Exploring how the integration of indigenous knowledge in the topic of acids and bases influences Grade 10 Physical Science learners' conceptions, dispositions and sense-making

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DECLARATION OF ORIGINALITY

I, Johanna Shetulimba Haimene, undersigned, hereby declare that the work contained in this thesis is my own original work and has not been previously submitted at any other university for degree purposes. Where I have drawn on the words or ideas of others, these have been acknowledged using complete references according to Departmental Guidelines.

Signature Date: 07-12-2018

ABSTRACT

The inclusion of indigenous knowledge (IK) in science education is gaining momentum. That is, it is acknowledged that the starting point in learning is what learners already know from their homes or community. This will be consolidated by what these learners will learn in classroom. It is for this reason that the Namibia National Curriculum for Basic Education (NCBE) advocates Learner Centred Education (LCE). The Physical science syllabus also encourages the use of practical activities to enhance the conceptual understanding of the learners. However, the views and beliefs that learners have towards science influence their learning of science. Looking at the same context, various studies carried out have pointed out that the attitude of learners towards the subject influences their performance in that specific subject. It is against this background that this study sought to explore how the integration of indigenous knowledge in lessons on acids and bases influences (or not) learners' conceptions, dispositions, interest and sense-making.

This study used a mixed-method approach whereby both quantitative and qualitative data were gathered. It is underpinned by the interpretive paradigm. Within the interpretive paradigm a case study approach was employed. The study was carried out with the Grade 10B Physical Science learners at Namaela Secondary School (Pseudonym) in the Oshikoto Region.

To generate data, a variety of data generation techniques were employed, namely pre-and post-intervention questionnaires, pre-and post-test, observations, learners' journal reflections and semi-structured interviews. Conceptions, dispositions and sense-making, and Vygotsky's socio-cultural theory were used as a lens to analyse the data. A deductive-inductive approach was adopted for data analysis.

The findings from the study revealed that learners were able to make sense of science concepts when IK is integrated in the lessons. Additionally, the learners' conceptions and dispositions shifted positively due to the use of the everyday materials. It emerged that learners were able to learn science well when they link their everyday experiences to school science.

This study thus recommends that teachers should be encouraged to integrate IK in their lessons. In order for teachers to effectively integrate IK, the curriculum developers should be explicit on how teachers should integrate IK in their lessons. Moreover, teacher-training institutions should include ways of integrating IK when they are training teachers.

DEDICATION

This thesis is dedicated to my mom, Hambeleleni Mutilifa (Haimene). It was through her hard work that I have managed to reach this stage. Your dedication and encouragement always motivated me to work hard. You always said *"okatanga na ka kale kokoola yoye" (the ball should be on your side).* This means that she has to do whatever she is able to do, to make sure that my basic needs are met.

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Table of Contents

List of abbreviations and/or acronyms

DNEA	Directorate for National Examination and Assessments
IK	Indigenous Knowledge
L1J-L7JF/M	Learner 1- Learner 7 Journal (Female or Male)
L1-L33	Learner 1- Learner 33
L1-L4SSIF/M	Learner 1-Learner 4 Semi-structured Interview (Female or Male)
LCE	Learner Centred Education
NCBE	Namibia National Curriculum for Basic Education
NSPIs	National Standard and Performance Indicators
QUAL	Qualitative
QUANT	Quantitative
TCE	Teacher Centred Education
TIMSS	Trends in International Mathematics and Science Study
WS	Western Science
ZPD	Zone of Proximal Development
ZPL	Zone of Proximal Learning

List of tables

List of figures

List of Appendices

CHAPTER 1: SITUATING THE STUDY

> *Learner-centred education is supposed to foster successful learning for all learners by taking each learner's existing knowledge, skills, interests and understanding - derived from previous experience in and out of school - as the starting point for each lesson (Nyambe, 2008, p. 23).*

1.1 Introduction

The purpose of this study was to explore whether or not the inclusion of indigenous knowledge (IK) in the teaching of acids and bases influences (or not) Grade 10 Physical Science learners' conceptions, dispositions, interest and sense-making. In this chapter, the context of the study is highlighted, both internationally and nationally. This is followed by statement of the problem and significance of the study. The research goal and research questions that guide this study are highlighted, followed by summary of the conceptual and theoretical framework. The data gathering techniques and definition of key concepts are provided, followed by the outline of the thesis, and the chapter ends with concluding remarks.

1.2 The context of the study

One of the first steps in completing the thesis is providing the background of the study (Alleyne, 2018). This provides the reader with crucial information about the study from the international contexts to the local contexts. It also identifies and describes a research problem in relation to the existing literature (Labaree, 2009). The background of the study provides a review of the researched area, recent information surrounding the issue, and notes previous studies and relevant history around the issue (Alleyne, 2018). In addition, it gives the researcher the relevance of the study and the way forward to further the study. The next section provides the background from an international and regional context.

1.2.1 The international and regional context

Various initiatives were developed in order to find out how Mathematics and Science are performed in different countries. For instance, the Trends in International Mathematics and Science Study (TIMSS) is one of the studies that highlighted the performance of different countries that participated in this initiative (Mullis, Martin, Gonzalez & Chrostowski, 2004). The aim of TIMSS was to improve the teaching and learning of Mathematics and Science by providing data about the performance of countries that participated in fourth and eighth grades. TIMSS is the project of Evaluation of International Achievement (EIA) and was first initiated in 1995. The report revealed that Singapore performed well in both eighth and fourth grades.

Other countries that performed well are Hong Kong SAR (Special Administrative Region), the Republic of Korea, and Chinese Taipei.

South Africa was the first African country that participated in TIMSS in 1995, and the performance was significantly low when compared to other participating countries. Some causes of poor performance are home environment, physical resources at school and home language (Howie, 2004; OECD, 2018; Reddy, et al., 2015) amongst others. Other African countries such as Botswana, Ghana and Egypt only participated in 2003. Their performances were also low as they all achieved marks below the benchmark. Even though Namibia has not yet taken part and the measure of international performance of Namibia cannot be established through international testing, the overall performance for Namibian learners in science is also low as shown by the statistics made available by the Directorate National Examination and Assessment (DNEA) for 2014 -2017 in the national examination. One of the topics that were identified as being poorly performed was acids and bases.

The poor performance in acids and bases is not only experienced in Namibia as other countries also experience similar problems. A study carried out in Turkey revealed that acids and bases is one of the problematic chemistry topics for many secondary school students (Demircioğlu, Ayas & Demircioğlu, 2005). In an attempt to address the poor performance on acids and bases in Turkey, new teaching materials were developed which consist of nine worksheets, five demonstrations and three analogies. Analogy is the way of explaining concepts so that they are understandable by comparing the target domain with a familiar source domain (Haglund & Jeppsson, 2012). The study showed that the new teaching materials yielded better results in terms of achievement and attitudes of learners.

Another study carried out at Hacettepe University, Turkey, by Morgil, Yavuz, Oskay and Arda (2005**)** pointed out the difficulty of this topic. As a result, computer software was introduced to the learners. The study revealed that there was a greater improvement in the group which was exposed to the computer-assisted teaching than in the group which was not exposed to it. In a similar study by Hand and Treagust (1988) in Queensland, Australia, a new teaching strategy was developed aimed at changing the misconceptions of learners about acids and bases. The strategy is comprises of worksheets that cover the practical activities to be carried out in class. The worksheets were divided into three sections; students' concepts, practical components and questions related to practical components. The study revealed that there was an improvement in the performance of learners as a result of this new teaching strategy. Hence, this study sought to close the gap, that even learners who are disadvantaged due to their home environment and lack of physical resources at school may use the materials from their homes to learn Physical Science, specifically acids and bases. Let us now turn our focus to the Namibian context in relation to the teaching and learning of science, and what the requirements of the Namibian curriculum are.

