Item 14: The wall of the laboratory is decorated with Science related posters.

Creating an enabling learning atmosphere in class is important for stimulating a conducive learning environment. This item helped in answering research question number seven. Most of the schools visited did not show evidence of posters in their classes and this is further shown in the way that learners answered the questionnaire. Around 24.3% (Almost Never) and 28.0% (Very Often) shows that some schools have posters while others do not have posters on their wall. The mean score for this statement across the visited regions is 3.17 on the scale of 0-5, with a high standard deviation of 3.17 which shows some degree of differences. The confident interval for this statement is at 95% ≈ {2.96~3.38}. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 at 5% level and it can be interpreted that there is no significant difference with regards to the way learners regard their classroom walls as having science related posters. This means that the dependent variables are not the same across all levels of a factor. Chi-square of .000 for this item suggests that there is statistical significant association of more than 95% between the regions and their opinion on this item.

Item 18: I apply my theoretical knowledge on Science in my practical work

The aim of this item was to find out to what extent learners applied their theoretical knowledge to their practical activities. Toplis and Allen (2012:1) "I do and I understand" it is important that theoretical knowledge that learners acquire during normal lessons is supported by evidence in terms of practical investigations or demonstrations. "At the level of concepts it is necessary for learners to see some experiments, perhaps even to handle them, in order to understand the theoretical ideas involved" (Millar, 1989:55). The mean score for this statement across the visited regions is 3.00 which represented Sometimes in the questionnaire. The confident interval for this statement at 95% ≈ {3.18~2.73}. The percentage of 33.5% (Sometimes), 22.6% (Often) and 14.3% (Very often) imply that most of the learners do apply their theoretical knowledge to their practical activities. *During the interview teachers were asked how the theoretical lessons they teach are incorporated in to the practical work they do in the laboratory: We try to back up every topic in the syllabi with practical demonstrations were we can, but due to lack of equipment, chemicals and time constrain not all topics are covered*. The low standard deviation of 1.401 suggests that the result of learners in the visited region is clustered nearly close to the mean. This item provided answers to research question seven on the type of laboratories in Namibia. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as there is no significant differences in the way learners "apply their Science theoretical knowledge to practical work." throughout the visited region. This means that the dependent variables are the same across all levels of a factor, and generally learners are having the same feeling with regards understanding Chemistry. Chi-square of .000 for this item suggests that there is a strong and significant association between the regions and their opinion on this item.

Item 23. The teacher only does practical work on topics that he/she likes.

This statement was stated negatively and the scores were reverse. The aim was to find out if teachers only did practical work on topics they liked or that were easy for them or whether they covered all areas of the syllabi that were required. This item can be linked to the previous item number 13 and the results show close associations. The mean score for this statement across the visited regions is 2.51 which represented sometimes to seldom in the questionnaire. The confident interval for this statement is at 95% ≈ {2.73~2.62}. This suggests that not all teachers did practical work on some selected topics but some teachers also did practical work on all items of the syllabi. The standard deviation of 1.517 suggests that the result of learners around the visited region is nearly clustered around the mean. There is generally a mixed reaction on how the teachers do practical work. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as; there is no significant difference in the way learners answer this item throughout Namibia. This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item this can be regarded as strong relationship between learners' opinions and the regions.

Item 28: I love practical lessons more than theoretical lessons.

The aim was to find out to what extent learners loved practical lessons in comparison to theoretical lessons. In general learners are positive about practical work and frequently teachers are greeted by "are we doing practical work today" (NESTA, 2005: 5). The aim of this item was to provide answers to research question seven. The nature of practical lesson will determine the interest that learners have in practical work. The mean score for this statement across the visited regions is 3.13 which represented sometimes in the questionnaire. The confident interval for this statement is at 95% ≈ {3.02~3.24}. This suggests that there is a certain percentage of learners who love practical lesson while others like theoretical lessons. The low standard deviation of 1.781 suggests that the result of learners in the visited region is clustered nearly close to the mean, this suggests that most schools' learners answered the questionnaire the same way. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as there are no significant differences in the way learners "love practical lessons more than theoretical lessons." throughout the visited region. This means that the dependent variables are the same across all levels of a factor, and generally learners have the same feeling with regards to understanding Chemistry. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item. *When asked during the interview: Which lessons do you like most between practical and theoretical? The majority opted for practical lessons with few opting for theoretical. Why do you like that? Practical lessons are fun, easy to understand and we can remember the outcomes longer. Theoretical lessons are the norms and we are used to it that's why we like it.*

Item 30: The laboratory atmosphere is so attractive to work in

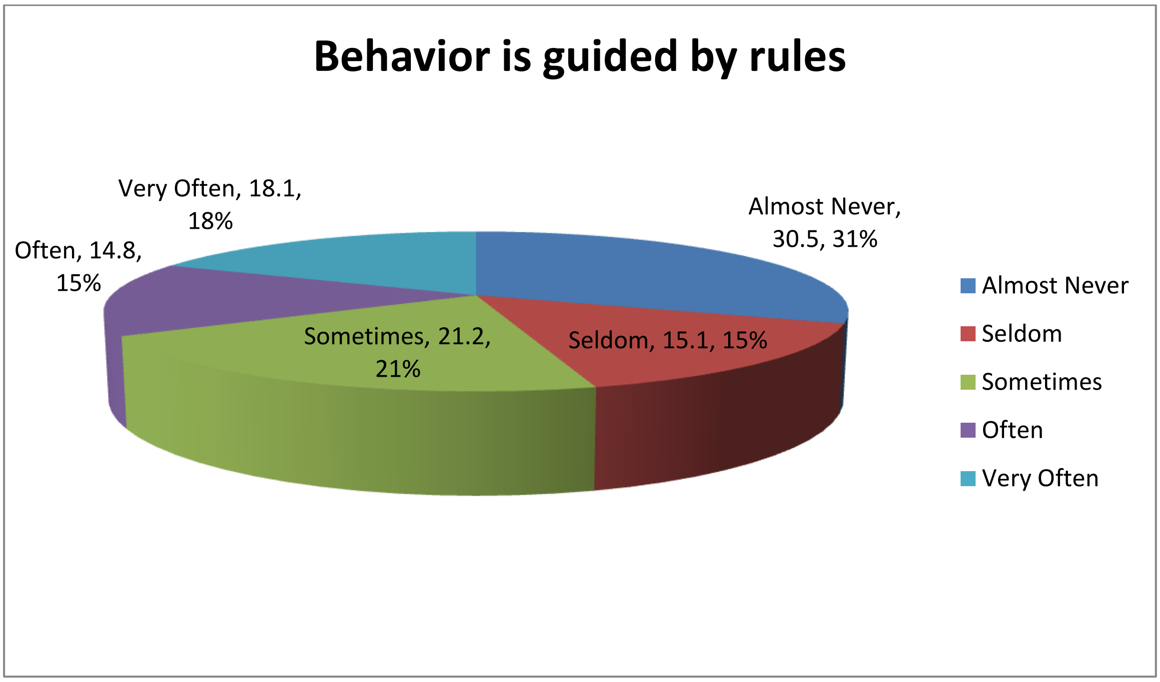
The mean score for this statement across the visited regions is 3.00 on the scale of 0-5, with standard deviation of 1,825. The confident interval for this statement is at 95% ≈ {2.89~3.11}. The intention of this statement was to measure the extent and conduciveness of the learning environment in the visited regions. This helped in answering research question seven about the nature of the laboratories in the visited regions. The results suggest that 38.8% of the learners disregard the classroom atmosphere as conducive while 37.8% regard the classroom atmosphere as conducive. The Kruskal-Wallis Test shows an insignificant value of .001 which is ≤ .05 and can be interpreted as there is no significant differences with regards to learners perception of the attractiveness of the atmosphere in the laboratories throughout the visited region. This means that the dependent variables are not the same across all levels of a factor. Chi-square of .000 for this item suggests that there is a significant association between the regions and their opinion on this item. The results from some schools show that some schools' laboratory atmosphere is attractive while not so in others. The results for this item are not generally speaking the same thing as far as the attractiveness of the laboratory environment is concerned.

Table 5.24. Rule clarity (Behaviours in school guided by rules)

	Almost Never	Seldom	Sometimes	Often	Very Often
4. Rules in practical work	15.4%	13.8%	21.0%	17.2%	32.6%
9. Break rules	51.2%	15.5%	16.3%	9.7%	7.0%
19. Safety practical work	21.3%	14.7%	23.8%	19.1%	20.8%
22. Copy answers	45.3%	17.6%	20.4%	8.7%	7.9%
24. Safety rules experiment	16.2%	10.5%	22.0%	21.7%	29.4%
29. Protective cloth	36.2%	16.6%	19.7%	13.1%	14.2%
33. Fail experiments	28.1%	16.9%	25.4%	14.4%	15.0%
Average percentage	30.5%	15.1%	21.2%	14.8%	18.1%

The percentage may not total 100% due to rounding off. The aim of this section of the questionnaire was to find out if there was an open-ended relationship in terms of laboratory activities. This section helped in understanding the type of relationship that existed in the laboratory and how it contributed to the learning environment in the laboratory.

Figure 5.19. Behaviour is guided by rules



Item 4: We follow rules and procedures during practical work

The aim was to find out the type of laboratory work in the visited region, especially in terms of following rules and procedures during laboratory practical work. The answer to this item will shed more light on the type of laboratories (Research question seven) that we find in the visited schools. The mean score for this statement across the visited regions is 3.38 which represented sometimes in the questionnaire. The confident interval for this statement at 95% ≈ {3.29~3.47}. *This suggests that not all learners agree with following rules and procedure in the laboratory, however, in the interview learners were of the opinion that there were no rules given to them for them to follow. "Do you follow laboratory rules? We do not have any laboratory rules to follow. Sometime the teacher tells us some safety rules"* The standard deviation of 1.446 suggests that the result of learners around the visited region is not clustered around the mean. This suggests that the dependent variables are the same across all regions. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as there are no significant differences in the way learners "follow rules and procedures in their laboratories during practical investigations." This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item and the result shows a 95% confident level that the learners response were not due to chance.

Item 9: We can break rules in the laboratory if we want and nothing will happen to us

The aim of this statement was to find out if learners broke rules in the laboratory, and if so, whether there were any consequences that usually followed them. This provided answers to research questions three and seven on the type of laboratory and teacher-learner interactions that prevailed in the visited regions. The mean score for this statement across the visited regions is 3.39 which represented sometimes in the questionnaire. The confident interval for this statement at 95% ≈ {1.99~2.17}. The standard deviation of 1.349 suggests that the result of learners around the visited region is clustered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as there are no significant differences in the way learners interpret this item throughout the visited regions. This means that the dependent variables are the same across all levels of a factor. The high scoring on the 5 point scale of 51.2% (Almost Never) and 15.5% (Seldom) suggests that the majority of the learners do not break rules. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Item 19: **I am always protected (safety) during practical work**

The aim was to find out if learners were protected during Chemistry laboratory sessions. The mean score for this statement across the visited regions is 3.07 which represented sometimes in the questionnaire. The confident interval for this statement is at 95% ≈ {2.97~3.06}. The aim of this item was to answer research question two on how learners perceived their Chemistry laboratory learning environment. The assumption is that if learners regard their learning environment as safe and they feel protected they will regard their learning environment as positive. The low standard deviation of 1.588 suggests that the result of learners around the visited region is clustered around the mean. The Kruskal-Wallis Test shows an insignificant value of .152 which is ≥ .05 and it can be interpreted as there are significant differences in the way learners are protected in the laboratories or how they view safety in their laboratories throughout the visited regions. This means that the dependent variables are not the same across all levels of a factor, and generally learners in some schools observe a high level of protection while others are not highly protected, e.g. 23.8% of learners opted for (Sometimes), 21.3% (Almost Never) while 20.8% opted for (Very Often). *When asked during the interview about the type of protections they get in the laboratory; most learners narrated the issue of not getting protective clothing, hand gloves and face mask. Teachers in the interview complained of lack of protective clothing to give to each and every child during experiments.* Chi-square of .000 is statistically significant and this further suggests that there is a strong significant association between the regions and their opinion on this item.

Item 22: During laboratory session, we can copy answers from one another

This statement was stated negatively and the scores were reversed. The aim was to answer research question three by showing the level of rules guiding the test in the laboratory. The mean score for this statement across the visited regions is 2.20 on the scale of 0-5, with standard deviation of 1.559. The mean of 2.20 represent Seldom on the Likert scale and highest score in this item were 45.3% (Almost Never) and 20.4% for (sometimes), this suggests that the majority of the learners do not copy answers from one another, although the percentage differs from school to school. The confident interval for this statement at 95% ≈ {2.10~2.30}. This item further denotes the class room environment and the teacher-learner interactions during Chemistry practical work because if there are strict rules for learners not to copy answers from others then learners will follow. The Kruskal-Wallis Test shows an insignificant value of .386 which is greater ≥ .05 at 5% level of significance and it can be interpreted as there are insignificant differences with regards to the copying of answers from one another from learners in Chemistry laboratories throughout the visited regions. Some schools used stricter rules than others. This means that the dependent variables are not the same across all levels of a factor. Chi-square value of .000 is < 0.05 for this item, which suggests that for this item there is a significant association between the regions and their opinion on this item.

Item 24: My teacher tells me the safety rules before I do experiments

The objective of this statement was to find out if teachers communicated safety rules to the learners before they started doing experiments or not. This statement further aimed at elucidating the relationship between teacher-learner interactions and learning environment and therefore providing answers to research question three and seven. The mean score for this statement across the visited regions was 3.42 on the scale of 0-5, which represented Sometimes in the questionnaire with a low standard deviation of 1,674. This low standard deviation suggests that the data are closely scattered around the mean. The mean of 3.42 also suggests that the some learners are usually not informed of safety rules by their teachers. The confident interval for this statement is at 95% ≈ {3.32~3.52}. The Kruskal-Wallis Test shows a significant value of .036 which is ≤ .05, this can be interpreted that there are no significant differences in the way learners regard this item through the visited regions. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Item 29: We wear protective clothing during laboratory experiments

The aim of this item was to find out if learners wore protective clothing during Chemistry practical work in the laboratory. The item further explains the type of laboratory found in the visited regions by providing answers to research question seven. The mean score for this statement across the visited regions was 2.57 which represented sometimes in the questionnaire. The confident interval for this statement is at 95% ≈ {2.45~2.69}. This suggests that not all learners agreed that they wore protective clothing during the laboratory sessions. The result in terms of percentages is spread all over the five point scale as shown in Table 5.24 above with the majority of learners (36.2%) opting for “Almost Never” as their choice. The standard deviation of 1.849 suggests that the result of learners in the visited region is scattered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as, statistically significant. There is an association between the region and this item. This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a significant association between the regions and their opinion on this item. The low value in Mann-Whitney U Test of 0.00 suggests that there is no difference between the regions and schools in terms of the way they answered this item.

Item 33: When my experiments fail other learners laugh at me

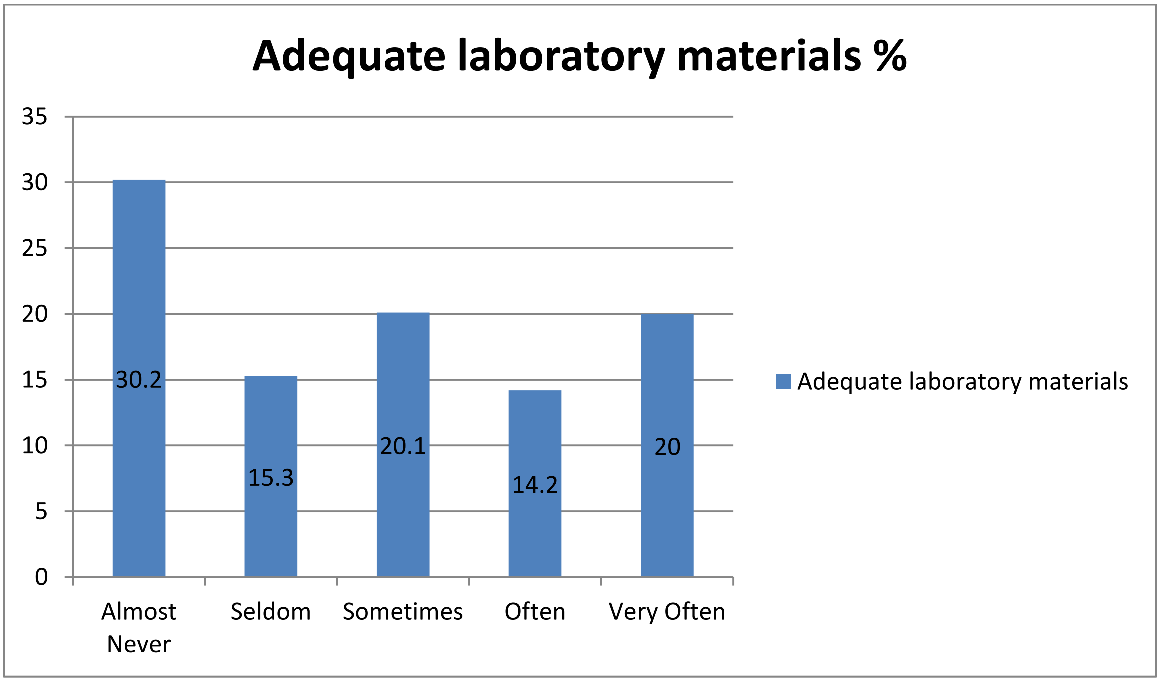
The aim was to find out the level of learner-learner interactions and the type of environment that prevailed in the laboratory. This item further sought to clarify if learners were helpful to one another or they simply laughed at each other’s failures. The item aimed at answering research question four by showing the learner-learner relationship during laboratory sessions. The mean score for this statement across the visited regions is 2.77 which represented some times in the questionnaire. The confident interval for this statement is at 95% ≈ {2.65~2.89}. The general score in the result is that 28.1% opted for (Almost Never) and 25.4% for (Sometimes) suggesting that the opinions are scattered and differed from school to school. The standard deviation of 1.932 suggests that the result of learners around the visited region is nearly clustered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as statistically significant. There is an association between the region and the way learners have answered this item. This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Table 5.25. Material environment (adequate laboratory materials)

	Almost Never	Seldom	Sometimes	Often	Very Often
5. Crowded laboratory	28.3%	14.0%	22.1%	16.3	19.3%
10. Available chemicals	24.6%	16.7%	28.6%	16.8%	13.2%
15. Clean and pack	22.5%	15.9%	15.5%	15.2%	30.7%
20. Expired chemicals	46.7%	20.5%	14.3%	6.4%	11.9%
25. Enough room	25.5%	12.8%	15.3%	19.6%	26.6%
31. Share equipment	23.5%	11.7%	28.4%	13.3%	22.9%
35. Hot unventilated laboratory	40.3%	15.8%	16.9%	11.5%	15.4%
Average percentage	30.2%	15.3%	20.1%	14.2%	20.0%

The percentage may not total 100% due to rounding off. The aim of this section of the questionnaire was to find out if there was an open ended relationship in terms of laboratory activities. This section helped in understanding the type of relationship that existed in laboratory and how it contributes to the learning environment in the laboratory.

Figure 5.20. Adequate Laboratory materials



Item 5: Our laboratory is crowed when we are doing experiments

Overcrowded laboratories can pose a health hazard and contribute to ineffective practical investigations or demonstrations and even accidents (West, Westerland, Stephenson, Nelson and Nyland, 2003:176). According to Tuysuz, (2010: 38) "sometimes due to the limitation of equipment, limited time allocated for the topic or insufficient laboratory conditions, forces teachers to perform laboratory activities in crowded groups, or sometimes opt for demonstrational activity." The aim of this item was to find out how over crowded the laboratories in the visited regions were. This helped in answering research question six by explaining the type of laboratories found in the visited regions. The confident interval for this statement at 95% ≈ {2.75~3.93}. The mean score for this statement across the visited regions is 2.84 on the scale of 0-5, with standard deviation of 1.478. The Kruskal-Wallis Test shows a significant value of .001 which is ≥ .05 at 5% level of significance and this can be interpreted as there is no significant difference in the way learners regarded their laboratories as crowded throughout the visited regions in Namibia. This means that the dependent variables are the same across all levels of a factor. Chi-square of .000 for this item suggests that there is a significant association between the regions and their opinion on this item. Referring to percentage the majority of learners fall in the category, almost never (28.3%) and sometimes (22.1 %). This indicates that there are few schools where the laboratories are overcrowded while other schools' laboratories are not overcrowded. Schools in the Erongo and Khomas regions have shown the highest score in terms of laboratories over crowdedness and this can also be attributed to the availability of chemicals and equipment teacher-learner ratio in these two regions. *During the interview the learners were asked: How do you regard your libraries during practical investigations; are they over crowded or not? Our library is not over crowded we are always less that 30 per session. I think we are overcrowded because there is not enough equipment for all the learners.*

Item 10: The chemicals and equipment that I need for my experiments are readily available

The mean score for this statement across the visited regions is 2.79 on the scale of 0-5, with standard deviation of 1.375. The confident interval for this statement at 95% ≈ {2.70~2.88}. The intention of this statement was to measure the extent to which chemicals and equipment were available for learners to use in the laboratories in the visited regions. The use of appropriate teaching equipment and teaching method is critical to the successful teaching and learning of science (Olufunke, 2012:2). This item further wanted to sketch the type of laboratory that was found in the visited regions, because the availability of equipment can attribute to positive learning environment. The main aim was to answer research question seven by describing the nature of Chemistry laboratories in Namibia. The Kruskal-Wallis Test shows a significant value of .001 which is <.05 and can be interpreted as statistically significant and there is no evidence to doubt the way learners answered this item throughout the regions. This suggests that learner's opinion with regards to the availability of chemicals and equipment in the visited region are the same. Chi-square of .000 for this item suggests that the result for this item was not due to error or chance but it showed a true association between the regions and their opinion on this item. The results from some schools show a high percentage of learners agreeing that the equipment and chemicals were not available, which may slowdown planning and deliverance of adequate practical investigations or demonstrations.

Item 15: We clean and pack the equipment and chemicals after each session.

The aim was to find if learners cleaned and packed equipment and chemicals after usage. The statement further aimed at finding out if learners took some responsibilities in terms of maintenance of equipment and the laboratory in general. This helped in answering research question two on how the learners perceived the learning environment in their laboratories. The mean score for this statement across the visited regions is 3.18 which represented sometimes in the questionnaire. The confident interval for this statement is at 95% ≈ {3.08~3.28}. This suggests that not all learners agreed with the statement of cleaning equipment and chemicals after practical sessions. The low standard deviation of 1.574 suggests that the result of learners around the visited region was scattered around the mean. This means that the dependent variables are the same across all levels of factor. In terms of percentages the value is scattered all over the five point scale with no congruent differences, e.g. Almost Never =22.5%, Seldom= 15.9%, Sometimes=15.5%, Often=15.2 % and Very often=30.7%. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as there are no significant differences in the way learners answered this item throughout the visited regions. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Item 20: The laboratory chemicals that we use have expired already

This statement was stated negatively and the scores were reversed. The mean score for this statement across the visited regions was 2.20 on the scale of 0-5 which represent Seldom, with standard deviation of 1,296. The confident interval for this statement at 95% ≈ {2.10~2.30}. In general the high scores of 46.7% (Almost never) followed by 20,5% (Seldom) suggest that most learners were of the opinion that the laboratory chemicals they were using had not expired. This item further denotes the type of laboratories found in the visited regions and hereby provides answers to research question two and six. Laboratories should use chemicals that are not expired for best and accurate results. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as there are no significant differences with regards to the way learners answered this item. This means that the dependent variables are the same across all levels of a factor. Chi-square value of .000 is ≥ 0.05 for this item, which suggests that learners show significant association between the regions and their opinion on this item.

Item 25: The laboratory has enough room for me to do my experiments

The aim was to find out the availability of space in the laboratories in the visited region. This item is paired with item number 5 and the aim was to answer research question seven. The mean score for this statement across the visited regions is 3.13 which represented sometimes in the questionnaire. This suggests that not all learners agreed with the availability of space in the laboratories in the visited schools. The standard deviation of 1.831 suggests that the result of learners in the visited region is clustered around the mean and the dependent variable is the same throughout the visited regions. The confident interval for this statement at 95% ≈ {3.01~3.25}. The two highest choices made by learners were the (Very Often) 26.6% and (Almost Never) 25.5%. During the interview it was clear that some schools had enough room to accommodate the learners for practical work, while some schools were of the opinion that their laboratories were congested and there were not enough places for everyone. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as, statistically significant. There is an association between the region and the way learners answered this item. This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a significant association between the regions and learners' opinion on this item.

Item 31: We share equipment during practical work

The aim of this item was to find out if learners shared equipment or if there was enough equipment for every learner in the laboratories of the visited regions. Sharing equipment during a practical test or investigation can slow down the pace and it can result in poor performance by learners because they have to wait for others to use the equipment that they need. The aim was to answer research question seven by providing answers on the current laboratories in Namibia, whether they had enough equipment or not. The mean score for this statement across the visited regions is

3.06 which represented sometimes in the questionnaire. The confident interval for this statement at 95% ≈ {2.94~3.18}. This suggests that not all learners agreed with the sharing of equipment in the laboratory. The standard deviation of 1.896 suggests that the result of learners around the visited region is nearly clustered around the mean. There is generally a mixed feeling on the issue of sharing equipment because 28.4% opted for (Sometimes), 23.5% (Almost Never) and 22.9% (Very Often) which shows that learners differ from region to region in their opinion on sharing of equipment. *During the interview most learners reported that they barely conduct their own experiments, only the teacher do demonstrations which they have to observe.* The Kruskal-Wallis Test shows insignificant value of .534 which is ≥ .05 and it can be interpreted as there is a significant difference in the way learners share equipment throughout the visited regions. This means that the dependent variables are not the same across all levels of factor. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Item 35: This laboratory is hot and unventilated

The aim of this item was to measure the learning environment in terms of ventilation and temperature hereby providing answers to research question seven. The mean score for this statement is 2.52 which represent Seldom, with standard deviation of 2.069. The confident interval for this statement at 95% ≈ {2.39~2.65}. This standard deviation suggests that the data is clustered closely around the mean. This suggests that the majority of the learners 40.3% (Almost Never) and (15.8%) (Seldom) see their laboratory as cool and well ventilated. The Kruskal-Wallis Test shows a significant value of .000 which is ≤ .05 this can be interpreted that there is no significant difference in the way learners regards their laboratories as cool and ventilated throughout the visited regions. The Pearson Chi-Square of .000 is statistically significant and there is an association between the region and this item.

5.4. Questionnaire on Teacher Interactions. (QTI)

The focus of this QTI is on the interpersonal relationship between the teacher and the learners during Chemistry practical work. The aim of the QTI is to provide answers to the following research questions:

i) How does teacher-learner interaction influence the learners' attitudes in Chemistry practicals?

ii) How does the learner-learner interaction influence the learners' attitudes to Chemistry practicals?

iii) How do learners perceive the interaction between them and their teachers during Chemistry practical work?

Items are analysed one by one with clear explanations with reference to the main research questions. Below is the table that summarises the entire QTI item as they are derived from the SPSS version 20 analysis.

Table 5.26 Results of the QTI from SPSS

ITEM	N	Independent Sample	Independent Sample	Pearson Chi-square	Mean		Confident Intervals	Std. Deviation
	Statistic	Kruskal-Wallis Test	Mann-Whitney U Test	Test	Statistics	Standard Error	CV 5%	Statistic
REGION	1351	.000	.000	.000	3.21	.031		1.139
SCHOOL	1351	.000	.000	.000	10.40	.171		6.271
This teacher talks enthusiastically about practical work.	1268	.138	.014	.001	3.53	.033	3.46~3.60	1.189
This teacher trusts us with handling equipments.	1326	.000	.000	.000	2.46	.035	2.39~2.53	1.284
This teacher seems uncertain about practical work.	1289	.000	.000	.000	2.27	.029	2.21~2.33	1.054
This teacher gets angry if things go wrong in practical work.	1330	.000	.000	.000	3.24	.039	3.16~3.32	1.438
This teacher explains clearly.	1333	.000	.000	.000	3.11	.034	3.04~3.18	1.235
If I don't agree with this teacher, we talk about it.	1335	.000	.000	.000	2.81	.042	2.72~2.90	1.534
This teacher is hesitating when doing practical work.	1323	.000	.000	.000	2.64	.035	2.57~2.71	1.275
This teacher gets angry quickly.	1328	.000	.000	.000	2.91	.033	2.84~2.98	1.202
This teacher holds our attention	1325	.000	.000	.000	3.16	.036	3.09~3.23	1.304

This teacher is willing to explain things again.	1307	.000	.000	.000	3.61	.035	3.54~3.68	1.278
This teacher acts as if he/she does not know what to do.	1336	.000	.000	.000	2.36	.035	2.29~2.43	1.289
This teacher is too quick to correct us if we break the rule.	1326	.000	.000	.000	2.77	.036	2.70~2.84	1.325
This teacher is aware of everything that goes on in the class room.	1338	.000	.000	.000	3.05	.037	2.97~3.13	1.338
If we have something to say, this teacher will listen.	1334	.000	.000	.000	3.65	.033	3.58~3.72	1.219
We can boss this teacher around easily during experiments.	1322	.000	.000	.000	2.25	.047	2.15~2.35	1.709
This teacher is impatient with us.	1315	.000	.000	.000	2.66	.034	2.59~2.73	1.226
This teacher is a good leader.	1294	.000	.000	.000	3.73	.039	3.65~3.81	1.392
This teacher realised if we don't understand.	1328	.000	.000	.000	3.53	.033	3.46~3.60	1.219
This teacher does not know what to do when we fool around.	1272	.000	.000	.000	2.89	.038	2.81~2.97	1.346
It is easy to pick a fight with this teacher.	1339	.000	.000	.000	2.25	.042	2.16~2.34	1.534
This teacher act confidently when doing practical work.	1302	.000	.000	.000	3.59	.035	3.52~3.66	1.266
This teacher is patient with us during experiments.	1336	.000	.000	.000	2.98	.043	2.89~3.07	1.589
This teacher allows learners to tease each other during practical.	1295	.000	.000	.000	2.28	.035	2.21~2.35	1.275
This teacher is sarcastic.	1328	.000	.000	.000	2.10	.038	2.02~2.18	1.395
This teacher helps us if we get stuck doing experiments.	1331	.000	.000	.000	2.92	.041	2.92~3.00	1.495
We can decide some things in this teacher's class.	1324	.720	.279	.000	2.69	.039	2.27~2.77	1.415
This teacher thinks we cheat in our experiments.	1299	.000	.000	.000	2.35	.041	2.27~2.43	1.475
This teacher is strict with experimental procedures.	1334	.000	.000	.000	3.21	.041	3.31~3.29	1.484
This teacher is friendly.	1312	.000	.000	.000	3.87	.036	3.80~3.94	1.318

We can influence this teacher in doing the practical that we like.	1327	.000	.000	.000	2.49	.043	2.40~2.58	1.567
This teacher thinks we cannot do practical on our own.	1316	.106	.006	.000	2.52	.040	2.44~2.60	1.453
We have to be silence during practical demonstrations.	1272	.000	.000	.000	3.49	.041	3.41~3.57	1.470
This teacher is someone we can depend on.	1300	.000	.000	.000	3.22	.049	3.12~3.32	1.755
This teacher let us get away with a lot in class.	1276	.000	.000	.000	2.67	2.76	2.58~2.76	1.512
This teacher put us town during practical work.	1286	.002	.001	.000	2.27	.038	2.19~2.35	1.366
This teacher's practical tests are difficult.	1287	.228	.856	.000	3.03	.039	2.95~3.11	1.397
This teacher has a sense of humour.	1331	.000	.000	.000	2.94	.040	2.86~3.02	1.453
This teacher doesn't mind how we behave.	1319	.001	.000	.000	2.32	.043	2.23~2.41	1.564
This teacher thinks that we can conduct experiments well.	1264	.427	.004	.000	3.16	.047	3.07~3.26	1.667
This teacher's standards are very high.	1297		.000	.000	3.45	.045	3.36~3.54	1.615
This teacher can take a joke.	1290	.001	.000	.000	3.06	.048	2.96~3.16	1.727
This teacher gives us a lot of free time in class.	1313	.023	.616	.000	2.09	.044	2.00~2.18	1.606
This teacher seems dissatisfied with our practical.	1282	.017	.000	.000	2.32	.046	2.23~2.41	1.647
This teacher is severe when marking papers.	1299	.008	.001	.000	3.15	.047	3.05~3.25	1.694
I enjoy this teacher's practical demonstration.	1325	.000	.000	.000	2.81	.048	2.71~2.91	1.760
This teacher is lenient.	1306	.000	.000	.000	2.83	.045	2.74~2.92	1.638
This teacher blames us for everything that goes wrong in class.	1317	.000	.000	.000	2.97	.050	2.87~3.07	1.814
We are afraid of this teacher.	1311	.000	.004	.000	2.71	.051	2.87~3.07	1.833
Valid N (list wise)	511							

The table above shows the QTI results for all items of the questionnaire and for the following variables: Kruskal-Wallis Test, Mann-Whitney U Test, Pearson Chi-Square, Mean, Confident Intervals and Standard Deviation.

Table 5.27 below shows a simple correlation analysis using the individual learner and the region as a unit of analysis shows that statistically significant correlations (p< 0.01) exist between students' attitudes to Chemistry and all QTI items.

Table 5.27 Correlations between Scales of the QTI final version

Scale	CD	CS	SC	SO	OS	OD	DO
Leadership (DC)	0.67**	0.75**	0.50**	-0.30**	-0.27**	-0.28**	-0.11**
Regions Mean	(0.79*)	(0.90*)	(0.69)	(-0.49*)	(-0.43*)	(-0.39)	(-0.44*)
Helping Friendly (DC)		0.76**	0.67**	-0.18**	-0.29**	-0.18**	-.026**
Regions Mean		(0.82*)	(0.89*)	(-0.41*)	(-0,46*)	(-0.34)	(-0.44*)
Understanding (CS)			0.61**	-0.31**	-0.31**	-0.32**	-0.15**
Regional Mean			(0.79**)	(-0.49**)	(-0.51**)	(-0.35*)	(-0.52*)
Learners Responsibility Freedom (SC)				0.08	-0.06	-0.04	-0.04
Regional Mean				(-0.22)	(-0.29)	(-0.07)	(-0.52)
Uncertain (SO)					0.72**	0.69**	0.22**
Region Mean					(0.82***)	(0.86**)	(0,51**)
Dissatisfied (OS)						0.72**	0.41**
						(0.99*)	(0.52*)
Admonishing (OD)							0.44*
Region Mean							(0.46*)

****p<0.001*   *** p<0.01*   ** p<0.05*   *n= 1383*

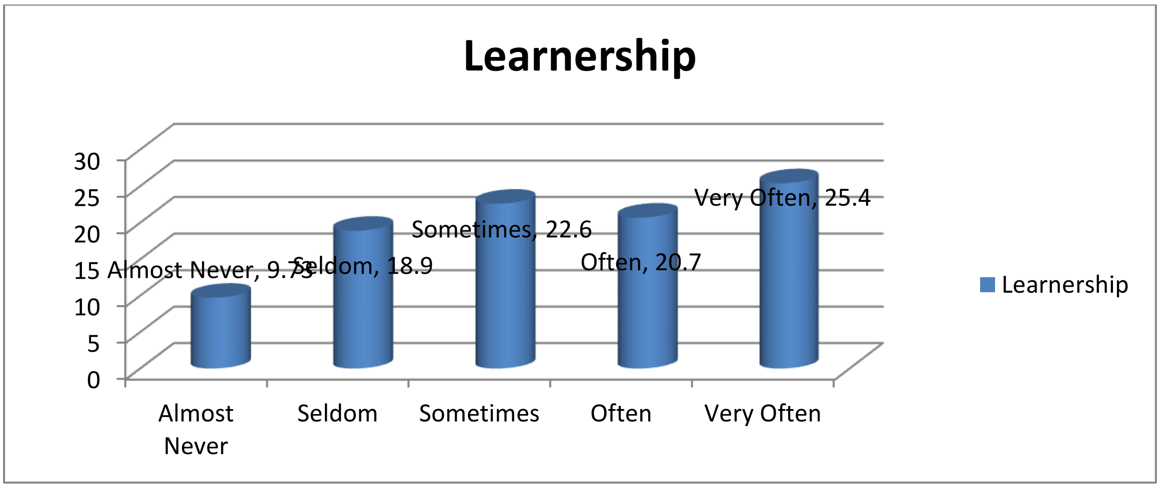
The QTI (See Table 5.27) the Helping/Friendly (CS) shows the greatest correlation 0.76** while the Leadership on Region mean (CS) shows the highest correlation. This shows that the QTI with its item is a good valid instrument that can be used to assess leaners perception in any secondary school Chemistry practical laboratory in Namibia.

Table 5.28. Leadership (DC) (Extent to which teacher leads, organises, provides orders, determines procedures and structures the classroom situations)

	Never	Seldom	Sometimes	Often	Always
1) Talk enthusiastically	5.90%	15.3%	24.2%	29.4%	25.2%
9) Holds learners attention	13.1%	22.8%	14.8%	34.2%	15.0%
13) Aware of classroom	9.50%	32.6%	25.5%	10.2%	22.7%
17) Good leader	5.30%	20.3%	15.2%	15.6%	43.4%
21) Confident teacher	5.80%	10.4%	32.2%	23.1%	28.3%
33) Dependable teacher	20.0%	19.2%	13.9%	14.3%	32.5%
37) Sense of humour	8.50%	30.7%	32.5%	17.8%	10.5%
Average percentage	9.73%	18.9%	22.6%	20.7%	25.4%

The percentage may not total 100% due to rounding off. The aim of this section of the questionnaire was to find out if there was an open-ended relationship in terms of laboratory activities. This section helped in understanding the type of relationship that existed in laboratory and how it contributes to the learning environment in the laboratory.

Figure 5.21. Leadership (DC)



Item 1: This teacher talks enthusiastically about practical work

The aim was to find out the extent to which teachers provided leadership during practical work through enthusiastic/motivating speech. This item provides answers to research question number three. The teacher as the leader in the class has to provide leadership qualities that will influence learners positively in doing practical work. Good class leadership is central to learners' achievements and teachers should act as primary classroom leaders and therefore carry the responsibility of managing learning in the classroom (Hess & Kelly, 2007: 266 and Lumsden, 1994). The mean score for this statement across the visited regions was 3.21 which represented sometimes in the questionnaire. The confident interval for this statement is at 95% ≈ {3.46~3.60}. This suggests that not all learners agreed with the leadership quality of their Chemistry teacher in terms of talking enthusiastically to them. The general score in the result is that 29.4% opted for (Never) and 25.2% for (Always) suggesting that the opinions are scattered and it differ from school to school. The standard deviation of 1.189 suggests that the result of learners around the visited region is nearly clustered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is <.05 and it can be interpreted as statistically significant. There is an association between the region and the way learners answered this item "teacher talk enthusiastically about practical work". This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Item 9: This teacher holds our attention

The mean score for this statement across the visited regions is 3.16 on the scale of 0-5, with standard deviation of 1.304. The confident interval for this statement at 95% ≈ {3.09~3.23}. The aim was to find out if Chemistry teachers held learners attention during laboratory sessions or not. This item provided answers to research question three. The average percentage of 34.2% (Often) and 15.0% (Always) shows that around half of the learners regarded their Chemistry teacher as someone who held their attention during class, while the other half regarded their teachers as not holding their attention. The Kruskal-Wallis Test shows a significant value of .001

which can be interpreted as there is no significant difference in the way learners answered this item. This means that the dependent variables were the same across all levels of factor. Chi-square of .000 for this item suggests that there is a significant association between the regions and their opinion on this item and the researcher can be more than 95% confident that the result was not due to error or chance.

Item 13: This teacher is aware of everything that goes on in the classroom

The aim was to find out the extent to which Chemistry teachers were aware of what was going on in their laboratories. Teachers should take full control of their classroom situations. The aim was to provide answers to research question number three. The mean score for this statement across the visited regions is 3.05 which represented sometimes in the questionnaire. The confident interval for this statement at 95% ≈ {2.97~3.13}. This suggests that not all learners agreed with seeing their teacher taking control of the classroom by knowing everything in the classroom. The general score in the result is that 32.6% opted for (seldom) and 25.0% for (sometime) suggesting that the opinions are scattered and it depend from teacher to teacher. *During the interview learners were asked: Does your teacher take full control of the situation in the classroom at all times? Our teacher is very strict and is always in control; Our teacher does not care with learners who are misbehaving or who disrupt lessons, he keeps on teaching.* The standard deviation of 1.338 suggests that the result of learners around the visited region is nearly clustered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 at 5% level of significance and it can be interpreted as statistically significant. There is an association between the region and the item “teacher is aware of everything that goes on in the classroom”. This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Item 17: This teacher is a good leader

The aim was to find out how good the Chemistry teachers were in terms of good leadership styles. The aim was to provide answers to research questions three and five. The mean score for this statement across the visited regions was 3.73 which represented often in the questionnaire. The confident interval for this statement is at 95% ≈ {3.65~3.81}. This suggests that the majority of the learners regarded their teachers as good leaders. In terms of percentages the value is scattered all over the five point scale but with the majority of the learners opting for Always =43.4% and Often =15.6%. The low standard deviation of 1.392 suggests that the result of learners around the visited region are scattered around the mean. This means that the dependent variables are the same across all levels of factor. The Kruskal-Wallis Test shows a significant value of .001 which is ≤.05 and it can be interpreted as there is no significant difference in the way learners answered this item throughout the visited regions. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item

Item 21: This teacher act confidently when doing practical work

Acting confidently during demonstrations not only removes doubt from learners about the success of the experiments, but also shows that the teacher knows what he or she is doing. The aim of this item was to find out what level of confidence Chemistry teachers displayed in the classroom because this will have influence on teacher-learners interaction which provides answers to research question three. The mean score for this statement across the visited regions is 3.59 which represented often in the questionnaire. The confident interval for this statement at 95% ≈ {3.52~3.66}. The standard deviation of 1.266 suggests that the results of learners around the visited regions are clustered around the mean. The dependent variables are the same throughout the visited regions. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as there are no significant differences in the way learners see their “teachers’ confident level” in their Chemistry laboratories throughout the visited regions. This means that generally the majority of teachers display confidence during their practical demonstrations. *During the interview questions were asked: Does your teacher know what to do during practical demonstrations or do they doubt their work? My teacher is very confident because I think he rehearses the demonstrations beforehand. My teacher shows confidence in demonstrations because he has done these activities for many many years.* Most learners in all visited regions opted for (Sometimes) 32.2% followed by

28.3% (Always) and 23.1 % for (Often). Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Item 33: This teacher is someone we can depend on

The aim was to find out to what extent learners trusted and depended on their teachers. A good leader is someone who can lead, guide, advise, provide orders, determine procedures and structure the classroom situation to be conducive to teaching and learning. Learning Chemistry can become a challenging work for learners of different ages, (Chiu, 2005:1) and therefore good dependable teachers are essential for successful laboratory teaching. The mean score for this statement across the visited regions is 3,22 which represented (Sometimes) in the questionnaire. The confident interval for this statement at 95% ≈ {3.12~3.32}. The percentages of 32.5% (Always), 20.0% (Never) and 19.2% (Seldom) imply that the learners' feelings on this item were not the same, in some schools learners show a negative perception on this item. Meaning that there are teachers who are dependable and there are teachers who are not dependable. The low standard deviation of 1.755 suggests that the result of learners in the visited region is clustered nearly close to the mean. The Kruskal-Wallis Test shows a significant value of .001 which is <.05 and it can be interpreted as there is no significant difference in the way learners "depended on their teachers" throughout the visited regions. This means that the dependent variables are the same across all levels of a factor, and generally learners are have the same feeling with regards understanding Chemistry. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Item 37: This teacher has a sense of humour

Good sense of humour is vital for a teacher as a leader and motivator. This item helped answering research question three because teachers with good sense of humour will most likely create positive learning environment. The mean score for this statement across the visited regions is 2.94 on the scale of 0-5, with standard deviation of 1.453. The confident interval for this statement is at 95% ≈ {2.86~3.02}.