1.2.2 Namibian context

Having highlighted the performance of science and mathematics internationally, in Namibia science is seen as a subject that requires the full engagement and participation of the learners in the classroom (Sedlacek & Sedova, 2017). The Namibian National Curriculum for Basic Education (NCBE) (2016) aims to empower learners to actively participate in making Namibia a knowledge-based society as this is one the country's vision 2030 goals. For this reason, the NCBE introduced Learner Centred Education (LCE) approach that replaced Teacher Centred Education (TCE). In TCE the teaching relies on the teacher, who plays the major role in disseminating the information to the learners and learners are considered as 'empty vessels' (Moll, 2002).

Thus the NCBE (2016) advocated that learners do not come to school like empty vessels, they have had some experiences. Hence, what learners already know should be considered as the starting point in the classroom (Nyambe, 2008) as highlighted in the epigraph above. Learners are central to the learning process as they are the active participants during the teaching and learning process. In addition, LCE enables teachers to identify the experiences and knowledge of the learners (Kasanda, Lubben, Gaoseb, Kandjeo-Marenga, Kapenda, & Campbell, 2005). The learners are expected to use the knowledge that they have gained in their society as well as from their interactions with their local environments to enhance their subject content knowledge, and not depend solely on the teachers (NCBE, 2016; MoE, Physical Science syllabus, 2010). The NCBE (2016) also aims at embracing indigenous knowledge (IK) for the learners. Hence, the NCBE suggests that only a society with a strong culture, positive values, and individual identity can influence globalisation positively and not be overwhelmed by it.

The NCBE also stipulates the subjects that have to be offered in Namibian schools. For instance, Physical Science is compulsory for all learners in Grades 8 to 10. Acids and bases is a topic under chemistry that is taught in Grades 9 and 10. As stipulated in the Physical Science syllabus, learners should be able to differentiate between acids and bases in terms of properties. Furthermore, learners need to be familiar with the testing of acids and bases using various indicators such as litmus papers and universal indicators. Learners also need to know the reaction of acids and metals and be able to test the gas that is released. They also need to know the reaction between acids and bases.

Even though this topic was taught in Grade 9, the examiners' reports for 2011-2017 have pointed out that this topic is poorly performed by Grade 10 learners in the final national examination. For instance, the examiners highlighted that learners struggle to give correct answers on *acidity*, *alkalinity* and *neutrality* of substances. They are also unable to name examples of acids and bases, their effect on litmus paper, as well as the reaction of acids. Most of abovementioned learning competencies require being taught through practical activities.

The Physical Science syllabus suggests the use of practical activities. However, at some schools science teachers do not carry out these practical activities. One of the reasons often given for not carrying out practical activities is the lack of teaching and learning materials (laboratory chemicals) in some schools (Asheela, 2017). Yet, easily accessible resources may be available in the environment, as evidenced in Asheela's (2017) study, but because some teachers may not be aware of how to use these materials in their teaching, they may not be able to utilise them (Cronje, de Beer & Ankiewicz, 2015).

Being a teacher myself, I experienced the same problem with the lack of teaching and learning materials that can be used to carry out practical activities for my learners. It was only after I was exposed to a workshop on how to use these local (indigenous and easily accessible) materials during my BEd Honours course that I became aware of them. For this reason, it dawned on me that the topic of acids and bases has a great potential to be taught using easily accessible resources.

1.3 Statement of the problem

It is observed that teaching and learning of acids and bases poses a challenge to many learners (Demircioğlu et al., 2005; Morgil et al., 2005**)**. The statistics provided by the Directorate National Examination and Assessment (DNEA) for 2014, 2015, and 2016 have shown that Grade 10 learners perform poorly in Physical Science. For instance, averages of 45.4%, 46.4% and 51.1% for 2014, 2015 and 2016 (pass rate) respectively were achieved by most schools (rural and urban) in the national examination. Examiners' reports for previous years (2011-2017) have also pointed out that acids and bases is one of the poorly performed topics in the national examination. As a science teacher, I have also experienced learners not doing well in this topic even though this topic is taught in Grade 9. Thus, I find myself spending many days teaching this topic and yet learners still score low marks. I have also observed that many learners find it difficult to differentiate between these two concepts in terms of testing, their effects on indictors (litmus paper and universal indicator) and their reactions.

Based on the examiners' reports, and what I have experienced as a science teacher about this topic (acids and bases), I aimed to undertake this study to explore whether or not the inclusion of IK during lessons on acids and bases influenced Grade 10 Physical Science learners' conceptions, dispositions and sense-making.

1.4 Significance of the study

The potential value of this study is that it may provide some insights on how IK may influence Grade 10 learners' learning of acids and bases when doing practical activities using easily accessible resources integrated into the lessons. It may also give an overview on learners' conceptions, dispositions and sense-making toward the topic of acids and bases when IK is integrated in the teaching. It may also help me and other teachers to improve our teaching of acids and bases by integrating IK in lessons. It may also provide an opportunity to other teachers on how to use the everyday materials (local materials) in teaching acids and bases. In order to understand this study the research goal and research questions are highlighted in the next section.

1.5 Research goal and questions

In order to understand this study, the research goal and research questions are presented below.

1.5.1 Research goal

The main goal of this study was to explore whether or not the inclusion of IK during lessons on acids and bases influenced Grade 10 Physical Science learners' conceptions, dispositions, and sense-making. To achieve this goal, the study was guided by the following research questions.

1.5.2 Research questions

1. What are Grade 10 Physical Sciences learners' conceptions, dispositions and interest towards learning science?
2. What prior knowledge on acids and bases do Grade 10 Physical Science learners have?
3. How does the integration of IK in lessons on acids and bases influence (or not) the conceptions, dispositions, interest of learners toward science learning?

4. How does the integration of IK influence (or not) learners' sense-making of the concepts on acids and bases?

1.6 Theoretical framework

Theoretical framework is an important part of the research as it guides the entire process of the research. The theories are developed to explain, predict and understand phenomena (Abend, 2008). Theoretical framework is the structure that can hold and support a theory of a research study (Swanson, 2013). This study was guided by Vygotsky's (1978) sociocultural theory, which emphasises that learning takes place in social contexts.

1.7 Data gathering techniques

To collect the data for this study the following data techniques were used:

- Questionnaires (pre- and post-intervention questionnaire);
- Tests (pre-test and post-test);
- Observation (videotaped lessons);
- Journal reflections; and
- Semi-structured interviews

I used these data gathering techniques to enhance validity and trustworthiness of the data generated through triangulation (Cohen, Manion & Morrison, 2018).

1.8 Definition of key concepts

Some key concepts that are frequently used in this study are defined below.

Indigenous knowledge (IK) is the body of knowledge that is passed from one generation to the other within the same ethnic group and it is also acquired through experience as well as the relationship with the environment (Kibirige & Van Rooyen, 2006).

Hands-on practical activities are the tasks whereby the learners manipulate the real objects in the classroom in order to make observations and draw conclusions.

Zone of Proximal Development is "the distance between a child's actual developmental level as determined by independent problem solving, and the higher level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Turuk, 2008, p.248).

Sense-making is the way of making the circumstance understandable in clear words.

Disposition is an attitude of someone regarding the situation. It can be positive or negative.

Conceptions are views that learners hold on the subject and what they believe is required in learning and doing the subjects.

1.9 Thesis outline

This thesis is comprised of six chapters:

Chapter 1: Outlines the context of the study, the problem statement, significance for carrying out the study, research goal and research questions. It also highlights the theoretical framework and gives the definition of the key concepts used in the study.