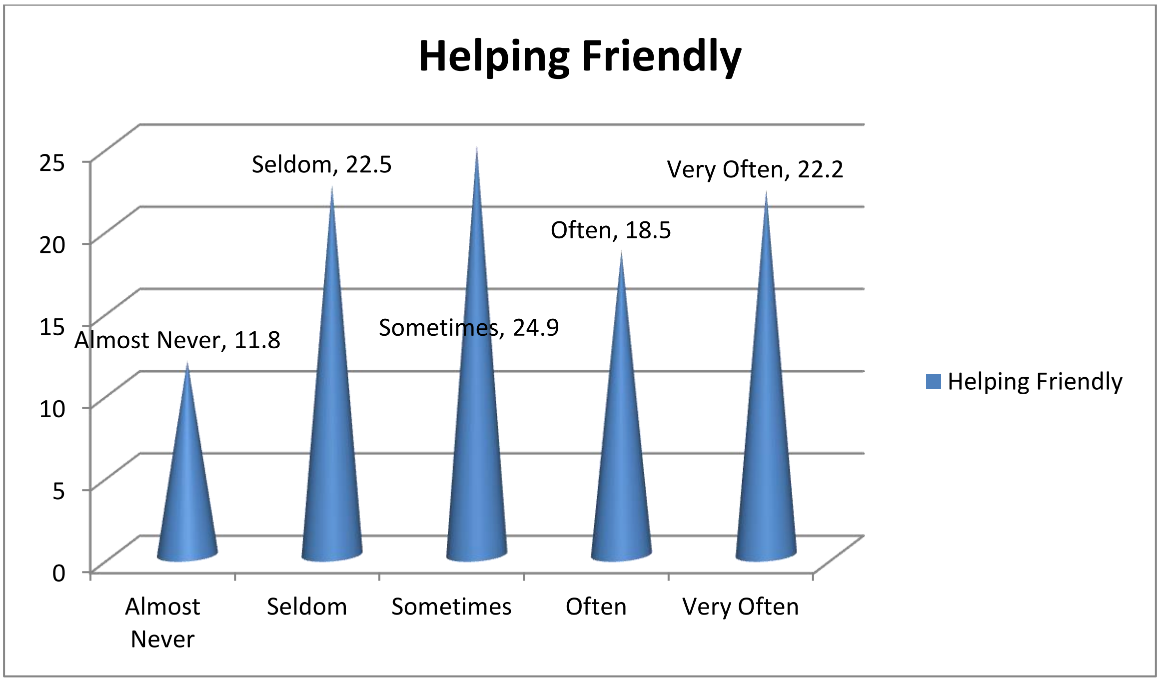
The intention of this statement was to measure the extent to which learners regarded their Chemistry teacher's sense of humour. In terms of percentages 32.5% (Sometimes) and 30.7% opted for (seldom), this shows a significant high amount of learners not in favour of their teachers' sense of humour. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted that there is no significant difference with regards to learners' knowledge of their teachers' sense of humour. This means that the dependent variables are not the same across all levels of a factor. Chi-square of .000 for this item suggests that it is statistically a significant association between the regions and their opinion on this item.

Table 5.29. Helping Friendly (CD) (Extent to which teacher is friendly, helpful and shows considerate manners that aspire confidence and trust from learners)

	Never	Seldom	Sometimes	Often	Always
14) Teacher listens	5.50%	9.00%	34.6%	17.8%	33.1%
25) Helps with experiments	12.0%	40.5%	14.9%	10.4%	22.2%
29) Teacher is friendly	7.10%	3.00%	19.8%	37.9%	32.2%
41) Teacher takes joke	15.2%	25.8%	19.8%	18.8%	20.2%
45) Enjoys demonstrations	21.2%	22.7%	27.5%	13.8%	14.6%
46) Teacher is lenient	10.0%	34.2%	32.8%	12.0%	10.8%
Average percentage	11.8%	22.5%	24.9%	18.5%	22.2%

The percentage may not total 100% due to rounding off. The aim of this section of the questionnaire was to find out if there was an open-ended relationship in terms of laboratory activities. This section will help in understanding the type of relationship that exists in laboratory and how it contributes to the learning environment in the laboratory.

Figure 5.22. Helping Friendly



Item 14: If we have something to say, this teacher will listen

The teacher-learners interactions are nurtured by good communications between the learner and the teacher. The teacher can enhance these interactions through listening to the learners and hearing their opinions. The aim of this item was to find out the extent to which Chemistry teachers listen to their learners if they have something to say in class. This helped in providing answers to research question five. The mean score for this statement across the visited regions is 3.65 which represented often in the questionnaire. The confident interval for this statement is at 95% ≈ {3.58~3.72}. The low standard deviation of 1.219 suggests that the result of learners around the visited region is clustered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as statistically significant. There is a relationship between the region and the way learners answered this item throughout the visited regions. This means that the dependent variables are the same across all levels of factor, with the majority of learners opting for (Sometimes) 34.6% and (Always) 33.1%. This high percentage shows that the majority of the teachers are really listening to the learners, which signifies a good learner-teacher relationship. Chi-square of .000 for this item suggests that there is association between this item and the visited regions.

Item 25: This teacher helps us if we get stuck doing experiments

The aim was to find out if teacher shows helping/friendly attitudes towards learners who are stuck doing experiments. The mean score for this statement across the visited regions is 2.92 which represented sometimes in the questionnaire. The confident interval for this statement is at 95% ≈ {2.92~3.00}. This suggests that not all learners agree or see their teachers as helping/friendly if they have difficulties during Chemistry practical work. The result in terms of percentages shows learners opting for Seldom = 40.5% and the rest of the percentages are spread over the other sections. The aim was to provide answers to research question three and five. The standard deviation of 1.495 suggests that the result of learners in the visited region is scattered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as statistically significant. There is an association between the region and the item "teacher helps us if we are stuck doing experiments". This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a significant association between the regions and their opinion on this item.

Item 29: This teacher is friendly

The aim was to find out to what extent Chemistry teachers showed friendliness. The mean score for this statement across the visited regions is 3.87 which represented often in the questionnaire. The confident interval for this statement is at 95% ≈ {3.80~3.94}. The aim was to measure to what extent the teachers portrayed friendship with their learners. Such friendship will foster positive learning atmospheres that are conducive for learning as addressed by research question one. The percentage of 37.9% (Often) and 32.2% (Always) imply that most of the learners regard their teachers as friendly. A friendly teacher will foster positive teacher-learner interactions which in turn create a positive learning environment. The standard deviation of 1.318 suggests that the result of learners in the visited region is clustered nearly close to the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as statistically significant. This means that there is an association in the way learners answered this item throughout the visited regions. This means that the dependent variables are the same across all levels of a factor, and generally learners are have the same feeling with regards to teachers' friendliness. *During the interview questions were asked: What can you tell me about the characteristics of your teacher in-terms of friendship?: Our teacher is always friendly, he always makes jokes in class although he does not like learners making jokes to him; Our teacher is friendly with everyone.* Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Item 41: This teacher can take a joke

The objective of this statement was to find out if learners regarded their teachers as people who can take jokes or not? The aim was to measure the type of relationship that existed between the learners and the teachers. This helped in providing answers to research question three. The mean score for this statement across the visited regions is 2.09 on the scale of 0-5 which represented Seldom in the questionnaire with a standard deviation of 1,727. The confident interval for this statement at 95% ≈ {2.00~2.18}. This low standard deviation suggests that data are closely scattered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05, this can be interpreted that there is no significant difference in the way learners answered this item. Chi-square of .001 for this item suggests that there is a strong significant association between the regions and their opinion on this item. Although during the interview some learners suggested that their teacher cracked joked, with them they did not agree that the teachers took can jokes from the learners (see Item 29).

Item 45: I enjoy this teacher's practical demonstration

The aim of this item was to find out if learners enjoyed the practical investigations from their teachers or not. The research question that was at the centre of this item was: How does the teacher-learner interaction influence the learners' attitudes to Chemistry practicals? It is believed that positive teacher-learner interactions in the laboratory are important for the creation of a good learning environment. The mean score for this statement across the visited regions is 2.81 which represented Sometimes in the questionnaire. The confident interval for this statement at 95% ≈

{2.71~2.91}. This suggests that not all learners agree or see themselves as enjoying their teachers' practical demonstrations. The result in terms of percentages is spread all over the five point scale as shown in Table 5.29 above with the majority of learners opting for sometimes as their choice. This shows that there are some schools in which learners did not enjoy teachers' practical demonstrations while others enjoyed. The standard deviation of 1.760 suggests that the result of learners in the visited region is scattered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as, statistically significant. There is an association between the region and item 45. This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a significant association between the regions and their opinion on this item. The low value in Mann-Whitney U Test of 0.00 suggest that there is no difference between the regions and schools in terms of the way they answered this item.

Item 46: This teacher is lenient

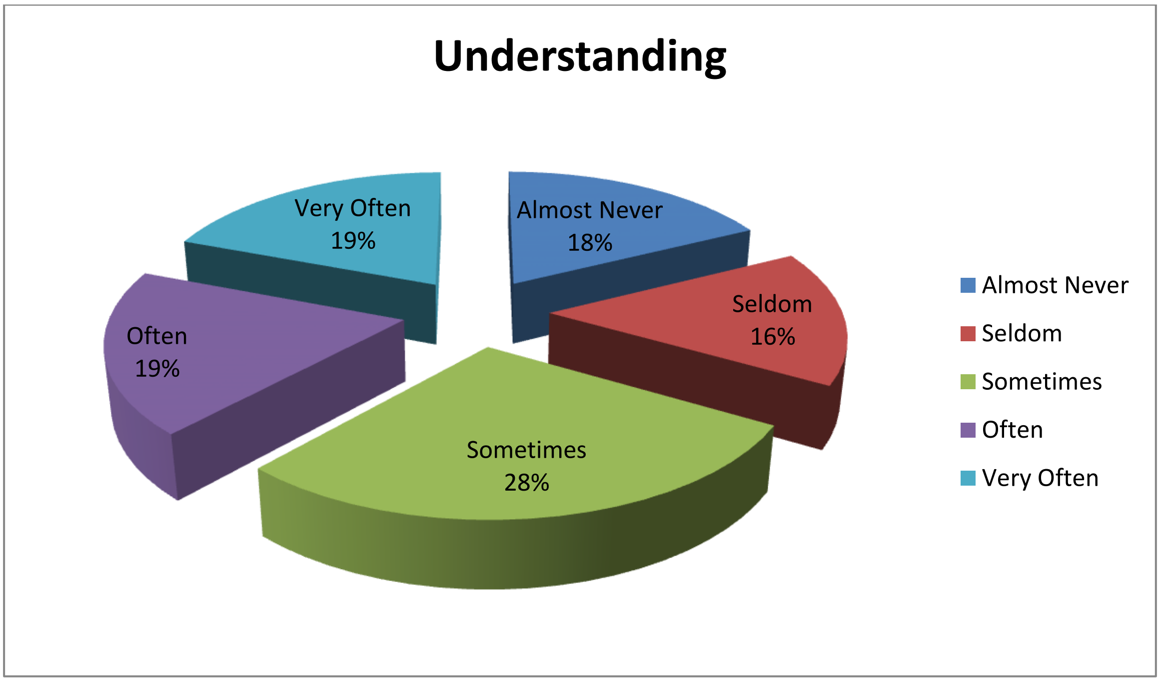
The aim of this statement was to find out how lenient the Chemistry teachers were towards their learners. This item helped in providing answers to research questions three and five. The mean score for this statement across the visited regions is 2.83 which represented sometimes in the questionnaire. The confident interval for this statement at 95% ≈ {2.74~2.92}. The standard deviation of 1.638 suggests that the result of learners around the visited region is not clustered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 at 5% level of significance and it can be interpreted as there is no significant difference in the way learners regard their teachers as "lenient" throughout the visited regions. This means that the dependent variables are the same across all levels of a factor. The scoring on the 5 point scale is scattered all over the scale with dominant two, Seldom = 34.2% and Sometimes =32.8%. Chi-square of .000 for this item suggests that the result for this item is statistically significant and the result is not due to chance or error.

Table. 5.30. Understanding (CS) (Extent to which teacher shows understanding/concern/care and openness to learners.)

	Never	Seldom	Sometimes	Often	Always
2) Trust handling equipment	31.9%	18.5%	30.4%	9.8%	9.4%
5) Teacher explains clearly	10.1%	23.6%	29.1%	20.6%	16.6%
6) Not agree we talk	29.0%	19.3%	15.4%	14.8%	21.3%
10) Willing to explain	8.6%	11.4%	21.1%	28.0%	30.8%
18) Realise not understand	7.50%	8.00%	32.0%	28.3%	23.3%
22) Patient teacher	29.2%	4.30%	29.6%	14.4%	22.5%
36) Practical test difficult	6.8%	23.9%	41.8%	16.7%	10.7%
Average percentage	17.6%	15.6%	28.5%	18.9%	19.2%

The percentage may not total 100% due to rounding off. The aim of this section of the questionnaire was to find out if there was an open-ended relationship in terms of laboratory activities. This section helped in understanding the type of relationship that existed in the laboratory and how it contributed to the learning environment in the laboratory.

Figure 5.23. Understanding



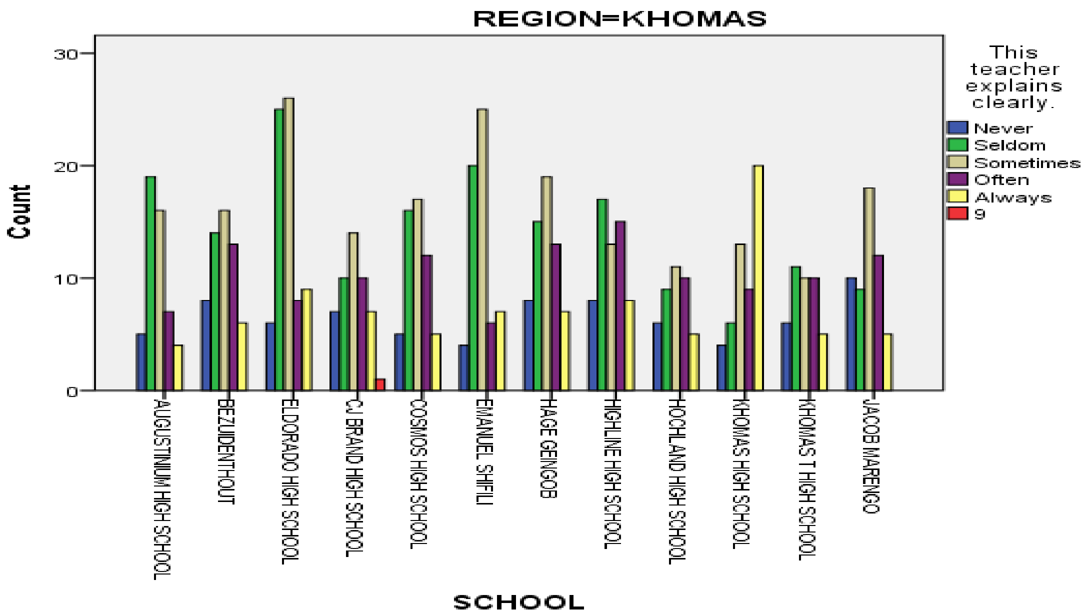
Item2: This teacher trusts us with handling equipment

The teacher-learners interactions are nurtured by trust between the learner and the teacher. The teacher can enhance these interactions through trust towards learners and giving them responsibilities for them to have sense of ownership. The aim of this item was to find out to what extent teachers trusted their learners in handling equipment in the laboratory and therefore provide answers to research questions three and five. The mean score for this statement across the visited regions is 2.46 which represented seldom in the questionnaire. The confident interval for this statement at 95% ≈ {2.39~2.53}. The standard deviation of 1.284 suggests that the result of learners around the visited region is clustered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as there are no significant differences in the way learners answered this item throughout the visited regions. This means that the dependent variables are the same across all levels of factor with the majority of learners opting for (Never) 31.9% and (Sometimes) 30.4% suggesting a low level of trust from the teachers towards learners as far as trust with handling equipment. *During the interview questions were asked: Does your teacher allow learners to use equipment during practical investigations, if not what do you think could be the reason? The teacher barely gives equipment to learners to use, he does not trust learners; The teacher only gives equipment to learners sometimes but only to his favoured learners. Teachers in the interview complained that most learners misbehaved if they were given equipment and tools to handle and their lack of skills in handling equipment could become a hazard to others' safety.* Chi-square of .000 for this item suggests that there is an association between this item and the visited regions.

Item 5: This teacher explains clearly.

The aim of this statement was to find out the extent to which teachers in the laboratory explained phenomena to learners. This provided answers to research questions three and five because clear explanations help in the understanding of concepts. The mean score for this statement across the visited regions is 3.11 which represented sometimes in the questionnaire. The confident interval for this statement at 95% ≈ {3.04~3.18}. The standard deviation of 1.1.235 suggests that the result of learners around the visited region is not clustered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as there are no significant differences in the way teachers explain things in the Chemistry laboratory throughout the visited regions. This means that the dependent variables are the same across all levels of a factor. The scoring on the 5 point scale is scattered all over the scale as follows: Never=10.1%, Seldom=23.6%, Sometimes=29.1% Often=20.6% and Always =16.6%. The answers to this item varied depending on the school. Look at the Khomas region as an example in the Bar-Chart 5.20 bellow. Most schools in Khomas opted for 'sometimes' and 'seldom' with the exception of Khomas high school which opted for 'always', that showed that the Chemistry teacher at Khomas high school was regarded by learners as an excellent explainer while other school learners saw their teachers as average to below average explainers. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Figure 5.24. Khomas Region



Item 6: If I don't agree with this teacher, we talk about it.

The main research question "How do learners perceive the interaction between them and their teachers during Chemistry practical work" was the main focus of this item. If the interactions between teacher and learners in Chemistry classes were good, they would be characterised by teacher-learners resolving their differences through constructive dialogue and finding amicable solutions. The aim of this item was to find out the extent to which learners could approach their teachers if they do not agree on issues. The item helped to provide answers to research questions three and five. The mean score for this statement across the visited regions is 2.81 which represented Sometimes in the questionnaire. The standard deviation of 1.534 suggests that the result of learners around the visited region is clustered around the mean. The Kruskal-Wallis Test shows a significant value of .000 which is <.05 and it can be interpreted as there is no significant difference in the way learners "resolved issues with their teachers if they do not agree" in their Chemistry laboratories throughout the visited regions. This means that the dependent variables are the same across all levels of factor, and generally in some schools learners can sit and talk with their teachers while others cannot as it is shown in the percentages Table 5.30 above. The two dominant categories in this item is (Never) = 29.0% and (Always) = 21.3%. The (Never) suggests a serious lack of learner-teacher interaction if problems arise in the visited regions. *During the interview learners were asked: Do you sometimes sit and talk to your teacher if you have problems in Chemistry or not and if not why not? Is difficult to talk to our teacher because we fear him; Is not easy to talk to the teacher because he does not open up good conversations; We can sit and talk but not in details.* The confident interval for this statement at 95% ≈ {3.476; 3. 544}. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item and the result is not due to chance.

Item 10: This teacher is willing to explain things again

The mean score for this statement across the visited regions is 3.16 on the scale of 0-5, with standard deviation of 1,278. The confident interval for this statement at 95% ≈ {3.09~3.23}. The aim was to answer research questions three and five. The mean of 3.16 represent sometimes on the Likert scale and highest score in this item were 30.8% (Always) and 28.0% for (Often). In general, the scores were scattered all over the scale, which shows that learners had different opinions in the way they regarded their teachers' ability to explain things again to them. The intention of this statement was to measure the extent to which teacher is able to explain phenomenon to learners who did not understand the first time. It is important that teachers show understanding and care for slow learners by explaining things over and over to them until learners grasp the meaning. *During the interview learners were of the opinion that their teachers were willing to explain issues that they did not understand.* Such explanations created good teacher-learners interactions which are needed for learners to understand difficult science phenomena. The Kruskal-Wallis Test shows an insignificant value of .001 which is ≤ .05 and it can be interpreted as there is no significant difference with regards to the way teachers explain things over and over in Chemistry laboratories throughout the visited regions. Some schools showed good scores on the Likert-scale while others showed poor results. This means that the dependent variables are not the same across all levels of a factor. Chi-square value of .000 is > 0.05 for this item which suggests that this item has a significant association between the regions and their opinion on this item.

Item18: This teacher realised if we don't understand

The aim was to find out how concerned, caring and understanding the teachers were towards learners who did not understand in the visited regions. Teachers should have the ability to sense if learners do not understand issues that he/she is explaining, because it is not always that learners ask questions. The aim of this item was to provide answers to research questions three and five. The mean score for this statement across the visited regions is 3.53 which represented 'often' in the questionnaire. The confident interval for this statement at 95% ≈ {3.46~3.60}. The standard deviation of 1.219 suggests that the results of learners around the visited region are clustered around the mean. The dependent variables are the same through the visited regions. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as statistically significant; meaning that there are no significant differences in the way learners answered this item throughout the visited regions. This means that the dependent variables are the same across all levels of factor, and generally learners are enjoying practical work in their lessons. Most schools in all visited regions opted for (Sometimes) 32.0% followed by 28.3% (Often) and (Always) 23.3 % which suggests that these teachers can sense if learners do not understand. *During the interview teachers where asked "How do you sense if learners understand or do not understand what you are teaching? Learners* *who don't understand usually do not take part in discussions, answering questions, they shows signs of lack of interest in the topic, while, those who understand are always eager to answer or ask questions. There are other physical signs that teachers look at e.g. body language, facial expressions and behaviour.* On the other hand, some learners are of the opinion that their teachers did not realise if they did not understand. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Item 22: This teacher is patient with us during experiments

The mean score for this statement across the visited regions is 2.98 on the scale of 0-5, with standard deviation of 1.589. The confident interval for this statement at 95% ≈ {2.89~3.07}. The aim was to find out if teachers as classroom leaders were patient with learners during practical experiments. This item ties up well with items 10 and 18 in a bid to establish the kind of Chemistry teachers we find in the visited regions schools. This provided answers to research questions three and five. The average percentage of 29.2% (Never) and 29.6% (Sometimes) shows that to a certain extent teachers in the visited regions are not patient with their learners during Chemistry practical work. The Kruskal-Wallis Test shows a significant value of .001 which can be interpreted as statistically significant and that there is no significant difference in the way learners regard their teachers as patient throughout the visited regions. This means that the dependent variables are the same across all levels of a factor. Chi-square of .000 for this item suggests that there is a significant association between the regions and their opinion on this item.

Item 36: This teacher's practical tests are difficult

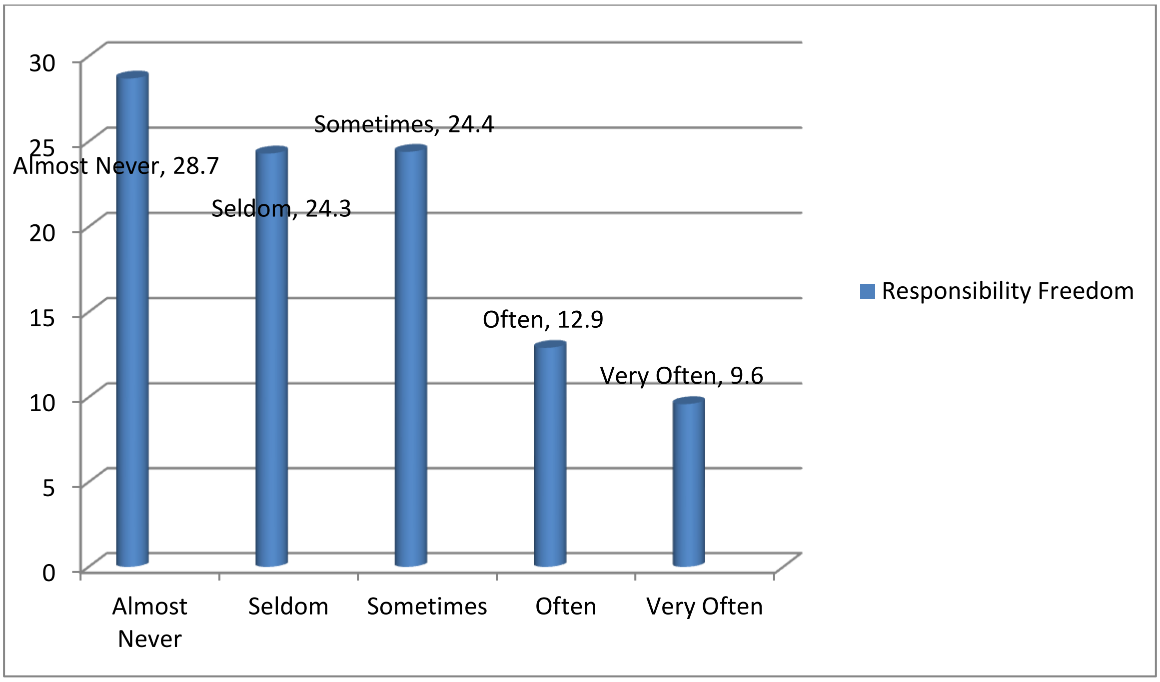
The aim of this item was to find out if learners regarded their teachers' practical work as difficult. The item further highlights the type of laboratories found in the visited regions by providing answers to research question four. The mean score for this statement across the visited regions is 3.03 which represented sometimes in the questionnaire. The confident interval for this statement at 95% ≈ {2.95~3.11}. This suggests that not all learners agreed that the teachers' practical tests were easy to answer. The result in terms of percentages is spread all over the five point scale as shown in Table 5.30 above. The standard deviation of 1.397 suggests that the result of learners in the visited region is scattered around the mean. The Kruskal-Wallis Test shows an insignificant value of .228 which is ≥ .05 and it can be interpreted as statistically insignificant. There is no association between the region and the way learners answered this item. This means that the dependent variables are not the same across all levels of factor. Chi-square of .000 for this item suggests that there is a significant association between the regions and their opinion on this item.

Table 5.31. Responsibility/Freedom (SC) (Extent to which learners are given opportunities to assume responsibilities for their own activities by encouraging independent work.)

	Never	**Seldom**	**Sometimes**	**Often**	**Always**
23) Teasing others allowed	34.6%	21.5%	30.0%	10.6%	3.2%
26) We can decide in class	20.2%	31.3%	19.3%	19.6%	9.5%
30) We can influence teacher	30.8%	30.2%	12.1%	14.5%	12.1%
34) Get away with lots	20.6%	26.1%	33.4%	7.9%	11.9%
38) Bad behaviours	37.8%	13.6%	36.6%	5.00%	6.9%
39) We can do experiments	16.6%	13.6%	28.7%	22.1%	18.9%
42) Get lots of free time	40.3%	33.7%	10.4%	10.7%	4.80%
Average percentage	28.7%	24.3%	24.4%	12.9%	9.60%

The percentage may not total 100% due to rounding off. The aim of this section of the questionnaire was to find out if there was an open-ended relationship in terms of laboratory activities. This section helped in understanding the type of relationship that existed in the laboratory and how it contributed to the learning environment in the laboratory. Teasing is considered to be a form of intentional provocation accompanied by playful off-record marks that comment on something relevant to the target (Keltner, Capps, Kring, Young, & Heerey, 2001) and it often occurs in response to norm violation and interpersonal conflicts
(Keltner et al., 2001).

Figure 5.25. Responsibility/Freedom (SC)



Item 23: This teacher allows learners to tease each other during practical

This item was stated negatively and the score where reversed. The objective of this statement was to find out the extent to which teachers allowed learners to tease each other in the laboratory. Teasing is considered to be a form of intentional provocation accompanied by playful off-record remarks that comment on something relevant to the target (Keltner, Capps, Kring, Young, & Heerey, 2001: 243) and it often occurs in response to norm violation and interpersonal conflicts (Keltner et al., 2001:244). The item aimed at providing answers to research question four. The majority of the students opted for (Never) 34.6 % with others opting for (Sometimes) 30.0% and 21.5% (Seldom). Such results suggest that the majority of the teachers in Chemistry classes are strict and do not allow teasing during laboratory sessions. Such strictness will foster positive learning environment where learners feel respected by their peers and protected by their teachers. The mean score for this statement across the visited regions is 2.28 on the scale of 0-5, which represented seldom in the questionnaire with a low standard deviation of 1,275. The confident interval for this statement at 95% ≈ {2.21~2.35}. This low standard deviation suggests that the data are closely scattered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05, this can be interpreted that there is no significant differences in the way learners see their teachers allowing teasing in the laboratory throughout the visited regions. In some schools the learners showed zero tolerance of teasing from their teachers while in some school teasing is allowed by teachers during Chemistry laboratory sessions. Chi-square value of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item. *During the interview some learners suggest that some teachers are never minded and learners are very much disturbed by others who tease them while teachers are doing demonstrations*. These types of behaviours highlight the type of Chemistry classes in the visited regions in Namibia.

Item 26: We can decide some things in this teacher's class

The mean score for this statement across the visited regions is 2.69 on the scale of 0-5, with standard deviation of 1,415. The confident interval for this statement at 95% ≈ {2.27~2.77}. The intention of this statement was to measure the extent to which learners could take leadership or have the freedom to decide on what is going on in the laboratory. This will help in giving learners the opportunity to assume responsibility for their own activities and projects. This item provided answers to research questions five and six. The Kruskal-Wallis Test shows an insignificant value of .279 which is ≥ .05 and can be interpreted as there is a significant difference with regards to the way learners are given freedom to decide on some issues in the laboratories. This means that the dependent variables are not the same across all levels of a factor. The high Chi-square value of .720 for this item is statistically insignificant and it suggests that there is no significant association between the regions and their opinion on this item. The results from some schools show lack of freedom to decide from teachers, especially from rural schools learners, while other schools show an average to above average support from teachers to have the freedom to decide in the laboratory. *During the interview learners were asked questions like: Are you as learners sometimes allowed by your teacher to take major decisions in class? The teacher does not allow us to take major decisions in class; The teacher depends more on the class captain to take major decisions; The teacher usually makes all the big decisions.*

Item 30: We can influence this teacher in doing the practical that we like

The mean score for this statement across the visited regions is 2.49 on the scale of 0-5, with standard deviation of 1,567. The confident interval for this statement at 95% ≈ {2.40~2.58}. The intention of this statement was to measure the extent to which learners can influence their teachers to do their preferred practical topics or experiments. This item can also be linked to item number 26 and answered research question seven by showing to what extent the learners influenced their teachers in doing the practical work that they enjoyed. The Kruskal-Wallis Test shows an significant value of .001 which is ≤ .05 and can be interpreted as there is no significant difference with regards to the way learners influenced their teachers to do their preferred practical work. This means that the dependent variables are the same across all levels of a factor. Chi-square of .000 for this item suggests that there is significant association between the regions and their opinion on this item. The results from schools in term of percentages shows that the majority of the teachers are not influenced by learners on which topics to do during practical sessions e.g. 30.8% (Never) influence and 30.2% (Seldom) influence shows that it is difficult for teachers to be influence by learners on the preferred practical work. This shows that teachers are in control of the topics to be discussed or the type of practical investigation to be conducted.

Item 34: This teacher let us get away with a lot in class.

The aim was to find out to what extent Chemistry teachers allowed their learners to get away with bad behaviour in class. Teachers should take full control of their classroom situations to foster positive learning environment. The aim was to provide answers to research questions five and seven. The mean score for this statement across the visited regions is 2.67 which represented sometimes in the questionnaire. The confident interval for this statement at 95% ≈ {2.58~2.76}. The natures of laboratories in Namibia are derived from the interactions between the learners and the teachers. This result suggests that not all learners agreed that teachers allowed them to get away with a lot in class. The general score in the result is that 33.4% opted for (sometimes) and 26.1% for (seldom) suggesting that the opinions are scattered and it depended from teacher to teacher, but generally the majority of the teachers did not allowed getting away with what they wanted. The standard deviation of 1.512 suggests that the result of learners around the visited region is nearly clustered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as statistically significant. There is an association between the region and the way learners answered this item "teacher let us get away with lots in the class". This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Item 38: This teacher doesn't mind how we behave

The aim of this item was to find out how teachers are concerned with the behaviour of learners. This helped in answering research question five. The mean score for this statement across the visited regions is 2.32 on the scale of 0-5, with standard deviation of 1,564. The confident interval for this statement at 95% ≈ {2.23~2.41}. The Kruskal-Wallis Test shows a significant value of .001 which can be interpreted as statistically significant. This means that there are no significant differences in the way learners answered this item throughout the visited regions in Namibia. This means that the dependent variables are the same across all levels of factor. Chi-square of .001 for this item suggests that there is a significant association between the regions and their opinion on this item. Referring to percentages the majority of learners fell in the category, never (37.8%) and sometimes (36.6%). This indicates that there are some schools where teachers mind the behaviour of learners while few school teachers do not mind the behaviours of learners. It can be inferred that the majority of the teachers are concerned with the behaviours of the learners. This could lead to order and discipline in the laboratory which in-terns create a positive learning environment. *During the interview learners were asked: If learners misbehave in the laboratory how does the teacher act in-response to this behaviour? The teacher is very strict and learners are always punished if they misbehave; Our teacher will not act immediately but should the misbehaviour persist he will act. How does he act, what punishment strategy is he using? Learners' names are recorded and they go in his record book, if the offence is repeated the leaner is issued with a warning letter, and after that parents are informed, if behaviour persists suspension follows.*

Item 39: This teacher thinks that we can conduct experiments well

The aim of this statement was to find out how learners regarded their teachers' trust in them; that they could successfully conduct experiments. The aim was to provide answers to research question five. The mean score for this statement across the visited regions is 3.16 which represented sometimes in the questionnaire. The confident interval for this statement at 95% ≈ {3.07~3.26}. The standard deviation of 1.667 suggests that the result of learners around the visited region is clustered around the mean. The Kruskal-Wallis Test shows a significant value of .004 which is ≤ .05 and it can be interpreted as statistically significant. This means there are no significant differences in the way learners answered this item throughout the visited regions. This means that the dependent variables are the same across all levels of a factor. The scoring on the 5 point scale is scattered all over the scale as follows: Almost Never=16.6%, Seldom=13.6%, Sometimes=28.7% Often=22.1% and Always = 18.9%. These results show that to a certain extent the majority of teachers do trust learners to do experiments. These build trust and confidence in learners especially with doing experiments. Chi-square of .427 for this item suggests that the result is statistically insignificant and there is strong insignificant association between the regions and their opinion on this item.

Item 42: This teacher gives us a lot of free time in class

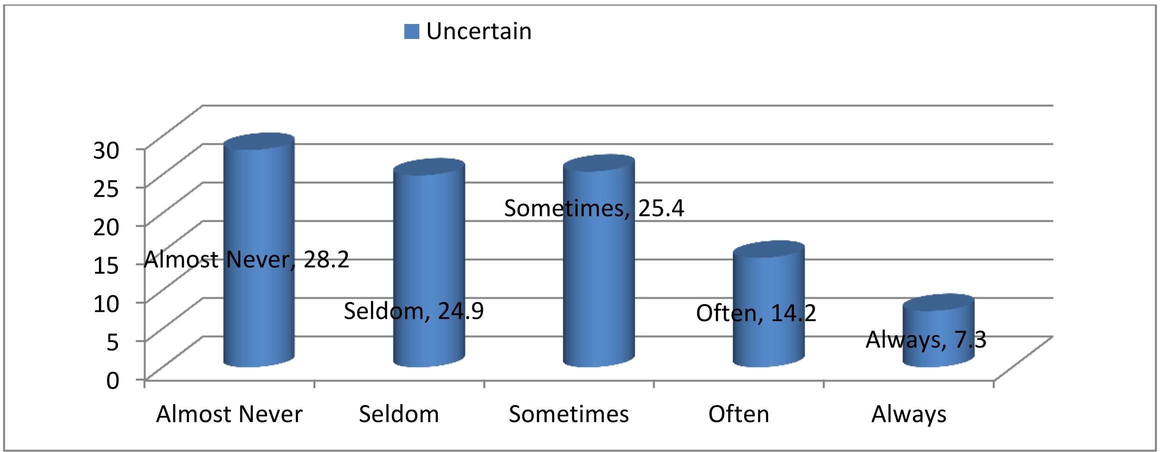
The aim was to find out if teachers in laboratories through the visited regions do gave a lot of free time to their learners or not. The mean score for this statement across the visited regions is 2.09 which represented seldom in the questionnaire. The confident interval for this statement at 95% ≈ {2.00~2.18}. The aim was to find out what types of class control is practiced in the visited regions. The results suggest that not all learners agreed with the idea of getting lots of free time from their teachers, meaning that there is proper class control in the visited regions. The standard deviation of 1.606 suggests that the result of learners around the visited region is significant. This means that the dependent variables are the same across all levels of factor. In terms of percentages the value is scattered all over the five point scale with (Never) taking 40.3% and (Seldom) 33.7%. The Kruskal-Wallis Test shows insignificant value of .061 which is ≥ .05 and it can be interpreted as statistically insignificant, this implies that there is a significant difference in the way learners answered this item of free time given by the teachers during laboratory sessions throughout out the visited regions. Chi-square of .023 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Table 5.32. Uncertain (SO) (Extent to which teacher exhibits her/his uncertainty by showing a low profile.)

	Never	Seldom	Sometimes	Often	Always
3) Uncertain teacher	25.8%	38.8%	21.1%	11.5%	2.8%
7) Teacher hesitating	23.5%	23.4%	30.0%	11.7%	11.3%
11) Act like not knowing	35.7%	17.3%	30.9%	7.5%	8.5%
15) We can boss teacher	39.5%	21.8%	21.0%	13.5%	4.2%
19) We fool teacher confuse	21.3%	13.5%	31.5%	23.6%	10.0%
31) We cannot do practical	23.6%	34.3%	17.6%	17.5%	7.0%
Average percentage	28.2%	24.9%	25.4%	14.2%	7.3%

The percentage may not total 100% due to rounding off. The aim of this section of the questionnaire was to find out if there was an open-ended relationship in terms of laboratory activities. This section helped in understanding the type of relationship that existed in laboratory and how it contributed to the learning environment in the laboratory.

Figure 5.26. Uncertain teacher



Item 3: This teacher seems uncertain about practical work

In a study done in the UK, (SCORE 2007:8) suggested that over 60 % of both primary and secondary teachers said they were confident and a further third were fairly confident in doing practical work. The main reasons given by most teachers for this were experience (that include experience gain e.g. years of experience teaching science), knowing the subject and having enthusiasm for it, and having time to practice and prepare before time in school or to attend courses and conferences. This item can be linked to Item 21 and the aim of this item was to find out the extent to which learners regarded their teachers as confident in doing practical investigations and hereby provide answers to research question five. Learners' confidence and trust will be boosted by teachers' confidence. The mean score for this statement across the visited regions is 2.27 which represented seldom in the questionnaire. The confident interval for this statement at 95% ≈ {2.21~2.33}. This suggests that not all learners agreed or saw their teacher as uncertain about practical work. The standard deviation of 1.054 suggests that the result of learners in the visited region is clustered around the mean and the dependent variable is the same throughout the visited regions. The two highest choices made by learners were the (Seldom) 38.8% and (Never) 25.8%. The percentage shows that the majority of the teachers were confident when doing practical investigations in the laboratory and this was also highlighted in Item 21. *During the interview it was clear that most learners were of the opinion that their teachers knew what to do during practical investigations (See Item 21).* The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as statistically significant. There is an association between the region and way learners answered this item. This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a significant association between the regions and their opinion on this item.

Item 7: This teacher is hesitating when doing practical work

This statement was stated negatively and the scores were reversed. The statement link up with the previous one and it measures the level of confidence among teachers in the visited regions. The item further provides answers to research question five by showing the type of laboratory interactions and teachers found in the visited region. The mean score for this statement across the visited regions is 2.64 on the scale of 0-5 which represent Seldom to Sometimes, with standard deviation of 1.275. In general, the highest scores of 30.9% (Sometimes) followed by 23.5% (Never) and 23.4 (Seldom) suggest that most teachers are not hesitant when doing practical investigation or demonstrations. The confident interval for this statement at 95% ≈ {2.57~2.71}. This item further denotes what (SCORE 2007: 8) suggested in the study done in the UK, that most experienced teachers show confidence during practical investigations. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as there is no significant difference with regards to the way teachers show hesitation during practical work. This means that the dependent variables are the same across all levels of a factor. Chi-square value of .000 is > 0.05 for this item, which suggests that there is a significant association between the regions and their opinion on this item.