Chapter 2: Reviews the related literature around the study. Firstly, it looks at what the Namibian curriculum has required from science in relation to Learner Centred Education (LCE). I looked at the benefits and challenges associated with the implementation of LCE. In this chapter, the teaching of acids and bases is discussed. It also unpacks how practical activities play a role in teaching and learning of science and its shortcomings. Additionally, it also looks at how prior knowledge plays the role in teaching and learning process. Thereafter, I explain IK teaching, how it enables and/or constrains the teaching and learning of science. It further looks at the conceptual framework, which consists of conceptions, dispositions and sense-making. Lastly, I explain in detail the theoretical framework that guided this study.

Chapter 3: This chapter is about the research methodology. It focuses on the research design, research paradigm, research goals and questions, research site, participants and sampling techniques. It also describes the data gathering techniques, how data were analysed, validity and trustworthiness, my positionality as a researcher as well as ethical considerations.

Chapter 4: In this chapter I present, analyse and discuss the quantitative data collected from the pre-and post- questionnaire as well as from the pre- and post-test. In addition, some data from learners' reflections is interwoven.

Chapter 5: This chapter presents, analyses and discusses the qualitative data collected from the classroom observations, learners' journal reflections and from the semi-structured interviews.

Chapter 6: This chapter summarises the findings of the study per research question. It also gives the recommendations for further studies, limitations of the study, some personal reflections and ends with the conclusion.

1.10 Concluding remarks

This chapter describes the context of the study at international and national level and explains the statement of the problem that triggered me to conduct this study. The significance of the study is explained as well as the research goal and research questions. The chapter also highlights the conceptual and theoretical framework as well as data collection techniques. The key concepts that were used in the study are defined and the chapter ends with the outline of each chapter in the thesis.

The next chapter discusses the literature relevant to this study, the conceptual and the theoretical framework informing it.

CHAPTER 2: LITERATURE REVIEW

> *Western science did not emerge in the vacuum, but was influenced by many factors such as those in other knowledge systems. This means that there are certain areas where the two knowledge systems coexist and overlap (Mukwambo, Ngcoza & Chikunda, 2014, pp. 69-70).*

2.1 Introduction

The main goal of this study was to explore whether or not the inclusion of indigenous knowledge (IK) in the teaching of acids and bases influences Grade 10 Physical Science learners' conceptions, dispositions, interest and sense-making. My interest in this study was triggered by poor performance of learners in Physical Science, specifically in the topic of acids and bases, as explained in Section 1.3.

In this chapter I discuss the literature relevant to my study. O'Leary (2014) defines a literature review as a review of a body of knowledge comprising of what has been found as well as methodological contributions. A literature review presents what is known about the problem under consideration (Ary, Jacobs & Sorensen, 2010).

Firstly, I discuss the expectations of the Namibian curriculum in relation to Learner Centred Education (LCE). I discuss what LCE is and how important it is to teaching and learning. I also look at the challenges associated with the implementation of LCE. Secondly, I discuss the teaching of acids and bases, focusing on different descriptions of acids and bases. The discussion is based on the different models that were developed and difficulties experienced (mostly by learners which is the focus of this study) in teaching acids and bases using these models. Thirdly, I discuss practical activities in teaching as one of the requirements of the Namibian curriculum specifically under Natural Sciences where we find Physical Science. I look at hands-on practical activities on teaching and learning of science and how they enable and/or constrain the teaching. Fourthly, I present the role of prior knowledge in teaching. Thereafter, I present the indigenous knowledge (IK) and teaching of science in the classroom. I look at how IK can enable and/or constrain teaching and learning of science. Afterwards, I discuss the conceptual framework, which comprises of conceptions, dispositions and sense-making. Lastly, I discuss Vygotsky's (1978) socio-cultural theory which is my theoretical framework in this study.

2.2 The expectations of Namibian National Curriculum for Basic Education (NCBE)

The national curriculum is the official document which serves the purpose of directing in planning, organising and implementing the teaching and learning process (MoE, NCBE, 2016). It provides a coherent and concise framework for consistency in delivering teaching and learning processes in all Namibian schools. As such, it is the umbrella for all the teaching and learning activities as well as directing the development of syllabuses and the textbooks to be used. It also stipulates all subjects that have to be taught per grade and the time allocated for each subject. NCBE emphasises the use of learner centred education (LCE) which was introduced after independence, replacing the teacher centred education (TCE).

The NCBE states that a knowledge-based society requires a LCE approach in the teaching and learning process. The LCE suggests that the starting point of teaching and learning is what learners already know from home (Roschelle, 1995). Thus, learners are required to use their cultural background knowledge when constructing their science knowledge (Mavuru & Ramanarain, 2017). Akena (2012) and Nyika (2017) stress that what learners learn from their homes or from their culture can be used in the classroom as the foundation for learning new concepts. As a result, the NCBE (2016) warn that teaching that does not build on the learners experiences, inhibits learners' thinking. Because of this, Ogunniyi (2007a) indicated that learners are loaded with science from their home backgrounds. This should be taken advantage of so that they can share their experiences and learn science concepts in relation to their experiences. Similarly, Kasanda et al. (2005) emphasise that use of everyday contexts in LCE brings the experience of the learners to the classroom which can be used to teach scientific concepts. LCE values life experiences which will assist the learners to integrate the school curriculum with life outside the classroom (Liveve, 2017; Mavhunga & Kibirige, 2018)

According to Nyambe (2008), LCE is intended to foster learners' knowledge, skills, attitudes and values. It also contributes to the development of critical thinking skills and encourages self-directedness in learners (Weimer, 2002). Furthermore, it enables the learners to participate in discussions as they are using their prior knowledge and exploring their physical environment (NCBE, 2016). To McCombs and Whisler (1997), LCE focuses on learners' experiences, perspectives, interest capabilities and needs. It also enables the learners to be involved in discussions with their peers and the teacher in order to make meaning and have a thorough understanding of concepts being discussed. It enables learners to learn from each other through social interaction as proposed by Vygotsky (1978) and encourages the learners to manipulate and relate to the natural environment so that they can be empowered with scientific knowledge in the classroom (NCBE, 2016).

Empowering learners with scientific knowledge may enable them to construct meaning and understanding and be engaged in tasks through relevant learning activities (Schreurs & Dumbraveanu, 2014). These tasks are set and facilitated by the teachers in order to achieve the learning outcomes (*ibid*). Liveve (2017) points out that LCE is aimed at harnessing learners' curiosity and excitement in learning science. It also involves active learning where learners should be involved in problem solving, formulating questions and taking part in debates. It encourages co-operative learning for learners to work as a team and solve the presented problem as well as the inductive learning, where learners are presented with a problem that they can solve in order to discover the solution to it (Schreurs & Dumbraveanu, 2014). Hence, teachers need to create a conducive learning environment for the learners to be creative, innovative and explore their environment so that they can learn new knowledge (Simasiku, 2017).

Despite LCE being seen to carry the promise to improve the quality of education, there are some challenges associated with its implementation (Schweisfurth, 2014). According to Chisholm and Leyendecker (2008), there is incompatibility between the goals of LCE and the reality of the classroom as there is little understanding on using or implementing LCE in the classroom (*ibid*). There are poor teacher training programmes and these may lead to poor teaching quality (Tabulwa, 2013). Nykiel-Herbert (2004) points out that, teachers need to be experts in the content knowledge for them to prepare quality work for their learners. It is the teachers who direct and orchestrate the learning process.