Item 11: This teacher acts as if he/she does not know what to do

The aim of this item was to solicit the learners' opinion in Item 7 and to see if teachers in the visited regions had high subject knowledge or not. It is easy for learners to find out if the teacher knows the subject or not, just by the way he presents the subject. This item provided answers to research question three by showing the level of subject knowledge that learners perceived in their teachers. The mean score for this statement across the visited regions is 2.36 which represented Seldom in the questionnaire. The confident interval for this statement at 95% ≈ {2.29~2.43}. This suggests that not all learners agreed with the statement that "Their teacher act as if they do not know what to do". The standard deviation of 1.289 suggests that the result of learners around the visited region is clustered around the mean. This suggests that the dependent variables are the same across all regions. The majority of the learners opted for (Never) 35.7% (Sometimes) 30.9% see Table 5.32 above which shows that learners have confidence in their teachers' subject knowledge. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as there are no significant differences in the way learners answered item 11 throughout out the visited regions. This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Item 15: We can boss this teacher around easily during experiments

The aim of this statement was to find out to what extent learners could manipulate situations in the class or control their teacher (Boss around their teacher). This showed the type of teacher-learners interaction relationships that prevailed in the visited regions whether authoritarian or democratic. This provided answers to research question three. The mean score for this statement across the visited regions is 2.25 which represented seldom in the questionnaire. The confident interval for this statement at 95% ≈ {2.15~2.35}. The standard deviation of 1.709 suggests that the result of learners around the visited region is clustered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as statistically significant, meaning that there is an association between this item and the way learners answered this item throughout the visited regions. This means that the dependent variables are the same across all levels of a factor. The scoring on the 5 point scale shows that learners barely boss their teachers around in the laboratory; Never=39.5%, Seldom=21.8%, Sometimes=21.0%. This further suggested that harmonious relationships exist in the laboratories of the visited schools and that such harmonious relationships contribute to positive learning environments in the laboratories. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Item 19: This teacher does not know what to do when we fool around.

This statement was stated negatively and the scores where reversed. The aim was to find out if teachers knew what to do in their classes if learners were misbehaved. This item can be link to the previous item number 15 and the results show close associations. The mean score for this statement across the visited regions is 2.89 which represented “sometimes” to “seldom” in the questionnaire. The confident interval for this statement at 95% ≈ {2.81~2.97}. This suggests that not all teachers are able to control the class well while some teachers are well in class control. The standard deviation of 1.346 suggests that the result of learners around the visited region is nearly clustered around the mean. There is generally a mixed reaction to this item because some learners showed that some teachers did not know what to do when learners misbehaved. During the interview some learners showed that learners misbehaved in female teachers' classes rather than in male teachers' classes. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as there are no significant differences in the way learners answered this item throughout the visited regions in Namibia. This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Item 31: This teacher thinks we cannot do practical on our own

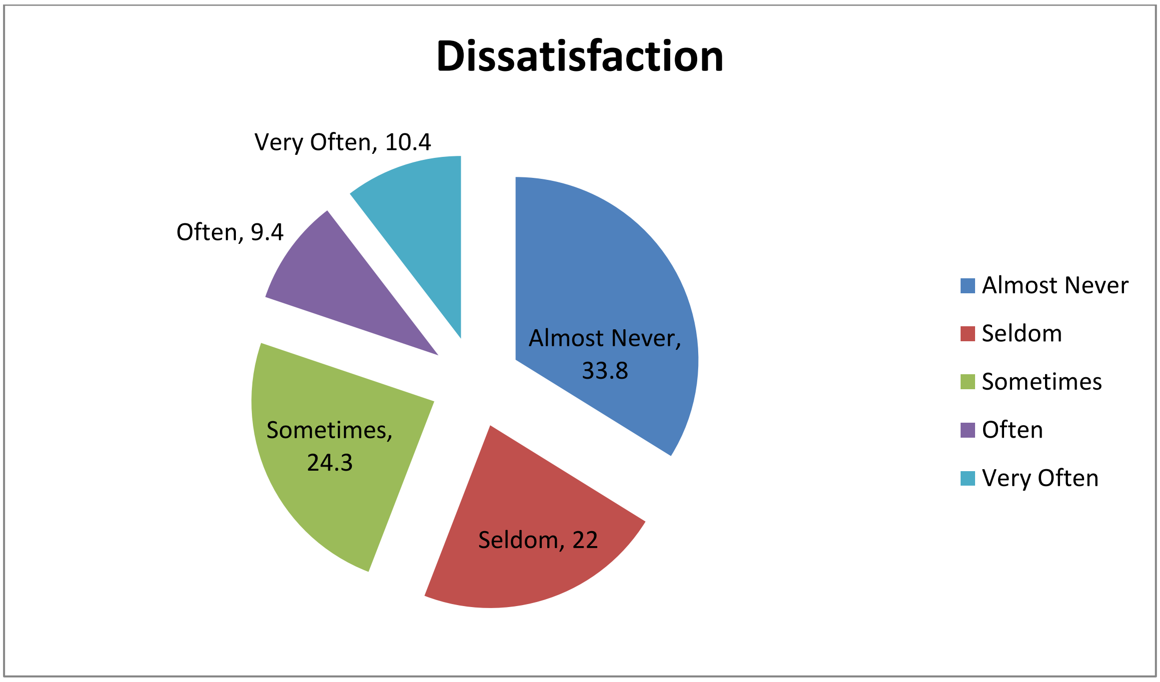
The aim was to find out how teachers viewed their learners' capability to do practical work. The trust that the teacher has in his learners to carry successful practical work will motivate learners to want to do more practical investigations and this will boost their confidence level. This item helped in answering research question three by showing the teacher-learners relationship in-terms of trust. The mean score for this statement across the visited regions is 2.52 which represented seldom to sometimes in the questionnaire. The confident interval for this statement at 95% ≈ {32.44~2.60}.This suggests that not all learners agreed with the statement. The general score in the result shows that 23.6% opted for (Never) and 34.3% for (Seldom) and the rest of the opinions were scattered in the other three options. This shows a high level of trust from the teachers towards the learners. Such trust usually contributes to positive teacher-learners relationships. The standard deviation of 1.453 suggests that the result of learners around the visited region is nearly clustered around the mean. The Kruskal-Wallis Test shows a significant value of .006 which is ≤ .05 and it can be interpreted as statistically significant. There is an association between the region and the way learners answered this item. This means that the dependent variables are the same across all levels of factor. Chi-square of .106 for this item suggests that there is no significant association between the regions and their opinion on this item. The result for this item might be due to chance or error.

Table 5.33. Dissatisfaction (Extent to which teacher shows unhappiness/ dissatisfaction/ criticise/)

	Almost Never	Seldom	Sometimes	Often	Very Often
24) Sarcastic teacher	48.0%	16.6%	21.8%	6.70%	6.90%
27) Cheat our experiment	31.9%	33.6%	15.9%	6.50%	11.9%
43) Dissatisfied with practical	35.5%	19.0%	33.9%	4.7%	6.9%
47) Blame us	19.7%	18.9%	25.4%	19.8%	16.0%
Average percentage	33.8%	22.0%	24.3%	9.40%	10.4%

The percentage may not total 100% due to rounding off. The aim of this section of the questionnaire was to find out if there was an open-ended relationship in terms of laboratory activities. This section helped in understanding the type of relationship that existed in the laboratory and how it contributed to the learning environment in the laboratory.

Figure 5.27: Dissatisfaction



Item 24: This teacher is sarcastic

The mean score for this statement across the visited regions is 2.10 on the scale of 0-5 which represents seldom, with standard deviation of 1.395. The confident interval for this statement at 95% ≈ {2.02~2.18}. The intention of this statement was to measure the extent to which learners see their teachers as sarcastic. This provided an answer to research question three by showing the type of teacher-learners relationship in the visited regions. The overall result shows a resounding disagreement of learners with this negatively stated statement. The result in terms of percentage is as follows; Never (48.0%), Seldom (16.6%) and Sometimes (21.8%) which suggest that there is a high percentage of teachers who are not sarcastic. It can be therefore deduced that most teachers in the visited regions are not sarcastic. This shows positive teacher-learners interactions or harmonious atmospheres in school Laboratories in the visited regions. The Kruskal-Wallis Test shows a significant value of .001 which can be interpreted that there is no significant difference with regards to learners seeing their teachers as sarcastic. This means that the dependent variables are not the same across all levels of a factor. Chi-square of .000 for this item suggests that there is a significant association between the regions and their opinion on this item.

Item 27: This teacher thinks we cheat in our experiments

The aim of this item was to find out if teachers trusted their learners with regard to honesty in experiments. This provided answers to research question three in terms of how teachers trust their learners. The mean score for this statement across the visited regions is 2.35 which represented Seldom in the questionnaire. The confident interval for this statement at 95% ≈ {2.27~2.43}. This suggests that the majority of teachers trust their learners with their experiments' results. The standard deviation of 1.475 suggests that the result of learners around the visited region is nearly clustered around the mean. There is generally an agreement from learners with regards to this negatively stated statement. The results in terms of percentages show that learners opted for 35.5% (Never), 19.0% (Seldom) and 33.9% (Sometimes). Some schools expressed a higher degree of disagreement than others which suggests that this varied from teacher to teacher or from school to school. During the interview, most learners were of the opinion that, their teachers trusted them and they did their best not to cheat in the tests. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as, there are no significant differences in the way learners answered this item throughout the visited regions in Namibia. This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Item 43: This teacher seems dissatisfied with our practical

The aim was to find out if teacher always showed dissatisfaction on the practical work of learners. This provided answers to research question three in terms of satisfaction from teachers towards learners. The mean score for this statement across the visited regions is 2.32 which represented seldom in the questionnaire. The confident interval for this statement at 95% ≈ {2.23~2.41}. This suggests that not all teachers are dissatisfied by the quality of practical work that learners produce. The overall highest score for this item in terms of percentage is 35.5% (Never) followed by 33.9% (Sometimes) and 19.0% (Seldom) see Table 5.33. This result suggests that the majority of the teachers show signs of satisfaction with regards to learners' practical investigations. This satisfaction will trigger positive teacher-learner interactions which in-turn lead to positive learning environment. The standard deviation of 1.647 suggests that the result of learners around the visited region is nearly clustered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as statistically significant. There is an association between the region and way the learners answered this item 43. This means that the dependent variables are the same across all levels of factor. The Mann Whiney U Test also records a high value of 2.32. The Chi-square of .017 for this item suggests that there is a significant association between the regions and their opinion on this item.

Item 47: This teacher blames us for everything that goes wrong in class

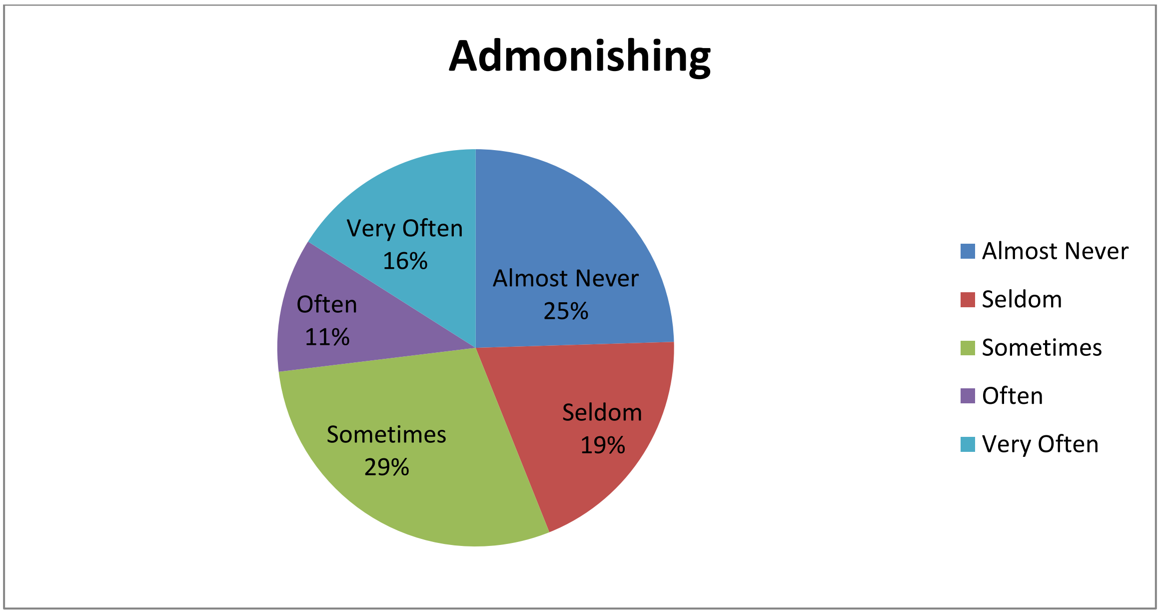
The aim of this item was to find out the type of relationship that existed between teachers and learners particularly in terms of teachers blaming learners if things went wrong in the class. This item provided an answer to research question three by showing the type of relationship that prevailed between teachers and learners in the visited regions. The results show a mixed reaction from the learners. There are some teachers who blame learners while others do not blame everything that goes wrong in the class on learners. The mean score for this statement across the visited regions is 2.97 on the scale of 0-5 which represented seldom, with standard deviation of 1.814. The confident interval for this statement at 95% ≈ {2.87~3.07}. The Kruskal-Wallis Test shows an insignificant value of .001 which is ≤ .05 and can be interpreted as there is no significant difference with regard to learners' opinion on this item throughout the visited regions. This means that the dependent variables are the same across all levels of a factor. Chi-square of .000 for this item suggests that there is an insignificant association between the regions and their opinion on this item. The results in terms of percentages are spread nearly equally throughout the five sections of the scale (see Table 5.33).

Table 5.34. Admonishing (Extent to which teacher shows anger/ temper/impatient/ irritation/ punishments in class.)

	Almost Never	Seldom	Sometimes	Often	Very Often
4) Angry if things go wrong	17.5%	13.8%	23.6%	17.2%	27.9%
8) Teacher gets angry	13.9%	21.6%	37.1%	14.1%	13.0%
16) Teacher impatient	19.8%	21.5%	42.2%	6.7%	9.7%
20) Pick up fight with teacher	45.9%	19.8%	13.8%	5.3%	15.2%
48) Afraid of teacher	25.6	20.4	28.8	11.1	14.0
Average percentage	24.5%	19.4%	29.1%	10.9%	16.0%

The percentage may not total 100% due to rounding off. The aim of this section of the questionnaire was to find out if there was an open-ended relationship in terms of laboratory activities. This section helped in understanding the type of relationship that existed in laboratory and how it contributed to the learning environment in the laboratory.

Figure 5.28: Admonishing



Item 4: This teacher gets angry if things go wrong in practical work.

The mean score for this statement across the visited regions is 3.24 on the scale of 0-5, which represented Sometimes, with standard deviation of 1,438. The confident interval for this statement at 95% ≈ {3.16~3.32}. The intention of this statement was to measure the extent to which teachers were able to control their anger if things went wrong in the laboratory. This item also contributed to answering research question three, because anger management contribute to the type of teacher-learner interactions as well as the laboratory atmosphere. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and can be interpreted as there are no significant differences with regard to learners' perception of the extent to which teachers controlled their anger. This means that the dependent variables are the same across all levels of a factor. Chi-square of .000 for this item suggests that there is a significant association between the regions and their opinion on this item. The results shows a high percentage of 27.9% (very often) and 17.2% (often) which suggest that a significant amount of learners show that, some teachers do get angry if things go wrong in the class (See Table 5.32). Such behaviour might have negative impact on teacher-learners relationship.

Item 8: This teacher gets angry quickly

This item teams up with Item 4 and the aim was to find out if teachers got angry quickly. The item helped in providing answers to research question three. The mean score for this statement across the visited regions is 2.91 which represented 'sometimes' in the questionnaire. The confident interval for this statement is at 95% ≈ {2.84~2.98}. This suggests that not all teachers got angry quickly but it varies from teacher to teacher as the results suggest in term of percentages (See Table 5.34). The 37.1% (Sometimes) shows that some teachers do get angry depending on the circumstance in the class. Teachers who cannot control their anger create fear in the learners and in most cases they become authoritarian. Such leaders will find the going tough in creating positive teacher-learners relationship. The standard deviation of 1.202 suggests that the result of learners around the visited region is nearly clustered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as, statistically significant. There is an association between the region and the way learners answered this item. This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Item 16: This teacher is impatient with us

This statement was stated negatively and the scores were reversed. The aim was to find out if teachers were patient with learners or not. This provided answers to research question three. The mean score for this statement across the visited regions is 2.66 which represented some times in the questionnaire. The confident interval for this statement is at 95% ≈ {2.59~2.73}. This suggests that not all learners agreed with the statement that their teachers got impatient. The results in table 5.34 show how diverse the learners' opinions on this item are, in terms of percentages 42.2% of the learners opted for (Sometimes). The standard deviation of 1.226 suggests that the result of learners around the visited region is nearly clustered around the mean. There is generally a mixed feeling on the way how learners perceive their teachers as impatient. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as there is no significant difference in the way learners answered this item throughout the visited regions in Namibia. This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Item 20: It is easy to pick a fight with this teacher

The aim of this item was to find out the opinion of the learners in terms of picking up fights with the teacher. Good relationship between teacher and learners usually leads to good learning environments and positive teacher-learners interactions, studies by Mucherah (2008:73) and Myint & Goh (2001:16) reported that classroom environments perceived by learners as being conducive with emotionally stable teachers tend to enhance the development of positive attitude towards a subject matter and hence, better achievement in it. This item provides answers to research question three. The mean score for this statement across the visited regions is 2.25 which represented sometimes in the questionnaire. The confident interval for this statement is at 95% ≈ {2.664; 2.794}. This suggests that not all learners agreed with the idea picking up a fight with their teachers easily. The standard deviation of 1. 534 suggests that the result of learners around the visited region is significant. This means that the dependent variables are the same across all levels of factor. In terms of percentages, the value shows that it is not easy to pick up a fight with these teachers in general because a 45.9% opted for (Never) and 19.8 (Seldom). The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 at 5% level of significance and it can be interpreted as, there is no significant difference in the way learners see their teachers as not easily picking up a fight. Chi-square of .002 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Item 48: We are afraid of this teacher

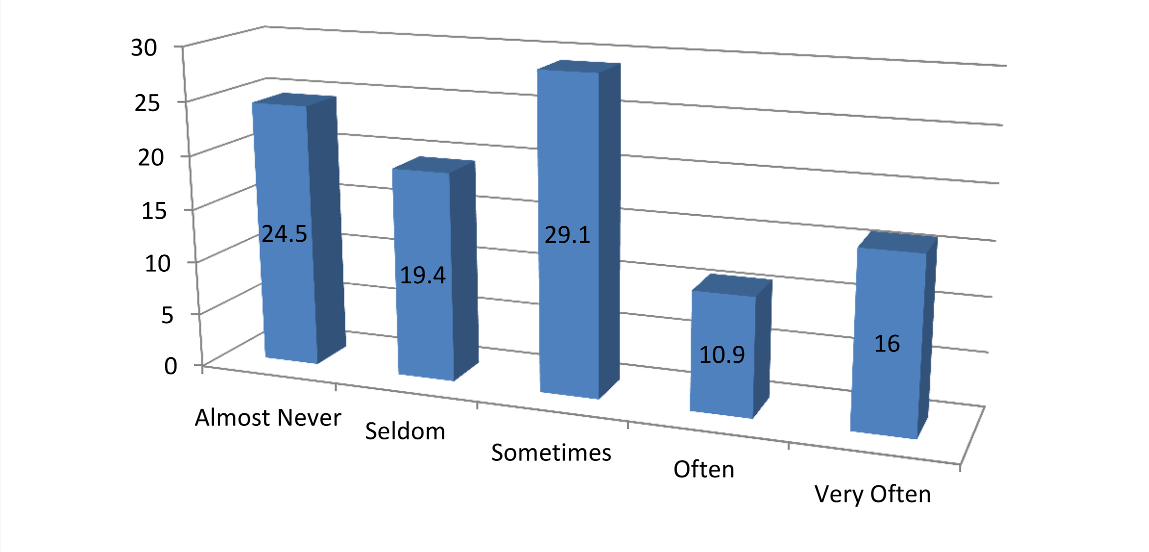
The aim was to find out if learners were afraid of their teachers or not. This item aims at showing how learners felt towards their teachers in terms of fear or no fear. The mean score for this statement across the visited regions is 2.71 which represented sometimes in the questionnaire. The confident interval for this statement is at 95% ≈ {2.87~3.07}. This suggests that not all learners agreed with the idea that they were afraid of their teachers; *however; in the interview learners were of the opinion that some of the teachers were too strict and too serious with rules while others were calmer and relaxed and the latter are regarded as good teachers.* The standard deviation of 1.694 suggests that the result of learners around the visited region is not clustered around the mean. This suggests that the dependent variables are the same across all regions. The Kruskal-Wallis Test shows a significant value of .004 which is ≤ .05 and it can be interpreted as; there is no significant differences in the way learners answered this item about fear for their teachers. This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Table 5.35. Strict (Extent to which teacher is strict/enforce rules with demands to learners.)

	Almost Never	**Seldom**	**Sometimes**	**Often**	**Very Often**
12) Too quick to correct	17.5%	13.8%	23.6%	17.2%	27.9%
28) Strict experimental procedures	13.9%	21.6%	37.1%	14.1%	13.0%
32) Silence during demonstrations	19.8%	21.5%	42.2%	6.7%	9.7%
35) Teacher put us down	45.9%	19.8%	13.8%	5.3%	15.2%
40) Teacher's Standard high	25.6%	20.4%	28.8%	11.1%	14.0%
44) Severe marking	30.1%	21.1%	40.3%	5.2%	3.3%
Average percentage	24.5%	19.4%	29.1%	10.9%	16.0%

The percentage may not total 100% due to rounding off. The aim of this section of the questionnaire was to find out if there was an open-ended relationship in terms of laboratory activities. This section helped in understanding the type of relationship that existed in laboratory and how it contributed to the learning environment in the laboratory.

Figure 5.29: Strict



Item 12: This teacher is too quick to correct us if we break the rule

The aim of this statement was to find out if teachers were keen in doing correction if learners broke rules. The item aims at answering research question three. The mean score for this statement across the visited regions is 2.77 which represented sometimes in the questionnaire. The confident interval for this statement at 95% ≈ {2.702~2.84}. The standard deviation of 1.325 suggests that the result of learners around the visited region is clustered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as there is no significant difference in the way learners answered this item throughout the visited regions. This means that the dependent variables are the same across all levels of a factor. The results in terms of percentages are spread through all five sections with around 27.9% (Very often) see Table 5.35. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Item 28: This teacher is strict with experimental procedures

The aim of this item was to find out if teachers were strict with following experimental procedures. The item meant to provide answers to research question three by showing the level of strictness among teachers with regards to following example. The mean score for this statement across the visited regions is 3.21 which represented sometimes in the questionnaire. The confident interval for this statement at 95% ≈ {3.31~3.29}. This suggests that not all learners agree or see their Chemistry teachers as following strict experimental procedure. The standard deviation of 14.84 suggests that the result of learners in the visited region is not squarely scattered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as statistically significant. There is an association between the region and the way learners answered this item. This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a significant association between the regions and their opinion on this item. The low value in Mann-Whitney U Test of 0.00 suggests that there is no difference between the regions and schools in terms of the way they answered this item.

Item 32: We have to keep quiet during practical demonstrations

The aim was to find out how strict the teachers were in maintaining silence and following experimental procedure. The item provided answers to research question three. The mean score for this statement across the visited regions is 3.49 which represented some times in the questionnaire. The confident interval for this statement at 95% ≈ {3.41~3.57}. This suggests that not all learners agree that they have to keep quiet during practical experiments. If learners are noisy and they are poorly behaved, experimental procedures become complex and difficult. The general score in terms of percentages is 30.0% (often) 24.7% (Always) suggesting that the opinions are scattered and they differ from school to school. The standard deviation of 1.470 suggests that the result of learners around the visited region is nearly clustered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as statistically significant. There is an association between the region and the way learners responded to this item. This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a strong insignificant association between the regions and their opinion on this item.

Item 35: This teacher put us town during practical work

The aim was to find out how teachers in Chemistry laboratories de-motivate or put learners down. This provided answers to research question three by showing the type of teacher-learners interactions. The assumption is that teachers should do not put learners down but encourage them to talk to one another. The mean score for this statement across the visited regions is 2.27 which represented seldom in the questionnaire. The confident interval for this statement at 95% ≈ {2.19~2.35}. This suggests that not all learners agree that their teachers put them down during Chemistry practical. This is further shown in the overall percentage in the questionnaires, with the majority of the learners choosing Seldom (42.1%), Never (24.7%) and Sometimes (19.8%), which suggest mixed feeling among learners. The standard deviation of 1.366 suggests that the result of learners around the visited region is nearly clustered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as statistically significant. There is an association between the region and the way learners' responded to this item, "This teacher put us down during practical work". This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

Item 40: This teacher's standards are very high

The aim of this item was to find out if learners regarded their teacher's standard as high or not. This item provided answers to questions five and six, by showing what type of laboratories existed in Namibia emanating from teacher-learner interactions. The item further explains the level of understanding between the teacher and the learners. The mean score for this statement across the visited regions is 3.45 which represented sometimes in the questionnaire. The confident interval for this statement at 95% ≈ {3.36~3.54}. This suggests that not all learners agree that their teacher's standards are very high although a significant amount shows that their teacher's standards are very high. The result in terms of percentages shows the different ways that learners answered this item e.g. 30.6% (Always), 30.4% (Sometimes) and 21.9% (Seldom). The standard deviation of 1.615 suggests that the result of learners in the visited region is scattered around the mean. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as statistically significant. There is an association between the region and this item. This means that the dependent variables are the same across all levels of factor. Chi-square of .000 for this item suggests that there is a significant association between the regions and their opinion on this item. The low value in Mann-Whitney U Test of 0.00 suggests that there is no difference between the regions and schools in terms of the way they answered this item.

Item 44: This teacher is severe when marking papers

The aim was to find out the learners' opinion with regards to the way teachers were marking their papers. The mean score for this statement across the visited regions is 3.15 which represented sometimes in the questionnaire. The confident interval for this statement at 95% ≈ {3.052~3.25}. This provided answers to research question three. The standard deviation of 1.694 suggests that the results of learners around the visited region are not clustered around the mean. The dependent variables are not the same through the visited regions. The Kruskal-Wallis Test shows a significant value of .001 which is ≤ .05 and it can be interpreted as, there is no significant differences in the way learners see their teachers marking their papers severely. This means that the dependent variables are the same across all levels of factor, and generally learners have mixed feeling on how they see the way their teachers do the marking; see Table 5.35. Chi-square of .001 for this item suggests that there is a strong significant association between the regions and their opinion on this item.

5.5. Integration of qualitative research in to quantitative research

The qualitative research which was answered by way of ticking on the three questionnaires provided limited but precise feedback on issues pertaining to the practical work in Chemistry classes in Namibia. The interpretation of quantitative research (questionnaire) was enhanced by the qualitative research (interview) by elaborating issues that needed clarity. The aim of the qualitative research as mentioned in previous chapters was simply to provide in-depth analysis of what was behind the way learners answered the questions the way they did. A good example is this item, “I will study Chemistry at University level”, results for this item shows 47% of learners opting for “Never” and 28% opting for “sometimes” or “unsure” suggesting that a high percentage of learners do not want any future career with Chemistry. Nonetheless, it is not clear why they do not want any future careers that involve Chemistry, but through the interview questions it becomes clear that learners regard Chemistry as boring, difficult to understand, having complicated calculations and not preferred above other subjects like Biology. The use of mixed research methods in this case had help to schism between qualitative and quantitative research. The following up of learners’ responds with questionnaires applied the *fundamental principle of mixed methods research* which require the researcher to use different strategies, approaches and methods in such a way that the resulting mixture or combination is likely to result in complementary strength and non-overlapping weaknesses. The complicated process of intergrading qualitative data in to quantitative data was not applied to all items in the questionnaire but only to some selected few that needed clarification. Maxwell and Loomis, (2003:256) stated it so well: “Uncovering the actual integration of qualitative and quantitative approaches in any particular study is a considerably more complex undertaking than simply classifying the study into a particular category on the basis of a few broad dimensions or characteristics”.

5.6. Conclusion

The main focus of this chapter was the analysis of data collected from various schools in the country. The data has shown the type of laboratories found in the visited regions and how they operated. Data was collected quantitatively through the use of three questionnaires namely: Questionnaires on Teacher Interactions (QTI), Attitudes on Chemistry Practical Questionnaires (ACPQ) and Science Laboratory Environment Inventory (SLEI). The qualitative part of the questionnaire addressed the underlying relationships that existed in the laboratories in the visited regions. The interviews were designed such that they analysed the motive behind the responses of the learners to various items in the questionnaires. The questionnaires and interviews that were conducted were such that they provided answers to the seven research questions that were highlighted in chapter 1.

From the results, it becomes clear that the majority of learners are positive about the learner-teacher interactions and the prevailing learning environments in Chemistry classes in the visited regions. Although a handful of learners were of the opinion that Chemistry practical work was boring; a waste of time; too complicated and does not have any future career benefits it can be concluded that the majority of learners are keen to do Chemistry. Generally the positive underlying relationships between learners and teachers and between learners and learners create conducive atmosphere for the teaching and learning of Chemistry to take place. From data collected, there is a great apathy among female learners towards career interest in Chemistry. Teachers who are enthusiastic and show good subject knowledge in Chemistry tend to be liked or favoured by their learners, this in turn also contributes to learners' interest in the subject and also creates favourable conditions for learners to understand the subject. A high percentage of learners show teasing, laughing and poor help from fellow learners as deterrent factors during practical investigations, while, a high percentage of learners see their teachers as helpful, caring and supportive during Chemistry practical work. The general feeling among learners towards teachers is that their teachers provide good leadership; organise events in the classroom; maintain order; and determine procedures and structures in the classroom. There were however, mixed reactions from learners on the issue of teachers being friendly, helpful and considerate during Chemistry practical work. This issue is vital in aspiring confidence and trust from learners towards teachers.

The results on the issue of teachers showing understanding of learners' problems; show concern towards learners' needs; open to discuss learners' problems and being open to helping learners with their problems, has been average to above average. This shows that there are some teachers who show understanding and show concern about learners' problems while on the other hand few teachers also show lack of understanding and poor concern about learners' problems. A worrisome high percentage of learners have shown that they are not given the opportunities to assume responsibilities or do independent work on their own during practical investigations. This issue creates problems to the High Level learners who have to sit for a practical examination at the end of the year which they are expected to carry out various experiments and arrive at predetermined answers. If they are not exposed to handling equipment and manipulating practical investigations and arrive at conclusions during the year it becomes new to them to do it only during the examinations.

The data also shows that a high percentage of learners are of the opinion that their teacher shows unhappiness about learners' work and in most cases learners are criticized or punished by their teachers for poor performance and misbehaviour. Generally learners regard their Chemistry practical work environment as positive and friendly, but they show a high dissatisfaction with regards to lack of equipment and chemicals; lack of support from teachers and the level of complexity of Chemistry as a subject.

The other crucial observation in this study is the way the questionnaire statements were organised, phrased and how easy they were for learners to understand. The majority of the learners are of the opinion that the questionnaires were clear, logical and cover most of the topics in Chemistry class situations especially with regards to teacher-learner interactions and learner-learner interactions. Other aspects highlighted by learners that needed to be considered in the ACPQ questionnaire were the high rate of learners who failed Chemistry; learners who dropped out of school, teachers who were not present at school; poor government support in-terms of provision of chemicals and equipment; and learners not doing their homework or projects.

Chapter 6

6.1. Introduction

This chapter presents the answers to the eight research questions, recommendations and conclusion. It further suggests areas that need research in Namibia. The research questions were answered based on the results presented in Chapter 5 and the methodology highlighted in Chapter 4. Below are the answers to the research questions.

6.2. Research question one

What underlying relationship exists between the laboratory learning environment and learners' attitudes to Chemistry practical?

The understanding of the underlying relationship between laboratory learning environment and learners' attitudes to Chemistry practical work is an important aspect in understanding the type of laboratories in Namibian schools. This is mainly due to the fact that the type of relationship, attitudes and perceptions that learners have towards Chemistry practical work will positively or negatively influence the learners' performance. The learners' level of engagement in investigations, discoveries, inquiry and problem solving activities depends on the relationship that exists between laboratory learning environment and learners' attitudes.

From the empirical evidence in this study it has become clear that learners are looking forward to doing experiments and in general learners have positive attitudes towards doing experiments. As Rodd (2003:3) suggested that attractive physical learning environment can be associated with good learners' attitudes, performance and behaviour. Learners in Khomas region show the highest percentage of learners looking forward to doing experiments, this is the most developed region in Namibia with sufficient equipment and chemicals in the schools' laboratories according to the observation of the researcher during the visits. Lunetta et al (2007: 405) emphasised the need for teachers to make practical work fun and enjoyable to learners, this was evident in the questionnaire results that most learners regard practical work as fun. This position is emphasised by most teachers in the interview that their learners do enjoy practical work. It is however not clear, what the major reason why learners enjoy practical work as this falls outside the scope of this study. Nonetheless, it is hoped that what Toplis and Allen (2012: 7) refer to as reasons for learners not enjoying practical work (when it require them to write and submit report) is not the case in the visited region. In general as Cerini et al (2003: 10) suggested the majority of the learners enjoy practical investigations, but when it comes to future career in Chemistry the results from the study are somehow surprising. The majority of the learners are of the opinion that they do not plan to have any future career that has Chemistry as a subject. Although the standard deviation suggests that the results of the regions were not clustered around the mean, if could be empirically established that a high percentage of learners who did not want any future career with Chemistry were girls. This poor future interest in Chemistry could also be attributed to few role models in field of Chemistry. This is evident in the interview were most learners were referring to male characters as their role models, the majority who were not in science related field. The other factor that could negatively affect the relationship between laboratory learning environment and learners' attitudes to Chemistry is the way learners perceive Chemistry as a difficult subject with complex calculations. Positive learning environment in laboratory also stem from availability of equipment and chemicals for learners to use, however, the result from this study suggests that the majority of the schools' laboratories either do not have enough equipment or the equipment are out dated or dysfunctional.

The relationship between the learning environment and the learners' attitudes in Chemistry is made up of many interacting factors that can cause the learning environment to be conducive or un-conducive for learning. In the case of Namibia, the learners are willing to attend Chemistry classes and do Chemistry practical work although there are other factors that impede their interest in Chemistry laboratories like; no future ambition in Chemistry field, lack of equipment and chemicals, complicated Chemistry calculations, not having Chemistry role models and the negative perceptions that learners have towards Chemistry.

6.3. Research question two

How do learners perceive their learning environment in Chemistry laboratory?

Laboratory learning environments refer to the physical surrounding in which the learners develop their understanding of the science concepts, inquiry skills and perceptions of science. The intention of establishing Chemistry laboratories is to create an environment whereby learners can work cooperatively in small groups to study scientific phenomenon that will enhance their constructive social relationship, positive attitudes, cognitive skills and growth in scientific knowledge. While attempting to answer research question 2, it is imperative to remember that apart from the physical setting of the laboratory, learning environments are partially influence by other important factors like learners' expectations, collaborations, social interaction between teachers-learners and learner-learner and the nature of activities conducted during laboratory sessions.

During the empirical study, the results show that the majority of the learners are of the opinion that the equipment they use is out dated or expired. The use of out dated equipments could have negative effects on the results of experiments which will intern create negative learning environment due to the failure of experiments. It can therefore be deduced that a small percentage of learners who have negative perceptions about learning environment might have been influenced by equipments that are in poor condition. It is however, imperative to note that 67, 2% of the learners are of the opinion that the chemicals they use in their laboratories are not expired. This might be a motivating factor that can create positive laboratory environment. A high percentage of learners have shown interest in practical lessons compared to theoretical lessons in the questionnaire, however, during the interview it was surprising to note that the reasons why they prefer practical lessons in comparison to theoretical lessons is because practical lessons are fun and enjoyable. The obvious expectation was that learners will give other reasons like, easy to understand practical lesson, easy to retain knowledge after practical work, improving skills and knowledge. The safety that learners enjoy during Chemistry practical work can also be attributed to the type of learning environment in the laboratory. It is essential for learners to feel safe and protected during Chemistry practical lessons because this will create a safe atmosphere and a sense of safety among learners. The results show that the majority of the learners feel safe and protected although there are some who feel that the safety is not enough. During the interview it was established that most learners are not protected during practical work due to lack of protective clothing in the laboratory. Creating a sense of ownership of equipment and laboratory activities among learners by the teacher can help in creating positive learning environment. The results from the questionnaire show mixed reactions which can be interpreted as average responsibilities given to learners in terms of cleaning equipment after experiments. This can negatively contribute to the sense of laboratory ownership among learners and the laboratory environment. The 38.5% of learners suggesting that they almost never get the chance to clean equipment and chemicals after experiments is enormous and can cause problems for creating conducive learning environment.

6.4. Research question three

How does teacher-learner interaction influence the learners' attitudes in Chemistry practicals?

Good Teacher-Learners interactions are regarded as the most important element in the creation of positive learning environment because they form the basis for social context in which learning takes place (Hughes & Chen 2011: 278). This statement was earlier discussed by Williams at el (2003: 325) who emphasised the need for educators to provoke learners' interest in practical work by relating practical activities to learners everyday life activities. The result on this item varies from school to school with learners in some regions showing high interest in doing practical work while other schools have poor interest in doing practical work. During the interview most learners blamed the teachers for lack of subject knowledge, poor planning and lack of interest from the learners. It is however imperative to note that the majority of learners who showed lack of interest in practical work were females and the regions that showed low interest in practical work performed below the ones that showed higher interest in Grade 12 results of 2012 November. It can therefore be deduced that practical demonstration by teacher as opposed to practical experiment done by learners themselves posts a challenge in knowledge acquisition. The opinion of the learner is that most of the time they do not use the equipment that teachers use to conduct practical demonstrations. It is however, interesting to note that the majority of the learners are of the opinion that teachers' practical demonstrations are fun and enjoyable. According to Hofstein at el (2000: 33) fun practical investigations will close the gaps between teachers' teaching and learners' wishes, which will ultimately result in positive attitudes among learners. According to the results nearly half of the learners in the visited schools like their Chemistry teacher while half shows mixed feelings about how they likes their teacher. It is further observed that Chemistry calculations are also proving to be difficult to the majority of learners and such perception might affect the relationship between the teacher and the learners. Despite the perceptions of learners towards Chemistry that are negative, teachers in the visited school played a central role in motivating, encouraging and inspiring learners to do their own experiments in order for them to discover things for themselves. According to Churchill, Ferguson, Godinho, Johnson, Keddie, Letts, Mackay, McGill, Moss, Nagel, Nicholson and Vick (2011: 264), the teacher should assist learners in practical work to explore ideas both individually and collectively. It is however not clear how leaners are expected to do their own practical work if they are not allowed to use the equipment. The motivations are done through giving guidelines and limited assistance in terms of strict supervisions. The majority of the learners are of the opinion that they are never alone in laboratories which suggests that leaners are most of the time under teachers' supervisions in the laboratory. The presence of teachers in the laboratory could boost teacher-learner interaction because learners could spent more time with their teacher and ask more questions and get support from the teacher. Teachers in the visited regions showed a high level of class control, whereby they explain all safety rules before experiments; they do not allow learners to break rules like copying answers from each other. The majority of the teachers are rated by learners as having good leadership skills like talking enthusiastically, holding leaners' attention, good class control, acting confidently, dependably and high sense of humour. Such characteristics will contribute to harmonious teacher-learners interaction. High percentage of learners indicated that the teacher helps them if they get stuck during experiments and they are willing to explain clearly. The majority of the teachers are able to sense if learners do not understand the topic they are teaching and they are patient and can explain phenomenon again to make learners understand. This characteristics also boots teachers-learners interaction during Chemistry practical work. Although most learners are of the opinion that their teachers do not accept jokes from them, the majority do agree that their teachers do crack a joke or two during lessons with them. Such method of teaching will ease tensions and harmonise the interactions between the teacher and the learners. They further agree that the majority of their teachers are friendly and it is difficult to pick-up a fight with them, boss them around or fool with them, however, the result suggest that there are teachers who are impatient, who gets angry when things goes wrong, blame learners for things that goes wrong in class although they are in minority. The latter characteristics do not encourage good teacher-learners relationship in Chemistry classes and should be looked into in detail to find solutions. Results further suggest that teachers are not lenient towards learners when marking although, generally there is satisfaction form teachers towards learners' work, some teachers are of the opinion that some learners cheat in experiments, most learners cannot do experiments on their own because they do not know how to handle equipment or use chemicals. With regards to teachers behaviour a low percentage of learners regards their teachers as sarcastic, they fear their teachers, their teachers are strict with them, they are put down during practical work, they have to be silent during practical work, they are afraid of their teacher and the teachers are severe when marking. These behaviours from teachers are not encouraging when it comes to teacher-learners interactions. Generally the teacher-learner interactions in Namibian schools are dominated by many positive characteristics although few negative characteristics do exist. The pre-dominant prevailing positive characteristics had influenced the majority of leaners in a positive way and created positive attitudes among most learners towards Chemistry practical work.

6.5. Research question four

How does the learners-learner interaction influence their attitudes during Chemistry practical work?

Good teacher-learners interaction and the forgotten learner-learner interactions are usually characterised by harmonious cooperation between the teacher and the learners as well as the relationship among learners themselves. NESTA (2005: 165) suggested that one of the most important phenomena in creating positive learning environment is to have good learner-learner interactions. The results from this study suggest that learners do not get on well in the laboratory and their opinion on this item varies from school to school with some schools showing good cooperation among learners while others are showing poor cooperation. The results further suggest that learners do not get a chance to know each other during laboratory sessions, because they have to take part in the experiments or observe the teachers demonstrations. During the interview teachers reported a high level of teasing during practical demonstrations if learners are not kept busy. Group work is not much encouraged by teachers in the visited schools because nearly half of the learners reported few group work activities in the practical work, as most practical lessons are done through teacher demonstrations. Teacher reported lack of equipment, teasing among learners and domination by gifted learners as reason why they do not encourage individual group work. This characteristic could influence the learners' attitudes negatively. Some learners suggested that they do not know each other although they attend the same class, which can negatively influence the attitudes of learners towards Chemistry. Some learners suggest that they collect different data than other learners during the same activities and if their experiment fails they laugh at each other. Laughing at each other's' work is a poor sign of good learner-learner relationship. As discussed in question three most teachers do not allow learners to tease each other during class. However, results suggest that a small percentage of learners tease each other during practical demonstrations. The result show some teachers not keeping control of their learners during practical demonstrations, the small number of learners could disrupt others who are trying to learner and understand demonstrations.