Thus, poor training or no training at all will be a challenge for the teacher to implement LCE in the classroom. Nyambe and Wilmot (2012) and Nykiel-Herbert (2004) add that LCE can be misinterpreted by teachers. For instance, the teachers may think that they do not need to have subject knowledge since learners already possess the knowledge and these learners have the ability to learn on their own in the classroom. Apart from preparation of the teachers, there are also limited resources to be used in the classroom such as textbooks (Schweisfurth, 2014). Some classrooms are overcrowded and printed materials are provided in limited numbers (Altinyelken, 2010; Nyambe & Wilmot, 2012). It is also difficult for the teacher to walk around the class and give feedback needed by the learners since the classes are overcrowded (Altinyelken, 2010).

In relation to what the NCBE is striving for, the foundation for learning in LCE is the prior knowledge of learners. Thus, in this study I focused on how the topic of acids and bases can be taught using everyday materials to find out whether or not these materials can influence learners' conceptions, dispositions and sense-making. This entailed integrating indigenous knowledge (IK) in the teaching of this topic (acids and bases) something which the curriculum encourages but is not explicit about it. Let us now shift our attention to the teaching of acids and bases.

2.3 Teaching of acids and bases

Acids and bases is one of the basic components of Chemistry in the curriculum. It is part of everyday life in context and is featured in everyday activities such as in food and industry (Drechler & Van Driel, 2007). This is an important topic in Chemistry (Kala, Yaman & Ayas, 2013), hence, there are various definitions of acids and bases and these definitions are based on the model that is being used. An acid is a substance that has a sour taste, turns blue litmus paper red and reacts with non-precious metals and carbonates, while bases are substances that have a soapy feel, turn red litmus paper blue and neutralise acid to produce salt (ancient model).

From a different perspective of Arrhenius model, acids are the substances that contain hydrogen ion (H^+) and the more hydrogen ions in the solution, the more acidic is the solution, while bases are substances that produce the hydroxide ion (OH^-) (Arrhenius, 1903). When acids react with bases, they form neutral solutions (salt and water). In the Brønsted-Lowry model, acids are seen as particles that donate protons and bases as receivers of protons. Hence, the strength of an acid or a base is interrelated with its tendency to donate or accept protons (Kauffman, 1988). The definitions of acids and bases in this model (Brønsted-Lowry) are abstract, which makes it more difficult for learners to understand the concepts.

It has also been observed that many students find it difficult to understand the concept of acids and bases because of the way these concepts are taught (Damanhuri, Treagust, Won & Chandrasegaran, 2015; Demerouti, Kousathana & Tsaparlis, 2004). Scholars acknowledge that acids and bases are difficult, abstract and problematic concepts (Sesen & Tarhan, 2011). One of the causes of difficulties in the learning of these concepts is that there are many misconceptions (Demircioğlu et al., 2005). Some of the misconceptions noted are that acids are substances that eat materials away and base is something which makes up an acid (Hand & Treagust, 1991), acids and bases have their own particular colour and acids melt metals (Nakhleh & Krajcik, 1994). Hence, Garnet, Garnet and Treagust (1990) and Widarti, Permanasari and Mulyani (2017) point out that misconceptions affect the way the learners learn since they have to link new information to their prior knowledge. Once the incorrect concepts become established, learners are reluctant to change in learning correct concepts (*ibid*). For this reason, Widarti et al. (2017) suggest that to identify and reduce misconceptions about these concepts, teachers need to implement suitable teaching strategies. Kala et al. (2013) proposed the Predict, Observe and Explain (POE) approach to elicit the understanding of the learners. The learners need to predict what will happen, then make observations and finally explain why certain phenomena occur.

Schmidt (1995) emphasises that difficulty is also caused by the confusion between scientifics acid-base terminologies and everyday words. In the same way, textbooks also cause confusion due to different definitions of these two concepts (acids and bases) (Drechler & Schmidt, 2005). For instance, some textbooks define acids and bases based on the pH value, and some on the hydrogen and hydroxide ions as well as the donating and receiving of protons. Most textbooks are not explicit about acids and bases or the model that is being used, for example, whether the model being used is the Arrhenius model or the Brønsted-Lowry model (Carr, 1984). De Vos and Pilot (2001) divided the acid-base concept into six different layers or contexts which are craft, synthesis, analytical, Arrhenius, Brønsted, and application contexts. Some textbooks do not clearly show these layers, which causes confusion among learners and similarly teachers do not explicitly use these layers in their teaching. For this reason, Pohan and Syahwin (2017) emphasise that, when students' conceptions differ from scientific concepts, it can lead to learning difficulties of new concepts. Thus, these scholars suggest that the previous experiences should align with new concepts in order for learners to make sense of concepts taught.

To minimise learning difficulties, Carr (1984) suggests that it is important for teachers to give a clear explanation of the new model introduced, how it is different from the previous model and why it works better than the other models. The teachers should avoid working with these models (ancient, Arrhenius and Brønsted- Lowry) simultaneously. Instead, they should work with one model at a time and later show how these are connected. They also need to explain how the present model is related to the previous model. It may be ideal to incorporate practical activities when teaching acids and bases to explain better the model used. For this reason, the next section discusses practical activities in teaching of science.

2.4 Practical activities in teaching science

One of the requirements of the Namibian Physical Science syllabus in Grade 10 is the carrying out of practical activities. Millar (2004) defines practical work as any teaching and learning which involves the learners in seeing or handling actual objects. Additionally, practical activities are defined as any type of science teaching and learning activity in which students work individually or in small groups as an essential element of what they are doing in manipulating and/or observing real objects (Abrahams, Reiss & Sharpe, 2013). Practical activities allow the learners to interact with the materials in order to make observations and understand the natural world around them (Abell & Lederman, 2007; Hofstein & Lunetta, 2003).

The Namibian Physical Science syllabus suggests the minimum activities that can be carried out for each topic. In the case where no practical activities are suggested, teachers are encouraged to use alternative activities relevant to the topic, such as the use of easily accessible resources from the learners' everyday environment to teach particular topics (Asheela, 2017). The practical activities are also considered essential and all learners need to be exposed to them during teaching and learning for the preparations for the assessment (MoE, Physical Science syllabus, 2015). Practical activities are assessed under assessment objective C (Practical (experimental and investigative skills) in the Namibian revised curriculum (*ibid*). The syllabus further suggests that learners should use and organise techniques, apparatus and materials; observe, measure and record; handle, process and evaluate experimental observations and data and plan investigations (MoE, Physical Science syllabus, 2015). All these are general requirements for the teaching of Physical Science and they can be applied to any topic, including acids and bases.

Specifically, in the topic of acids and bases, learners are expected to know and understand that the pH scale that ranges from 0 to less than 7, measures acid strength and from more than 7 to 14, measures the strength of an alkali. On the pH scale, they should be able to relate the pH of strong and weak acids and alkalis and the pH of pure water (*ibid*). The learners should know the nature, the effect on indicators and the reactions of acids and alkalis (bases). They also need to understand neutralisation as a reaction between bases and acids, All these concepts require learners to be exposed to practical activities and not only be taught theoretically as is currently happening in most under-resourced schools in Namibia (Asheela, 2017). The next section discusses the advantages of practical activities in teaching.

2.4.1 Advantages of practical activities

Practical activities afford learners an opportunity to carry out investigations and to follow the laboratory procedures, such as the handling of science equipment as well as the safety precautions that they have to be aware of when carrying out such a practical activity (SCORE, 2009). It is during practical activities that learners are exposed to science in detail which provides the concrete evidence about what is learnt theoretically. Sometimes it is not easy to explain some science concepts, but learners need to see what is happening for them to reason well and grasp the content of what is being taught. For this reason, Sheldrake, Mujtaba and Reiss (2017) emphasise that practical activities reflect the observed nature of science since learners are exposed to concrete evidence rather than being taught in the abstract (theoretically).

Abrahams and Millar (2008) point out that, practical activities are an essential part of teaching science. Concurring, Jokiranta (2014) emphasises that learners' understanding will be enhanced and they will be able to make sense when teaching is accompanied by both *theory* and *practice*. That is, what is explained to learners will be consolidated with what they observe when carrying out practical activities. Mandikonza (2006) maintains that learners need to have the conceptual understanding (theory) and procedural understanding (practical) for them to have a better understanding of science and be able to solve problems. Hence, theory and practice should complement each other in teaching science. Practical activities improve learners' understanding of science and promote their conceptual development by visualising the laws and theories of science (Asheela, 2017; Wellington, 1998). For instance, teachers might use cultural practices to carry out practical activities in the teaching of acids and bases and explain these concepts better. This enables the learners to make observations and draw conclusions better than when they are taught in an abstract ways. Uushona (2013) explains that practical activities help learners in developing understanding of abstract concepts by dealing with concrete situations.

Using concrete situations can be done through the use of practical activities. Practical activities can develop the manipulative skill of learners; promote higher level and transferable skills (Wellington, 1998). Jokiranta (2014), SCORE (2009) and Woodley (2009) explain that practical activities help in engaging the learners in the learning activity which will help them to develop the important skills, scientific investigations and conceptual understanding that are used in the science lesson. Similarly, practical activities can help learners generate interest and enthusiasm toward science (Wellington, 1998).

Practical activities enable the learners to think critically in order to provide clear explanations of what happens based on the practical activity which is carried out. Millar (2004) points out that for the learners to make sense of science taught, they need to be actively involved in the construction of knowledge. Explanation given by the learners may enable the teacher to determine how far the learners understand the topic and how much assistance the learners still need in order for them to grasp the content which is learned (Vygotsky, 1978). This gives an opportunity to the learners to evaluate and draw conclusions about what is observed during the practical activity. Practical activities can be done individually, in pairs or in groups. Such a process will enable the learners to share their ideas. It may enable learners to interpret the new information using the knowledge and experience that they already have (Schreurs & Dumbraveanu, 2014). Learners are able to see what has happened and not just memorise concepts based on the teacher's explanation and what is written in the textbooks. They are learning concepts with understanding, which is one of the aims of the Namibian Physical Science syllabus. Learning with understanding enables the learners to explain the concepts and to be able to apply them to new situations (Millar, 2004).

Carrying out practical activities in the classroom might help learners to develop scientific inquiry skills, which enable them to acquire scientific concepts used in the classroom (Millar, 2004). Millar explains that practical activities make the learner participate confidently in the activity and be able to be oriented when it comes to science literacy. This enables the learner to understand the language that is used in science and to make contributions that will bring changes in learning of science. Apart from the development of scientific inquiry of learners, the use of IK to carry out practical activities also addresses the lack of teaching materials (laboratory chemicals) in schools. Some schools lack laboratory chemicals, which can pose a challenge to a teacher to carry out practical activities (personal experience).

Practical activities stimulate and engage learners at different learning levels as well as challenging them (SCORE 2009b). An advanced practical activity may enable learners to think critically and this may lead to high development of concepts. Hence, it forms a bridge between what the learners can see and do and the scientific concepts that emerge. SCORE (2009) adds that practical activities make the situation more real because learners are using concrete materials and are making observations. This enables them to draw conclusions themselves and not to rely only on what they are being told by the teacher. In this study, I used hands-on practical activities to refer to the activities carried out using easily accessible materials as explained by Asheela (2017) and Maselwa and Ngcoza (2003). Despite the perceived advantages associated with carrying out practical activities in the classroom, it should be acknowledged that there are some challenges.

2.4.2 Disadvantages of practical activities

Some scholars identify some of the disadvantages associated with practical activities as being a waste of time in terms of completing the syllabus on time as teachers are expected to cover the syllabus on time for tests (Oloruntegbe & Ikpe, 2011; Parkinson, 2002). Hodson (1990) points out that, practical activities may be ill-conceived, which may cause confusion and be unproductive. Confusion can be also encountered if something goes wrong and the results produced are not what the theory suggested (Wellington, 1998). In addition, the National Research Council (2002) has reported that students do not learn much from the laboratory activities as these activities sometimes do not show the connection between the classroom content and activities outside the classroom. It can also demotivate the learners if they cannot see the point of carrying out that practical activity (Wellington, 1998).

Millar (2004) points out that some learners might not know the reason why they are carrying out such practical activities. For this reason, Helliar and Harrison (2011) point out that not all students learn from the practical work as suggested by various scholars. Moreover, doing practical activities might be hindered by overcrowding in classrooms (Uushona, 2013) and limited physical resources. In this situation, it will be difficult for the teacher to provide sufficient assistance to individual learners and to clear all the misconceptions that might arise. Having discussed the practical activities, in the next section I discuss the role of prior knowledge in the teaching and learning process.

2.5 Prior knowledge

Prior knowledge is a frame of organisation that students bring from home before they engage in instruction and use it to make meaningful connections between concepts, information and strategies that have to be learned (Okanlawon, 2012). These skills and experiences that the learners bring into the classroom can be from the previous grades or social interactions. It is knowledge that learners possess from their immediate environments, peers, parents and previous lessons (Kuhlane, 2011). Graven and Schafer (2013) assert that it is important to know what the learners already know, since learners acquire new knowledge by relating it to what they already know. This makes it easier to assimilate and internalise new concepts. Prior knowledge arouses the interest of learners since a familiar topic is introduced. It helps learners to be involved in the discussions during social interactions and be more participative (Sedlacek & Sedova, 2017; Vygotsky, 1978)

When teachers take learners' prior knowledge into consideration, they are acknowledging the socio-cultural background of these learners (Mavuru & Ramnarain, 2017; Stears, Malcolm & Kowlas, 2003). According to Stears et al. (2003), prior knowledge adds greater connectedness of materials learned which will deepen the level of engagement between learners and the teacher. Prior knowledge has an influence on the way people construct knowledge as indicated by Vygotsky (1978). Thus, learners also construct new concepts using their prior knowledge (Resnick, 1983). It gives ample opportunity for the teacher to know what learners already know and to avoid the repetition of content already known (Moore & Van Rooyen, 2002) and helps in clearing up the misconceptions that the learners may have. In this situation, IK can be used as prior knowledge of learners to enrich the teaching of science (Kibirige & Van Rooyen, 2006) and to counterbalance the challenges that are posed by Western Science (Mukwambo, Ngcoza & Chikunda, 2014).

Prior knowledge helps the learners with their cognitive development as it assists in identifying what the learners already know and what is intended to be learned. Hence, learning in school must involve, build on, extend and challenge the prior knowledge and experience of learners (MoE, Physical Science syllabus, 2015). Stears et al. (2003) explain that building on the learners' prior knowledge when teaching the science curriculum is beneficial as the learners are relating the content to what they deal with in their daily lives. For this reason, as the NCBE (2016) pointed out, neglecting the learners' prior knowledge limits their thinking. Stears et al. (2003) further emphasise that learners learn well and embrace learning of science when their everyday experiences are incorporated into the teaching and learning process. Hence, to achieve the LCE, teachers need to include the learners' prior knowledge in their teaching (Nyambe, 2008).

Prior knowledge affects the way the learners understand new concepts (Svinicki, 1993) and helps the learners to form new ideas during the teaching and learning process. Furthermore, it prevents learners from memorising concepts that they do not understand. If the person does not have the background of the concept introduced, that person will tend to memorise concepts. Svinicki (1993) further emphasises that once there is connection between what the learners know, it is easier to remember new concepts learned. Prior knowledge can also be used as a diagnostic tool. To this end, Hailikari, Katajavuori and Lindblom-Ylanne (2008, p.7) explain that prior knowledge assessment is used to "identify students who are struggling with their studies", to help in "finding an appropriate level at which to start the course" and what the "students' actual knowledge base" is. Roschelle (1995) indicated that neglecting prior knowledge can result in the learner learning something which is different from what is being intended to be learned, no matter how well it was executed.