6.6. Research question five

How do learners perceive the interaction between them and their teachers during Chemistry practical work?

Positive learning environment emanates from the way learners perceive their interactions during laboratories with their teachers. According to Abrahams and Millar (2008: 28) teachers should devote a great deal of time during their practical work to helping learners to use ideas associated with the phenomenon that they have to produce rather than just waiting up on the last product to evaluate. The result show average support and assistance from teachers when learners got stuck during experiments. The result suggests that learners in most schools are not given the freedom to pursue their own methods in Chemistry practical work, even though

NESTA (2005: 165) highlighted the need to allow students to follow their own methods to arrive at answers and become independent thinkers. The situations in Namibian schools are still the one whereby learners follow prescribed methods, rule and procedures to arrive at answers and also the fact that the teacher does all the demonstrations and learners have to observe. Although Davis (2013: 2) suggested that learners should do their own experiment in order for them to learn and understand phenomenon, the results suggest that teachers in Namibian schools barely allow learners to do their own experiments. According to some teachers this is because schools lack proper equipment and chemicals for every learner to do experiments on their own. These types of characteristics of teachers in Namibia make the interactions between teachers and learners a one way flow, from teachers to learners. A high percentage of learners regard their teachers as good leaders, they see them as helpful during experiments, good listeners and friendly. These characteristics could contribute positively to the way learners perceive their teacher-learners interactions. The results suggest that high percentage of learners regards their teachers as impatient during demonstrations and not lenient when marking but they apply strict procedures. The teachers in the visited schools barely give equipment to learners, because they are of the opinion that the majority of learners cannot conduct experiments. Such characteristic negatively affect the way learners perceive their teacher-learners interactions.

The result further suggested that half the learners are of the opinion that their teachers explain things clearly; they are open to discussions if there are differences; learners can decide some things in the class; their teachers do not mind how they behave and teachers are uncertain when doing practical work. Although these characteristics are having good and bad parts in fostering teacher learners' interactions, they form the basis for good teacher learners' interactions. Generally learners in the visited schools do not have good experience as far as teacher learners' interactions are concerned. They claim to have less information chairing sessions among themselfs and the relationship is more of teacher informing learners what to do and for learners to follow. This position is criticised by Churchill et al (2011: 264) who emphasised the need for teachers to assist their learners to explore ideas both individually and collectively. This study suggest that leaners see their teachers as moderately in terms of Strict and Understanding scale but highly positive in terms of Leadership and Helping friendly scale.

6.7. Research question six

What are the characteristics of Chemistry practicals in Namibia?

Learners views on this question vary from region to region, Erongo region have shown the highest percentage of learners not bored in the laboratory. Studies by Webster and Fisher (2004:107) and Temons (2005: 17), suggest that the type of laboratory activities done in the classroom determine the characteristics of that laboratory. The results from Namibian schools show that the majority of the learners find Chemistry practical work interesting and not boring. Generally Chemistry practical work in Namibian schools is fun and enjoyable. The result further suggests that practical work is enjoyable in the schools visited, with almost all regions opting for (very often) they enjoy practical lessons. Although learners are of the opinion that practical work is fun and enjoyable in their schools, they also find it irrelevant to their future career and to their every day’s life. Lords (2006:33) suggested that there should be a link between what learners do in the laboratory and what they experience in every day’s lives. Teachers and syllabi developers in Namibia need to establish this link in order to make practical work relevant to learners every day’s lives. This means the characteristics of Chemistry practical work in Namibian schools are thought-provoking due to the fact that learners enjoy Chemistry practical work yet they do not connect any Chemistry knowledge to their future career. This somehow does not contradict what Millar (2006: 1513) suggested that if learners do not connect what they are studying to future career the retention of the information gain become minimal, because although learners enjoy practical work their performance in Chemistry has been disappointing. This suggests that although they enjoy the practical part of Chemistry the retention of information gain for examination purposes becomes minimal. The other reason given is the lack of equipment and chemicals that have expired that cause chemical reactions to fail. Practical work that does not produce the desired results will be regarded as a waste of time and irrelevant by learners. Nearly half of the learners show that they love Chemistry more than other subjects, while the other 50% are not sure if they love Chemistry or not. This symbolise the type of Chemistry laboratories found in Namibia, whereby it is clear that not all learners love the subject Chemistry although they have taken it. When learners were asked if they could take other subjects or stick to Chemistry the majority opted to take other subjects if they could have a choice. The reasons given vary from difficult calculations to no future career interest in Chemistry and also the fact that they understand other subjects easily than Chemistry. The majority of the learners are of the opinion that they will never study Chemistry at University level, most of the learners do Chemistry because it is in the same field as Biology which they want to do at University level. The majority of the learners regard Chemistry calculations as complicated while teachers are of the opinion that learners have negative connotation towards Chemistry and this might block their mind psychologically because they think it is too complicated. As Millar (2006:1513) reported that if learners do not attach a subject to their future career their interest and need to retain knowledge gain in that subject become minimal. The results from this study showed that majority of the learners were questioning why they should study a subject that they will not have any future career with? It becomes imperative for Namibian teachers to sell the idea of future career that entail Chemistry as a subject to learners at school level because Chemistry practicals in Namibia are characterised by negative perceptions about the subject itself. Chiu (2005:1) stated that learning Chemistry can be a challenging task to learners at different ages, nonetheless the situation in Namibia proves to be the same with most learners suggesting that they have difficulties in understanding Chemistry concepts throughout the visited regions. The study further reported that most girls do not even know the names of most equipments that they are using and they hate the subject Chemistry. This scenario is reported by Osborne at el (2003: 1064) that there is still prejudice against Physical Science held by more girls in comparison with boys.

Davis (2013:2) argues that learners should do experiments in Chemistry themselves so that they grasp and understand concepts, but the majority of the learners (61%) reported that they do not do any experiment by themselves, only the teachers carry out demonstrations. Teachers also reported lack of chemicals and equipment as reasons not to allow learners to do their own experiments. The characteristics of Chemistry laboratories in Namibia are more based on teachers' demonstrations rather than learners doing practical work themselves. Results suggest that most teacher do Chemistry practical work (demonstrations) based on availability of tools and chemicals as well as the prescriptions of the syllabi. Although the results from the study show that classrooms are not over crowded during practical work, teachers reported that limited equipment, limited time allocation and expired chemicals are factors that force them to do demonstrations. These factors indirectly lower the standards of the laboratory work because the qualities of the practical investigations are compromise to fit the circumstances. The correlation shows that a high percentage of learners' attitudes to Chemistry and the learning environment could be attributed to their perceptions of Chemistry practical work. The results of simple correlation analysis shows that there is a correlation between learners' attitudes and learning environment in Chemistry laboratories in Namibia especially with Rule Clarity and Leadership scales but the correlation is very weak in terms of availability of instruments.

6.8. Research question seven

What is the nature of the current laboratories in Namibian schools?

When answering this research question, it is imperative to keep in mind what Churchill et at., (2011: 278) stated, that teachers should make their classroom/laboratory a good place for learners to be, if learners are constructively on task; obviously they will be well behaved.

According to the results laboratories in Namibia are not overcrowded, yet there is a great shortage of equipment and chemicals in most schools to cater for every individual learner. Olufunke (2012: 2) highlighted the need for equipment and chemicals in laboratory for successful teaching of science, but the result from this study suggests that there are enough rooms or spaces available for every learner but not enough chemicals and equipment for every learner. The results show well ventilated and cool laboratories although poorly equipped. The nature of laboratories in Namibia is characterised by lack of equipment and chemicals and learners have to share equipment or chemicals during laboratory experiments. The results also show that learners are not keen to attend Chemistry classes more often. The majority suggested that they do not want to attend because they do not understand the subject or is a waste of time to attend classes that you do not understand. Most laboratories apply sufficient safety standards with regard to protecting learners from harm, but they fail to provide protective clothing to each learner during practical investigations due to lack of safety clothing. The results also suggest that some teachers try to create an enabling environment in the classes by decorating their classrooms with Science related posters and applying basic safety rules. Nearly half of the learners say the laboratories atmospheres are conducive for learning to take place. The teachers are making sure that rules and regulations in the laboratory are adhered to and obeyed. The nature of laboratories in Namibia is such that rules and regulations in the laboratory are en-forced by the teacher and learners have to follow. The Leary model of interpersonal behaviours has shown a high level of (Dominance-Submission) from the teachers side, meaning the level of cooperation between the teacher and the learners is influence or directed by the teacher. The frequency in the results shows the dominance characteristics of the teachers in practical investigations, which in many cases leave the learners as mere observers. The same category was observed as reversed from the learners' side because they regard themself as (Submission-Dominance) meaning they were more submissive than dominant while teachers were more dominant. Another sector (Cooperation Dominance) shows more teacher cooperation and less teacher dominance because teachers usually move around the learners and render assistance where necessary. The results show that the practical topics that teachers do are related to the theoretical topics that they cover, although a high percentage of learners reported that practical experiments are not done in all topics covered in theoretical lessons. Teachers were also rated high on the Leadership sector (DC) because they could sense if learners did not understand, they knew what was happening in the laboratory and could give orders, nonetheless they were rated very low on strict (DO) because they kept order, allowed learners to get away with wrong things and maintained silence. During the interview learners from different region complained that due to un-availability of equipments and chemicals for some topics teachers tended to do practical work that they find equipment and chemicals for. The breaching of the gap between theoretical lessons and practical lessons is very crucial to the understanding of Chemistry concept according to (Millar, 2004: 6). Learners do not regard teachers practical test as difficult, however the majority of the learners are of the opinion that their teachers are not doing the practical work that they like or prefer. High percentage of learners claim that their teachers keep them constantly busy in the laboratory and do not give them free time to relax. This suggests that the nature of laboratories in Namibia is one whereby learners are constantly busy and it does not give them room to relax or misbehave.

6.9. Research question eight

Is the Namibianised version of the of the QTI and SLEI suitable and valid instrument for the use in Namibia?

Generally speaking, the results from the QTI and SLEI shows that the validity and reliability of these two scales are consistent with other previous studies and this two instrument can be used by teachers, researchers, subject adviser and curriculum developers in Namibia to improve the teaching and learning in the laboratory classes in Namibia. The QTI and SLEI that was used in this study to collect data from learners through a five point Likert scale have been altered. The QTI has been derived from the original version Wubbels, Crẻton, Levy, and Hooymayas (1993:26) and has been altered to fit the Namibia situation as well as the Chemistry part of the studies. The original version of the QTI was meant to assess teacher-learners interactions in a general classroom. It is clear from past research that the QTI has been used in various countries with great reliabilities like in the USA with 0.90 reliability in the 7 scales out of 9. The QTI in this study has only 5 scales with 48 items on teacher learners' interactions. It is also reported that the QTI showed internal consistency reliabilities in other studies ranging from 0.76 to 0.84 for learners' responses and 0.74 to 0.84 for teachers' responses (Wubbels, Crẻton, Levy, and Hooymayas, 1993:26). Previous studies have indicated that teachers' interpersonal behaviour usually determined learners attitudes in various countries (Khine & Fisher, 2003: 25) however, this study suggests that in spite of some teachers poor interpersonal behaviours the influence in Namibian schools is mostly attributed to other factors like lack of facilities, learner-learner interactions and learners' interest in the subject. The 48 item version of the Questionnaire on Teacher Interaction (QTI) has provided useful feedback to teachers to allow improvements in instruction and the overall learning environment (Koul & Fisher, 2004) in many countries around the world. The other reason why the QTI has gained such popularity is the easy way of completion due to the fact that responses are given few items that they only need to tick using the five scales. The questionnaire could be easily administered and the respondents can complete it easily and faster. The QTI was first piloted to a school that did not take part in the real survey and the results from this school helped the researcher to establish difficulties or unclear items from the change version of the QTI. The results from the pilot study have shown the same consistency as the main research, this show great reliabilities as the original version. Although some items have been changed to fit the practical aspect of Chemistry the results still show consistency even with results in Australian version of the QTI. This suggests that the Namibianised version of the QTI could be used anywhere in the world with any school that offers Chemistry as a subject and practical work in particular. The result from the pilot QTI when compare to the final QTI shows that female learners consistently rated their teachers' interpersonal behaviours as positive and girls' interest in Chemistry as negative, while the boys rated the opposite. Although there were some gender differences in the way learners answered the three QTI categories e.g. Leadership, Helping/Friendly and Admonishing it is was interesting to note that girls were more positive towards personal behaviours of their teacher and more negative towards Chemistry as a subject. The finding of positive correlation between learners' perceptions of teacher-learner interaction and the influence it has to learners' attitudes towards Chemistry is one of the valuable achievements of this study. Such correlations could help teachers in improving their interactions with their learners by creating positive atmosphere in their laboratories that will in the end give rise to learners' interest in Chemistry especially among the Namibian girls.

Four Alpha reliabilities were calculated during these studies. The first during piloting in the chosen school whereby the class mean was used as the basis of analysis and also were the individual learner was used as the basis of analysis. Secondly, the calculation was done on the real QTI that was used to collect data and analysis was done on both the individual learners and the mean of the regions. When the pilot QTI was analysed the reliability ranges from 0.63 to 0.80 when the individual learners was used and 0.59 to 0.84 when the region mean was used as point of analysis. When the main QTI was used for individual analysis the range was between 0.64 to 0.97 when the region was used as the basis of analysis. Such results closely resemble other studies e.g. Fisher and Rickards (1996: 12) whose value ranges from 0.62 to 0.88 when the individual learner was used as the unit of analysis, and from 0.60 to 0.96 the class mean was used as unit of analysis.

The SLEI has also been modified to fit Chemistry and practical work in particular; it was also piloted with the same school as the QTI and the results show resemblance of the real SLEI when it was used with all the visited schools. Although some changes have been done after the piloting, no significant changes have been done to the original intention or meaning of items. In earlier studies, the SLEI was field tested and validated simultaneously across different countries with a sample of 5447 learners in 269 classes in more than five countries (USA, Canada, England, Australia, Nigeria, Israel and cross-validation with Australia) (Fisher, Henderson & Fraser, 1997: 25; Fraser & McRobbie, 1995: 301), it all proved to be consistent and highly reliable. This reliability was tested during the piloting in the school and the results were compared to that of Kim in South Korea (Kim & Kim, 1995:163) which shows the same validity. Another important finding is that the SLEI is equally valid for use in other subjects with small alterations to meet the subject content and characteristics.

6.10. Recommendations for further studies

The field of Science in Namibian school is relatively not well researched and there is a lot to be studied in this field. Apart from the physical challenges faced by many Namibian schools' learners like lack of equipment and chemicals, there are also the psychological challenges or aspects that hinder learners mentally to progress in these fields. This study has proven that many Namibian children have no interest of doing Chemistry as a subject in future and this can be narrated as a global trend as Ho and Boo (2007:17) suggest that the number of learners showing less interest in Science subject is on the increase globally. Some reasons provided by the learners in this study is that Chemistry calculations are complicated, its practical work are dangerous, it has no future careers in Namibia and it is highly regarded as a male subject by most school girls in Namibia. The majority of girls in Namibia have shown that they have no future career with Chemistry as a subject, which is a very worrisome perception. It is for this reason that studies should be conducted to find out the cause of this thinking among learners and how it can be alleviated.

The Namibian government should look in to the issue of shortages of equipment and chemicals. There are schools that have enough equipment and chemical for their practical investigations but quite a huge number of schools do not have the basic equipment and chemicals to perform the required experiments in their laboratory. The lack of equipment and chemicals serve as a deterrent in the performance of practical investigations and might also contribute to the falling number of learners interested in pursuing Chemistry related career. Teachers are also demotivated in conducting experiments because there are no tools or equipment to conduct the experiment. Research is needed in these areas to find out the extent to which lack of equipment and chemicals affect the teaching and learning of Chemistry in Namibian schools and what can be done to curb the problem with a limited budget from government.

Laboratory environment is an avenue that differs from the classroom environment because in the laboratory the interactions in between teacher-learner-chemicals-equipment. The results in this study show that the interactions are between teacher and learner but predominantly from teacher to learners. It is imperative that the interactions should also move from learners to teachers and also from learners to equipment and chemicals. Such interactions can improve learner's skills, interest and understanding of Chemistry phenomenon. Research is needed in establishing methodology, ways and policies on how teachers in Namibian school laboratory should go by creating favourable learning environments in the laboratories that they are working in. Such research will help in cementing what Mucherah (2008: 73) said about the importance of creating favourable laboratory learning environment by science teachers, because evidence in various studies suggest that conducive learning environment influence learners positively in their learning.

Some factors that are influencing the learning environment in the Namibian schools seem to be related to beliefs, culture and traditions. These make it difficult to compare the results of other countries to the Namibian situations due to cultural and traditional differences. Most research studies on learning environments are from first world countries which differ a lot in terms of culture and tradition. It is therefore imperative for studies in Namibia to focus on how tradition, culture and beliefs influence the learning environment, perception and relationships in Chemistry practical work or laboratories in schools. Such studies should focus not only in the laboratories but should include the communities from where these learners come from, the traditions, cultures, the ministry of education, the employment sector and vision of the country as a whole.

Teachers reported that due to lack of equipment they turn to do demonstrations rather than allowing learners to do practical work. This could have negative consequences in terms of developing leaners skills because all they do is observing without handling equipment. Research is needed in determining the extent to which teachers demonstrations in Namibian school affect learners' performance as opposed to practical work done by learners in Namibia. Although the main reasons for teachers opting for demonstration was lack of equipment, limited time and no chemicals, the study should look in to other alternatives that could be used to uplift practical skills and interest among learners in Namibian schools.

In spite of all these short comings in the Chemistry practical work in Namibian schools, e.g. lack of chemicals, tools and demonstrations it is worth noting that the majority of the learners enjoy practical lessons, see forward doing experiments and constantly request teachers to do practical work during lessons. As noted earlier it is not clear why learners like doing Chemistry practical lessons, yet they do not like the subject? Various reasons could be attributed to the excitement for practical investigations e.g. leisure time, not doing the experiments themselves but only observe, getting away from normal theoretical lessons, not writing test or exam on practical work, not getting homework on practical work and the excitement of chemical reactions or explosions. Research in this area is needed to discover the reason behind the excitement in learners to do practical lessons rather than theoretical lessons.

More research is needed on the role that teachers should play during Chemistry laboratory work and how they could positively contribute to harmonious laboratory learning environment.

The SLEI, QTI and AQCP have the potential to be adapted, modified and or integrated in to other subject areas to study the learning environment in these subjects.

It is imperative to know that these recommendations for further research are neither complete nor exhaustive in nature, but they simply indicate possible directions for further research by anyone wishing to expand knowledge in those areas.

6.11. Research limitations

The study was limited by some constrains and was heavily depended upon some basic assumptions. The first limitation concerned geographical constraints, although some remote schools were visited not all schools in the country were visited. The samples for this study were drawn randomly; it was assumed that the teachers and learners who took part in this study represented the Namibian schools communities for years before and after 2012. This meant that the information recorded was typically for the whole country. The other assumption was that this study was a “one shot” survey, thus making the assumption that Chemistry laboratory teaching practice of science teachers and learners in 2012 was of the above mentioned parties over the last few years. The questionnaire and the interview were done in English which is a second language to all the participating schools. Although the medium of instruction in Namibian schools is English, the understanding of the questionnaires could be a challenge to both teachers and learners because they used other home languages rather than English.

6.12. Conclusions

The section presents the concluding remarks. The study has found that there are several underlying relationships in Chemistry laboratories in Namibia that contribute to the type of attitudes that learners have towards Science as a subject and Chemistry practical work in particular. Learners are generally positive about doing Chemistry practical work and they look forward to doing practical experiments, even though most of the time they end up doing only observation in the laboratory according to the results. The observations that they undergo do not really develop their practical skills as it does not involve the handling of equipment and manipulations of scientific processes. The un-availability of chemicals and equipment also contributes to the prevailing laboratory learning environment and learners’ attitudes to Chemistry. If the prevailing learning environment is negative it will negatively affect the learners’ attitudes to Chemistry and learners will tend to dis-like Chemistry as a subject and this process will in turn affect their performance. Generally Namibian learners see the learning environment in their laboratories as positive, nonetheless, they should be given amble opportunities for them to handle equipment, develop their practical skills and master their Chemistry concepts. The teacher-learner interaction is generally acceptable even though the interactions are mostly spear headed by the teacher to the learners and not the other way around. Teachers in Namibia should move away from teachers' centred interactions to learners' centred interactions but most importantly to subject centred interactions. Teachers should open up the path to teacher-learners interactions, they should create conducive environments in their laboratories that will motivate learners to participate in practical experiments. Teachers should also help with fostering positive learner-learner interaction by encouraging group work, good discipline, social cohesion among learners and do more practical activities that will require learners to cooperate with each other. Learners need to create a culture of support, be friendly, and take initiative in finding solutions to Chemistry problems. Learners should be less disruptive during Chemistry practical work, they should focus on the experiment at hand, ask questions, suggest ideas and learn to work together in groups. The QTI and SLEI have proved that they are valid instruments to be adopted and used by researchers in all areas of schools subjects in Namibia.