On the other hand, Roschelle (1995) also points out that for learners to make new experience, teachers need to understand the effect that prior knowledge has on learning as it influences what is experienced by individuals. He further states that prior knowledge can also produce mistakes and misconceptions in some contexts for students can often construct non-conforming understanding of science concepts. Concurring, Taylor (1999), adds that not all everyday contexts afford appropriate entry points into school knowledge as some of the contexts may be misleading. Learners might also find it difficult to establish the bridge between science learned in school and phenomena that they experience in their everyday chores (Oloruntegbe & Ikpe, 2011). This makes it difficult for learners to make sense of the content delivered in the classroom. In that case, it is important to know the prior knowledge of the learners about acids and bases prior to the introduction of the topic using IK. In this study, the teacher needs to know the prior knowledge of learners about indigenous practices that can be used to teach acids and bases in order to find out how much they know about these concepts. Thus in the next section, I discuss the role of IK in teaching and learning process.

2.6 Indigenous knowledge and teaching

Many literature sources support the inclusion of indigenous knowledge (IK) in teaching of science (Erinosho 2013; Le Grange, 2007; Nyika, 2017; Shizha, 2007). These scholars believe that the incorporation of IK benefits learners in learning science. For instance, it may increase the participation of learners (Sedlacek & Sedova, 2017), it helps to contextualise science (Aikenhead & Jegede, 1999) and enhances parental involvement (Klein 2011; Lareau, 1987).

From the works of various scholars, different definitions of IK emerge. IK is a place-based knowledge, rooted in local cultures, and mostly associated with long-settled communities which have strong ties to their natural environment (Orlove, Roncoli, Kabugu & Matagu, 2010). It is a way of knowing and interpreting experiences peculiar or innate to a particular cultural group (Ogunniyi, 2007b). Similarly to Kibirige and Van Rooyen (2006), Mapara (2009) defines IK as a legacy of knowledge and skills unique to a particular indigenous culture involving wisdom that has been passed down over generations. It is locally bound and knowledge is orally passed from one generation to the other, thus involving the interaction of people from that particular community and it is also acquired through experience as well as the relationship with the environment (Kibirige & Van Rooyen, 2006). In this study, I used the definition of Kibirige and Van Rooyen (2006) as well as Ogunniyi (2007b). It looked at how the materials that can be found from learners' immediate environment can be used to teach scientific knowledge. I believe that it is the use of these materials that enable learners to relate scientific concepts to their everyday experiences. Since it is local knowledge, it is believed that it might benefit them in learning science.

2.6.1 Benefits of inclusion of IK in teaching

There are various benefits of integrating IK in teaching science. The use of IK in the classroom may increase learners' participation during science lessons (Erinosho, 2013; Sedlacek & Sedova, 2017). Sedlacek and Sedova (2017) posit that the participation of the learners in the lesson determines the quality of the teaching and learning process. Hence, the participation of learners in the lesson can be enhanced once they see the connection between everyday activities and what is learned in the classroom. When learners are exposed to everyday activities in the classroom, they might understand what they are learning and that might in turn increase their participation. It also gives an opportunity for the learners to interact socially as proposed by Vygotsky (1978) so that they can share their experiences. It is anticipated that during social interactions, learners are able to hone their IK and obtain some clarity on the knowledge learnt from home.

Furthermore, IK contextualises science so that learners do not feel the foreignness of science (Aikenhead & Jegede, 1999). It encourages the learners to engage with materials that are familiar to them as they are exposed to scientific concepts. IK makes science to be local and contextualised within the learners' socio-cultural contexts (Mavuru & Ramnarain, 2017). This suggests that, the inclusion of IK in the lessons may serve as the starting point in teaching science concepts (Simasiku, Ngcoza & Mandikonza, 2017). For this reason, Shava (2000) suggests that educational pedagogics should be contextualised so that it encourages the learners to share their experiences.

Using IK to contextualise science provides an opportunity for learners' prior knowledge to be taken seriously during teaching and learning (Erinosho, 2013; Oloruntegbe & Ikpe, 2011) as discussed in Section 2.5**.** This may be done through Africanising the science curriculum by adopting methods and approaches in teaching and learning relevant to the African context

(Mukwambo, et al., 2014). Context-based teaching enhances the interest of learners (Mavuru & Ramnarain, 2017; Sheldrake et al., 2017). Hence, Hofstein and Mamlok-Naaman (2011, assert that if learners are not interested in science they will not make an effort to learn and understand the science concepts. It might enable learners to make sense of what is being taught in the classroom if they are using materials from their immediate environment or materials that they are familiar with (Stears et al., 2003). When learners use indigenous materials from their environment, they may be able to see how these materials contain some features of the science that they are learning in their classrooms.

Mukwambo et al. (2014) state that western science (WS) is embedded in indigenous practices as it is highlighted in the epigraph above. Hence, teachers need to consider the context of the learners in disseminating the science curriculum content. For instance, there are concepts in science that are linked to cultural practices as is illustrated in the study carried out in Namibia by Nicodemus (2017) about teaching the rates of reactions using *Oshikundu*, which is a traditional brew for *aawambo* communities. The learners may see how WS is embedded in their cultural practices and how WS and IK contain features that are similar. Thus, IK and WS should not be seen as competing with one another, but rather they should be seen as complementing one another (Ngcoza, 2017). IK used in the classroom may consolidate that connection between the learners' everyday life (prior knowledge) and the scientific world (Le Grange, 2007; Nyika, 2017; Shizha, 2007). Under these circumstances, Mandikonza (2006) stresses that IK may be used to explain how things are done and be complemented by WS, that is explaining why things are being done.

Subsequently, combining these two bodies of knowledge may enable the learners to clearly understand the science learnt in the classroom. This can be made easier as there are some concepts that are shared by these two bodies of knowledge. For instance, these bodies of knowledge share ideas about the preservation of seeds and protection against radiation (Mukwambo et al., 2014). This may enable the learners to relate science to their real life knowledge and use their prior knowledge. It may also be easier for the learners to understand the scientific knowledge when they are relating it to their everyday knowledge, since this is the knowledge that is generated within their community.

Furthermore, learners are more likely to be engaged in education that is more focused on their cultural identities (Mukwambo et al., 2014). It might be easier for the learners to grasp new content when they have a foundation on which they are building (Simasiku, 2017). Oloruntegbe and Ikpe (2011) point out that if learners do not see science as real life experiences, they are likely to experience difficulty in learning science. This might make the learners have negative attitudes towards science as they cannot make sense of the content delivered to them (*ibid*). In contrast, once learners show a positive attitude towards science they might be encouraged to study and their interst in learning science may be aroused (Hofstein & Mamlok-Naaman, 2011).

Using IK may promote the LCE approach as discussed in Section 2.1. It may allow learners to be engaged in classroom discussions, using the knowledge that they have obtained from their environment. Concurring, Lemke (2001) adds that learning becomes effective when participants' cultural resources are used in the teaching and learning of science. Furthermore, considering learners' cultural beliefs or everyday experiences creates cultural interaction among different cultural groups and provides learners with insight to value their cultural heritage and that of others (Cocks, Alexander & Dold, 2012; Hewson, Javu & Holtman, 2009). This may make the learners feel proud of their culture as it is recognised in the classroom where they are taught alongside western science. It identifies the identity of individuals and builds their self-confidence (Taylor, 1999). Thus the use of IK in the classroom contributes to learners' cultural capital (Mandikonza, 2006). According to Bourdieu (1977), cultural capital refers to the cultural experiences for learners that facilitate their adjustment in school and their academic achievement. Once the learner is able to relate what he or she knows with what is being learned at school, then this particular learner may be able to make meaning of school. Learners will see that IK is equally as important as WS. In this case, the materials that learners are familiar with are brought into the classroom and used to teach the topic of acids and bases.

Likewise, IK promotes teaching and learning in which both teachers and learners are engaged in knowledge construction for common understanding (Mukwambo et al., 2014). Learners are engaged in discussion about things that they know from their homes and the teacher facilitates by bringing in the scientific concepts that the learners are supposed to learn in the classroom. Through this, the discussions and arguments held in the class enable the learners to learn the science concepts by relating them to their everyday life in order to further their knowledge.

Put differently, IK forms the bridge between everyday knowledge and school knowledge - what Aikenhead and Jegede (1999) refer to as 'border crossing'. In addition, Aikenhead and Jegede (1999) reiterate that successful learning of science is determined by the degree of cultural differences, how effectively the learner moves between the everyday life and the science classroom, as well as the assistance that the learner receives to make the transition easier. This transition can be smooth, manageable, hazardous, or impossible (Aikenhead & Jegede, 1999). The teacher should facilitate this transition by acting as a culture broker (Wyatt, 1978). That is, to enable all the learners to learn effectively, the teacher acts as the middle man between scientific concepts (learned in the classroom) and everyday activities (learned at home) **(*ibid*).**

Learners can use the materials from their environment in the classroom as illustrated in Asheela's (2017) research conducted in Namibia. Thus, Le Grange (2007) points out that teachers should not ignore learners' prior knowledge as their learning is embedded in their socio-cultural environment (Mavuru & Ramnarain, 2017), which plays a major role in learning of science in the classroom. The responsibility of the teacher is thus to make the transition from everyday science to classroom science easier (Aikenhead & Jegede, 1999; Kuhlane, 2011) and the teacher should help the learners see the link between their everyday science and classroom science. It is for this reason that Ngcoza (2017) suggests that teachers need to be equipped with skills and knowledge on how to integrate IK in the teaching of science. In the case of this study, everyday materials are the ones that make this transition easier with the explanations of the teacher in teaching acids and bases. In his seminal work, Vygotsky (1978) refers to these as cultural tools.

Using cultural tools in the classroom might enable the teacher to involve the parents in the education of their children. It strengthens the community and cultural identities when community members are taking part in educational matters (O'Donoghue, Lotz-Sisitka, Asafo-Adjei, Kota & Hanisi, 2007). Klein (2011) and Cocks et al. (2012) also support the idea that engaging community members to share their cultural knowledge encourages the teachers and learners to have positive attitudes towards the inclusion of IK in the science classroom. This is evident in Nikodemus's (2017) study in which he invited a community member who is a custodian of cultural knowledge to make *oshikundu* in order to teach rates of reactions. His study found that after the intervention there was an increase in the understanding of concepts on rates of reactions. At the end, the learners benefited from the intervention and grasped the content knowledge well. Thus, Mandikonza, (2006) noted that community members have knowledge in cultural practices and these practices can be used in teaching science. Hence, they need to be engaged in school activities.

In the same way, engaging parents in school-related matters is also supported by the National Standard and Performance Indicators (NSPIs) for Namibian schools, as it is one of the seven Key Areas (KAs). It states that there should be a link between school and the parents and community in order to enhance learning. Lareau (1987) maintains that parental participation in educational activities promotes the educational achievements of learners as this will acknowledge the social identities of the learners, which will arouse their interest. The learning might be turned into a positive experience and the attitude of learners towards science might change as suggested by de Beer and Whitlock (2009). Learners will also be motivated and be able to participate when their cultural materials are recognised and used in the classroom. Even though IK is beneficial, in the next section I discuss the constraints associated with the inclusion of IK in teaching.

2.6.2 Constraints of IK in teaching

According to Hortshemke and Schafer (2007), IK should not be seen as the solution to the teaching of science as some problems may arise when it is integrated in teaching. Learning through the use of IK may cause cognitive conflict or dissonance between scientific language and everyday language (Le Grange, 2007). Learners have to replace their existing knowledge with the new knowledge that they are acquiring through schooling (Kibirige & Van Rooyen, 2006; Le Grange, 2007). Learners might have problems in using the scientific concepts which are required from them in the classroom. For instance, the learner might use everyday language to answer questions in the examination, which might lead to the learner losing marks, as he or she is required to use scientific concepts. In Namibia, the national examinations are marked by teachers from different regions and these teachers have different cultural backgrounds. These teachers might not understand what the learner wrote during the marking of these national examinations because of the cultural differences, which may lead to misunderstanding of what learners expressed in the examination paper. As a matter of fact, Kibirige and Van Rooyen (2006) acknowledged that since IK is locally based, it cannot be coded or exchanged across different communities.

Similarly, Nyika (2017) noted that most teachers do not use IK in the classroom as it is not assessed in the examinations and so tend to focus on the work that will be assessed in the examination. IK is seen as a waste of time as teachers need to finish the syllabus on time and prepare the learners for examinations. In the same way, IK might conflict with the religion of teachers and learners (Cronje et al., 2015; Hodson, 2009).

Mhakure and Otulaja (2017) point out that IK might be misinterpreted if teachers do not have a thorough understanding of the relationship between IK and WS. They further argued that the syllabus also does not specify how to teach IK in the classroom, and this can be a challenge to the teachers to integrate it in their lessons. Most schools have teachers who are not from the local environment. Using IK in the classroom might therefore not materialise and fit the situation of these learners. A problem may also arise when teachers are not from the same community as their learners (Mhakure & Mushaikwa, 2014), or when the class consists of many learners from different cultural backgrounds (multicultural class), as the teacher might not know whose IK to use. In that case, using IK can cause inequity in the classroom due to the different social backgrounds of the learners (Taylor, 1999).

Furthermore, Cronje et al. (2015) and Ogunniyi (2007a) point out that as some teachers were trained in western ways of knowing, they may experience some problems in integrating IK in their teaching. For that reason, lack of locally trained teachers to teach IK might also be a challenge (Mhakure & Otulaja, 2017). Mukwambo et al. (2014) stress that, science concepts are not explicit in most indigenous practices. For this reason teachers need to think critically in order to identify science concepts that are embedded in cultural practices as well as identifying practices that may conflict with WS. Besides, not all IK is relevant to science (Hortshemke & Schafer, 2007). In other words, not all everyday contexts provide the information needed for school knowledge as some may be misleading or cause confusion (Taylor, 1999). Hence, context should be chosen with care in providing that bridge between everyday knowledge and school knowledge (*ibid*).

Consequently, extra caution should be taken to avoid misconceptions when teaching acids and bases using IK and making sure that IK used in the teaching of acids and bases benefits all the learners in the classroom. Having discussed the benefits and constraints associated with IK, in the next section I discuss the conceptual framework used in this study.

2.7 Conceptual framework

Conceptual framework can be represented by a "systematic diagram which tries to explain the entire process of the inquiry or research" (Okeke, 2014, p. 5). It is a set-up of connected concepts that provide understanding of the phenomenon (Jabareen, 2009). The concepts that will be used in this study are conceptions, dispositions and sense-making. The next section discusses the conceptions of the learners toward the use of IK in teaching science.