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Appendix A: SLEI

The SLEI for measuring learner's perceptions of their Chemistry laboratory environment.
Format This questionnaire contains statements of situations that could take place in your laboratory. The aim is to find out how often each practice takes place during your practical work. There is no 'right' or 'wrong' answers. Your opinion is what is needed. Think back to what is happening in your laboratory and answer the statements by circling how often each situation takes place. If you make a mistake and want to circle another number, please draw a circle through the incorrect one and circle the correct one.
Circle: 1 If you think the practice **ALMOST NEVER** happen **2** If you think the practice **SELDOM** happen **3** If you think the practice **SOMETIME**S happen **4** If you think the practice **OFTEN** happen **5** If you think the practice happen **VERY OFTEN**
Do not write your name on the form just fill in your Region, age and gender.

Region..............................School ....Gender................

Situations in your Chemistry laboratory classroom.	**Almost Never**	**Seldom**	**Sometimes**	**Often**	
1) Students get on well in the laboratory.	1	2	3	4	5
2) Students are given freedom to pursue their own methods in the laboratory.	1	2	3	4	5
3) The experiments we do are related to topics in the syllabi.	1	2	3	4	5
4) We follow rules and procedures during practical work.	1	2	3	4	5
5) Our laboratory is crowed when we are doing experiments.	1	2	3	4	5
6) I got little chance to get to know other students in this laboratory.	1	2	3	4	5
7) In this laboratory I am required to design my own experiments to solve given problems.	1	2	3	4	5
8) In this laboratory everyone is doing experiments on his/her own.	1	2	3	4	5
9) We can break rules in the laboratory if we want and nothing will happen to us.	1	2	3	4	5
10) The chemicals and equipment that I need for my experiments are readily available.	1	2	3	4	5
11) Everyone takes part in doing practical work.	1	2	3	4	5
12) During laboratory sessions other students collect different data than I do for the same problem.	1	2	3	4	5
13) We have practical experiment for every topic that we do in Chemistry class.	1	2	3	4	5
14) The wall of the laboratory is decorated with Science related posters.	1	2	3	4	5
15) We clean and pack the equipment and chemicals after each session.	1	2	3	4	5
16) We are encouraged to work in groups during practical work.	1	2	3	4	5
17) We are encouraged to do our own experiments to find out things on our own.	1	2	3	4	5
18) I apply my theoretical knowledge on Science in my practical work.	1	2	3	4	5
19) I am always protected (safety) during practical work.	1	2	3	4	5

20) The laboratory chemicals that we use have expired already.	1	2	3	4	5
21) I am able to depend on other students for help in laboratory activities.	1	2	3	4	5
22) During laboratory session, we can copy answers from one another.	1	2	3	4	5
23) The teacher only does practical work on topics that he/she likes.	1	2	3	4	5
24) My teacher tells me the safety rules before I do experiments.	1	2	3	4	5
25) The laboratory has enough room for me to do my experiments.	1	2	3	4	5
26) I know everyone in this laboratory by name.	1	2	3	4	5
27) During laboratory session the teacher only give guidelines to do experiments.	1	2	3	4	5
28) I love practical lessons more than theoretical lessons.	1	2	3	4	5
29) We wear protective cloth during laboratory experiments.	1	2	3	4	5
30) The laboratory atmosphere is so attractive to work in.	1	2	3	4	5
31) We share equipment during practical work.	1	2	3	4	5
32) When I got stuck during the experiment I request my teacher's assistant.	1	2	3	4	5
33) When my experiments fail other learners laugh at me.	1	2	3	4	5
34) My teacher leaves us alone in the laboratory.	1	2	3	4	5
35) This laboratory is hot and unventilated.	1	2	3	4	5
THANK YOU FOR YOUR ANSWERS, IS VERY MUCH APPRECIATED.					

Appendix B: Attitudes on Chemistry Practical Questionnaire (ACPQ)

Region:………………………………….School:………………..Gender:……………

Please circle the correct answer e.g. (1) 2 3 4 5 that describe the situation in your Chemistry class.

Attitudes Towards Subject	**Almost Never**	**Seldom**	**Sometimes**	**Often**	**Very Often**
1) I look forward to doing experiments in the laboratory.	1	2	3	4	5
2) Practical work is fun to do.	1	2	3	4	5
3) I dislike doing practical investigations.	1	2	3	4	5
4) Practical work bore me.	1	2	3	4	5
5) Practical work is one of the interesting things to do.	1	2	3	4	5
6) I enjoy practical lessons.	1	2	3	4	5
7) Practical work is a waste of time.	1	2	3	4	5
8) I love Chemistry more than any other subject.	1	2	3	4	5
8) I don't see the need for practical work.	1	2	3	4	5
9) Chemistry is not important in comparison with other subjects.	1	2	3	4	5
10) My Chemistry teacher is my role model.	1	2	3	4	5
11) I will study Chemistry at University level.	1	2	3	4	5
12) Chemistry is one of the easiest courses for me.	1	2	3	4	5
13) We never use equipment in Chemistry practical.	1	2	3	4	5
14) I would love to have Chemistry classes more often.	1	2	3	4	5
15) Chemistry knowledge is vital for my future career.	1	2	3	4	5
16) My Chemistry teacher makes practical work fun.	1	2	3	4	5
17) I have difficulties to understand Chemistry.	1	2	3	4	5
18) I know the names of most equipment we use.	1	2	3	4	5

19) I hate Chemistry lessons.	1	2	3	4	5
20) I would like to work in a laboratory in future.	1	2	3	4	5
21) I don't need Chemistry knowledge.	1	2	3	4	5
22) I like my Chemistry teacher.	1	2	3	4	5
23) Chemistry calculations give me hectic.	1	2	3	4	5
24) Most of our school's equipment are out date.	1	2	3	4	5
25) Safety comes first in our laboratory.	1	2	3	4	5

Appendix C: Questions on Teacher Interactions QTI

Questionnaire on teacher's behaviours

Procedures
This questionnaire aim at describing your teacher's behaviour in Chemistry practical. This is not a TEST. There are no Marks to be awarded to you, but simply your opinions are needed. Remember your honest opinion will help improve Practical work in Chemistry Classes in Namibia. Please do not write your name anywhere on the questionnaire.
This questionnaire has 48 items about the teacher. For each item, circle the number that is corresponding to your opinion. Example: Never Always This teacher knows what to do during his practical experiments. 1 2 3 4 5 If you think that your teacher knows what he/she is doing during practical experiments, you circle 5 and if you think he/she is always unsure of what to do next, you circle 1. Please remember that you can also circle any number between 2, 3 and 4 if you think it fit your teacher's behaviours.
If you realise that you make a mistake just cross the number and circle the correct one. Please write your Region, age and gender on the space provided.
Thank you for your cooperation

Region......................................School..Gender................

Your actual teacher's behaviour in Chemistry practical work.	Never	Seldom	Sometimes	Often	Always
1) This teacher talks enthusiastically about practical work.	1	2	3	4	5
2) This teacher trusts us with handling equipment.	1	2	3	4	5
3) This teacher seems uncertain about practical work.	1	2	3	4	5
4) This teacher gets angry if things go wrong in practical work.	1	2	3	4	5

5) This teacher explains clearly.	1	2	3	4	5
6) If I don't agree with this teacher, we talk about it.	1	2	3	4	5
7) This teacher is hesitating when doing practical work.	1	2	3	4	5
8) This teacher gets angry quickly.	1	2	3	4	5
9) This teacher holds our attention	1	2	3	4	5
10) This teacher is willing to explain things again.	1	2	3	4	5
11) This teacher acts as if he/she does not know what to do.	1	2	3	4	5
12) This teacher is too quick to correct us if we break the rule.	1	2	3	4	5
13) This teacher is aware of everything that goes on in the class room.	1	2	3	4	5
14) If we have something to say, this teacher will listen.	1	2	3	4	5
15) We can boss this teacher around easily during experiments.	1	2	3	4	5
16) This teacher is impatient with us.	1	2	3	4	5
17) This teacher is a good leader.	1	2	3	4	5
18) This teacher realised if we don't understand.	1	2	3	4	5
19) This teacher does not know what to do when we fool around.	1	2	3	4	5
20) It is easy to pick a fight with this teacher.	1	2	3	4	5
21) This teacher act confidently when doing practical work.	1	2	3	4	5
22) This teacher is patient with us during experiments.	1	2	3	4	5
23) This teacher allows learners to tease each other during practical.	1	2	3	4	5
24) This teacher is sarcastic.	1	2	3	4	5
25) This teacher helps us if we get stuck doing experiments.	1	2	3	4	5
26) We can decide some things in this teacher's class.	1	2	3	4	5
27) This teacher thinks we cheat in our experiments.	1	2	3	4	5
28) This teacher is strict with experimental procedures.	1	2	3	4	5
29) This teacher is friendly.	1	2	3	4	5
30) We can influence this teacher in doing the practical that we like.	1	2	3	4	5
31) This teacher thinks we cannot do practical on our own.	1	2	3	4	5
32) We have to be silence during practical demonstrations.	1	2	3	4	5
33) This teacher is someone we can depend on.	1	2	3	4	5
34) This teacher let us get away with a lot in class.	1	2	3	4	5
35) This teacher put us town during practical work.	1	2	3	4	5
36) This teacher's practical tests are difficult.	1	2	3	4	5

37) This teacher has a sense of humour.	1	2	3	4	5
38) This teacher doesn’t mind how we behave.	1	2	3	4	5
39) This teacher thinks that we can conduct experiments well.	1	2	3	4	5
40) This teacher’s standards are very high.	1	2	3	4	5
41) This teacher can take a joke.	1	2	3	4	5
42) This teacher gives us a lot of free time in class.	1	2	3	4	5
43) This teacher seems dissatisfied with our practical.	1	2	3	4	5
44) This teacher is severe when marking papers.	1	2	3	4	5
45) I enjoy this teacher’s practical demonstration.	1	2	3	4	5
46) This teacher is lenient.	1	2	3	4	5
47) This teacher blames us for everything that goes wrong in class.	1	2	3	4	5
48) We are afraid of this teacher.	1	2	3	4	5

Appendix D

Interview

Attitudes on Chemistry Practical Questionnaire (ACPQ)

In this transcribe (Q) represent the Question asked and (L) represent the learners' answers while (T) will represent the teachers' answers. The answers vary from learner to learner and teacher to teacher but their answers are summarised as much as possible.

Q = Are the statements in these questionnaires clear and logical to understand?

A = The questionnaires are clear and the items are well arranged. The items are too many and require time to answer and most of us do not have the time to answer these long items.

Q = Does the QTI address relevant issues with regard to teacher-learner interactions; should other statements be added or removed?

A = I think all issues are covered. Most of the important issues are covered these is almost everything that goes on in the laboratory. I think more personal issues should also be asked like "why do teachers behave in the way they do?" Teachers should explain the courses or reason for their behaviours.

Q = With regards to the learning environment in your laboratory does the SLEI access all aspects of what is happening in your laboratory?

A = I think most aspects are covered by this questionnaire. It addresses everything from learner-teacher relationship to learner-learner relationship in the laboratory. It also covers behavioural issue and also learning environment issues.

Q = What other attitudinal problems do you experience in your laboratories that are not addressed by the ACPQ?

A = High rate of learners who fail, learners who drop out of school, teachers who are not present at school, poor government support towards science laboratories, learner who do not turn up to class, learners who do not do assignment and homework. Learners complain that practical work is time

consuming and is not examine at the end of the year. Practical work is dangerous and challenging.

Item 1: Q = *Do you like doing experiments? If so what do you like about it, is it the explosion or the knowledge gain or the method or any other think that provoke your interest in doing experiments?*

A = I like experiments because they are fun and easy to understand. I like experiment because we learn a lot through experiments. Experiments are enjoyable.

Item 4: Practical work makes learners bored. Q = Do you find practical work to be exciting and thought provoking? If not why not?

A = Practical work are very interesting because they are based on the reality on the ground. We are challenge mentally by doing practical investigations in the classroom. We the girls hate practical work; we do not see the need of doing all these investigations.

Item 7: Practical work is a waste of time.

Q = Why do some learners regard practical work as a waste of time in your opinion?

A = Mainly because sometimes we come to do practical work but the teacher is not prepared. Sometime we do not have the equipment or chemicals to do the experiments as per textbook requirement, we end up improvising things.

Item 9: Should we choose between Chemistry and other subjects, what would you choose and why?

A = I would rather do other subjects because Chemistry is too complicated for me and I do not see a future with it. The calculations are too complicated e.g. the mole calculation, the Concentration calculations and the mass calculations. I will rather do a subject that I will understand easily and that I want to pursue at university level in future.

Item 12: Q = Some people regards Chemistry as a difficult subject while others are not seeing it that way, what are your opinions in this regards?

A = Chemistry is too difficult it demands cognitive thinking, calculations, equations and formula. I would rather do a subject that is easy like history, accounting and biology.

Item 14: Why do you like or dislike attending Chemistry classes?

A = I attend because I don't understand and I want to understand, I attend because I understand and I want to understand more, I do not attend because I do not understand, I hate Chemistry staff.

Item 18: Boys love Chemistry than girls.

Q = Between boys and girls which ones love Chemistry most and why?

A = I think the boys enjoy Chemistry more because they like the burning, the explosions and the reactions. I think girls don't like Chemistry because girls are afraid of the reactions that catches fire and explode some times, these dangerous reactions seems to be fun for boys. Chemistry is widely seen as a man subject at our school.

Item 20: Most girls would not want to work in the laboratory?

Q = Why will most girls not want to work in the laboratory?

A = Laboratory are dangerous places, chemicals can cause sickness if not handle very well. Woman will rather work in other places than in a laboratory. Laboratories are male dominated environment. Wearing those apron sounds more like a male job for me.

Science Laboratory Environment Inventory (SLET)

Item 1: Q = How do you get on with each other during practical investigations?

A = We have a good working relationship with each other during experiments. Some learners are not serious they tease each other while the teacher is doing experiments. In our class we help the weak learners to understand the work.

Item 16: Q = Does your teacher encourage you to do group works during Chemistry practical? If so how does he do it?

A = The teacher barely ask us to do group work, most of the time the work we do are just individual work. Group work is not done in our class. We only do group work if we are doing projects or assignment but not during practical investigations.

Item 21: Q = Do you people depend on each other for help when you are doing experiments or projects?

A = Yes there are some learners who are helpful. Some leaners like to tease and laugh at others experiments if the experiment fail, particularly the boys or the clever learners.

Item 2: Q = Are you sometimes allowed by the teacher to come out with your own topics or projects to investigate or is it only the teacher that suggests topics?

A = Our teacher always suggests the topic; I think the teacher follow the syllabi on which topic to do.

Item3: Q = Are your practical investigations related to your theoretical topics and if not what type of topics do you do in your practical work?

A = We don't know if they are related because we don't have the syllabi to compare; We are following the syllabi. Q = Why do you think your teacher do other topics apart from the syllabi? ***A = He wants us to know more than what is in the syllabi. Some of the topics he does are not in the examination or test.***

Item 13: Q = Does your class do practical work for every topic taught?

A = We rarely do practical investigations because our teacher always complain of lack of equipment, lack of time and class miss behaviours during the practical investigations; We do not do practical investigations for all topics because some topics do not need practical investigations.

Item 28: Q = Which lessons do you like most, practical or theoretical topic and why?

A = Most learners opted for practical lesson with just a few opting for a theoretical. Practical lessons are fun, easy to understand and learners can retain information longer. Theoretical lessons are the norms and therefore have become boring.

Item 4: Q = Do you follow any rules and procedures in the laboratory?

A = We do not have any laboratory rules to follow, the teachers simply maintain the discipline in his own way.

Q = How does the no rules ideology affect the discipline in the class?

A = It sometimes causes miss behaviours in the class and learners start teasing each other during laboratory practical work.

Q = And you how is your class doing in-terms of disciplines?

A = Our class have rules and regulations pasted on the wall and the teacher make sure that the rules are followed and every one live by the rules.

Q = How does that affect the discipline in the class?

A = The rules and regulations to be followed always promote discipline and learners are well behaved.

Item5: Q = Do you think that your laboratory is overcrowded when you are doing experiments?

A = I think the laboratory is overcrowded because we are between 35 and 40 in a class. This forces the teacher to rather do demonstrations. The learners are too many and there is no enough equipment for everyone to use. The laboratory is too small.

Item 31: Q = Do you share equipment during practical work or does everyone use his or her own equipment?

A = We do not do practical experiments, the teacher does demonstrations. We do not have equipment for every one so we have to share. The equipment are never enough in the laboratory, I think we need some donations because the school cannot afford equipment.

Questionnaire on Teacher Learner Interactions (QTI)

Item 13: Q = Does your teacher take total control of your class at all times?

A = Our teacher is very strict and is always in control. Our teacher does not care with learners who are misbehaving or disrupting the lessons, he just continues teaching.

Item 21: Q = Does your teacher know what to do during practical demonstrations or do they doubt their work?

A = My teacher knows what to do during the practical demonstrations because he rehearses the demonstration beforehand. My teacher is showing confidence in demonstrations because he has done these activities for many years.

Item 29: Q = What can you tell me about the characteristics of your teacher in terms of friendship?

A = Our teacher is always friendly, he always makes jokes with us though he doesn't take our joke; our teacher is friendly with everyone. Our teacher is not friendly at all she has moods that change from day to day

Item 2: Q = Does your teacher allow learners to use equipment during practical investigations?

A = The teacher barely gives equipment to learners; I think he does not trust us; if he gives equipment, it will be to his favourite learners.

Item 6: Q = Do you sit and talk to your teacher if you have problems in Chemistry? If not, why not?

A = The teacher is too strict and we fear him; the teacher is not really open to discuss issues; we can sit and discuss some issues but not all. Sometimes you can sit and talk about subject matters issues but sometimes not

Item 26:

Q = Are you as learners, sometimes allowed to take major decisions in your class?

A = The teacher does not allow us to take major decisions in class; the teacher depend more on the class captain to take mayor decisions on behalf of the class; the teacher usually make all the big decisions.

Item 39: Q = If learners misbehave in the laboratory, how does the teacher act in response to that behaviour?

A = The teacher is very strict and the learners are always punished; our teacher will not act immediately but should the behaviour persist he will act.

Q = How does he act? What punishment strategy is he using?

A = Learners' names are recorded and to the record book if the offence is repeated the learner is issued with a warning letter and parents are informed, if behaviour persist suspension follows.

Item 48: Q = Are you afraid of your teacher?

A = Yes the teacher is too strict; yes the teacher is too serious with rules; no we are not afraid of the teacher, he is too friendly.

Teacher Interview

Q = What is the level of demand from learners with regards to doing practical work?

T = Learners always demand teachers to do practical work because they do not understand theoretical lessons, they do not understand the purpose of practical work, there is poor interest in theoretical lesson, they regards practical work as free time to engage and play.

Q = Do you think learners enjoy practical work?

T = Generally learners are very excited about practical lessons because they find it fun and enjoyable.

Q = Do you think you as a teacher you are doing enough practical work according to the syllabi demand?

T = There is a huge shortage of equipments and chemicals to do the expected amount of experiments. We mostly do the topics of experiments that we have chemicals or equipment for. . .

Q = How do learners perceive Chemistry in terms of difficulties and understanding?
T = Learners are generally negative towards Chemistry especially the calculations, formulae and the balancing of equations. Such negative connotation hampers the understanding of the subject because learners are psychologically retarded towards the subject.

Q = What is the regular attendance to extra classes from your learners?
T = It is difficult to get learners to attend extra classes after school because they complain of not having transport, too tired, hungry, poor concentration and they claim to stay far.

Q = Between boys and girls which ones do you think enjoy practical work most?
T = I think boys enjoy more practical work than girls because boys are more handy than girls in terms of handling equipments, girls turn to be shy and afraid of reactions while boys usually enjoy the explosions.

Q = How committed are learners in doing practical work project?
T = Some learners are very serious while others are taking practical work lightly. There are too much teasing, laughing and jokes during practical demonstrations.

Q = What type of assistant do you offer to your learners?
T = We offer individual support, advice, guidance and any other support or advice as requested by learners.

Q = Can learners do their own practical investigations without the teachers' supervision?
T = Learners are not that much responsible to do practical work on their own. Chemicals and equipment can be dangerous to the learners and therefore we do not allow learners to carry their own practical investigations.

Q = How do you as a teacher incorporate your theoretical lessons in to your practical lessons?

T = We try to incorporate the practical lessons after each topic covered, but it is not always possible due to lack of equipment and chemicals. In most cases we do practical lessons for topics that we have chemicals and tools for.

Q = Chemistry practical work can be a dangerous and excitants can happen. How are learners protected during Chemistry practical work?

T = We do not have protective clothing, gloves, mask and other safety equipment for learners to wear during practical investigations. There is one or two of these protecting cloths that are usually used by the teacher.

Q = Chemistry Practical demonstrations can be a very tricky operation to understand, explain how you as a teacher can sense if the learners understand what you are teaching or not?

T = Learners who do not understand usually do not ask questions or take part in the discussions. There are other body languages, or physical signs that learners portray if they understand or if they don’t understand, e.g. facial expression, gesture and silence.