2.7.1 Conceptions

Pehkonen and Pietilä (2003) suggest that beliefs are central to conceptions as they are possessed by the individual based on personal experiences and understanding. Extending on these scholars' views on conceptions, Tsai (2004) defines conceptions of learning as the academic epistemological views demonstrating learners' beliefs about school knowledge and learning. According to Vermunt and Vermetten (2004), a conception of learning is a coherent system of knowledge and beliefs about learning and related phenomena. Conception is the perception of learners toward learning (Tsai & Kuo, 2008). That is, it indicates how the learners structure, infer and reflect their own learning (Lin, Tsai & Liang, 2012). It is recognised, however, that learners' conceptions are subjected to their learning styles and the quality of their education outcome as suggested by Dart, Burnett, Purdie, Boulton-Lewis, Campbell and Smith (2000). Attalah**,** Bryant and Dada (2010) agree that conceptions are views that learners hold on the subject and what they believe is required in learning and doing the subject.

Attalah et al. (2010) point out that conceptions have two components: knowledge and beliefs. Knowledge has to do with the actual subject content knowledge (scientific concepts) whereas beliefs have to do with whether learners can understand that knowledge or not. Expanding on Atallah et al.'s seminal work, Perkins (2008) and Richardson (2011) point out that there are two types of conception approaches: deep approach and surface approach. In deep approach, the learners are constructing meaning, relating ideas and using evidence while in the surface approach learners reproduce learning materials for the purpose of assessment (Lin et al., 2012; Richardson, 2011).

In this study, I have used Attalah et al.'s (2010) definition in order to understand the conceptions of learners toward science when the teacher uses everyday materials to teach acids and bases in particular. Based on what is discussed above, the views and beliefs that the learners have about the use of easily accessible materials might influence how they perceive the learning of acids and bases. Thus, the intention of this study was to employ methods whereby the learners are self-motivated and able to explore more rather than reproduce the information that is given to them. It is recognised also hat conceptions are related to dispositions and hence in the next section I discuss dispositions.

2.7.2 Dispositions

Da Ros-Voseles and Fowler-Haughey (2007, p.1) define disposition as "frequent and voluntary habits of thinking and doing". Disposition, which can be positive or negative, is all about the attitudes of someone regarding a situation. It is traits or characteristics that lead a person to follow certain choices or experiences (Damon, 2005). According to Atallah et al. (2010), dispositions are the beliefs or tendencies to exhibit a frequent, conscious and voluntary behaviour directed towards learning a subject.

Similarly, attitude is defined as a notion that denotes favourable or unfavourable the response of an individual to things, people, places and ideas (Freedman, 1997). Likewise, Adolphe (2002) defines attitudes as a non-observable emotional construct whose occurrence can be only realised from the behaviour manifested. Lending support, Salta and Tzougraki (2004) explain that attitude is a tendency to think, feel, or act positively or negatively toward an object in our environment. Moreover, it involves effective behaviour such as desire, agree, appreciate and commit (Welch, 2010). Thus, Raved and Assaraf (2011) assert that, attitudes toward science are influenced by the interaction between the learners and teachers as well the teaching pedagogies employed.

In this study disposition and attitudes are used interchangeably because both (attitudes and disposition) have to do with the personal feelings of an individual toward the object. It thus, focused on attitudes as an indicator of dispositions. Moreover, I have used attitude to describe disposition.

Positive attitudes can influence the performance of learners (Anwer, Iqbal, & Harrison, 2012). If the learners are positive about learning science, they may score better marks than those with negative attitudes. Similarly, Ben-Chaim, Ron, and Zoller (2000) emphasise that learners' positive disposition is also influenced by motivation. When learners' disposition is increased positively, it will lead them to be fully engaged and effective in the classroom activities. Their dispositions may also be influenced by the connection between the curriculum and the home environment (incorporating cultural relevance in the curriculum) as the first step in learning as suggested by Agunbiade, Ngcoza, Jawahar and Sewry (2017); Gresalfi and Cobb (2006). Teachers should strengthen the positive (desired) disposition qualities in learners such as independence, self-motivation, creativity and resilience (Carr & Claxton, 2002; Da Ros-Voseles & Fowler-Haughey, 2007). In order to foster the attitudes of learners, teachers need to apply different teaching and learning approaches that can inspire and engage the learners (Sheldrake et al., 2017). As a result, Lynos (2006) suggested that incorporating experimental activities promotes a positive attitude toward science.

Additionally, the disposition of the learner may also be influenced by the environment in which a learner is learning as well as by the way the teacher is teaching. Papanastasiou and Papanastasiou (2002) posit that attitude can be shaped by teaching, school climate, level of aspiration and parental influence. In this study I wanted to find out how the dispositions can be influenced (or not) by teaching using a different teaching approach. Hofstein and Mamlok-

Naaman (2011) expressed that there is a relationship between relevance, attitude and interest toward the subject learned. Thus, Bybee and McCrae (2011) pointed out that, the learners' interest in science depends how they perceive the relevance of science to their lives and their immediate environment.

Attalah et al. (2010) suggest six disposition indicators that can be used to measure the disposition of individuals (See Appendix E). Hence, this study has looked at the following disposition indicators, namely, *ability*, *attitudes*, *learning approach* and *values*. These have been used to measure the ability of learners to learn acids and bases when IK is integrated in the lessons. That is, attitudes of learners towards the inclusion of IK, for example, how IK will impact their attitudes toward learning of science. The learning approach used to teach this topic and the values that learners have toward those materials. It is thus important to have an understanding of how IK has an impact on the teaching and learning of acids and bases and how it influences disposition of learners. It was hoped that this might also determine how they make sense of the topic acids and bases. In my view, conceptions and dispositions are related to sense-making and in the next section I discuss sense-making, which might have an influence on learning of science and specifically acids and bases in the context of this study.

2.7.3 Sense-making

Sense-making is a way of making a circumstance understandable in clear words (Weick, Sutcliffe & Obstfeld, 2005). It is all about finding new meaning for the situation that already exists and being able to make it clearer so that it is understandable (Kezar, 2013). Weick, et al. (2005) further express that sense-making increases motivation since the person is making sense of what is being discussed. Sense-making is about interpreting the clues that can be found in the environment (Maitlis, 2005) that make the situation meaningful. Sense-making enables learners to understand the situation that is being discussed. Nyambe (2008) points out that if the teaching and learning environment includes the understanding and knowledge of learners' culture and language, as proposed by Vygotsky (1978), then learners are more likely to understand and make meaning of the subject materials presented to them. Mwamwenda (2004) also emphasises that information that is meaningful can be stored for long-term memory, which enables the learners to retrieve this information for future use.

In addition, integrating IK in teaching makes teaching and learning interesting as suggested by Kibirige and Van Rooyen (2006) for it allows the learners to make sense of the concept learned. IK makes the concepts learned accessible and relevant as learners are relating to their experiences and cultural practices (Lemke, 2001). As a result, IK can be seen as another way of knowing that can be used in order to understand scientific concepts and thereafter contribute to meaningful learning (Mandikonza, 2006). This implies that it encourages the learners to become involved in discussions with one another in order to make sense of the concepts taught in the classroom.

Integrating IK into teaching of acids and bases might enable the learners to make sense of these concepts by interpreting the scientific knowledge that is embedded therein. One can then encourage learners to write out the scientific concepts that emerge from the practical activities using the materials from their everyday life. In this case, it can be done by writing the concepts emerging as mind maps and concept maps. According to Budd (2004), a mind map is a plan in which the main groups radiate from the central image and minor groups are represented as subdivisions of larger divisions. Major topics that are related to the central topic are represented by means of branches flowing from central image (*ibid*). Mind maps help learners to have organised and coherent ideas about the topic under discussion. This encourages learners to think critically as they have to come up with categories (Budd, 2004). Concept maps can be also used in teaching and learning. According to Hwang, Yang and Wang (2013), concept maps are tools that help learners to organise what they have learned during the learning process. This helps in evaluating the cognitive degree of a set of relevant concepts (Hwang, Shi, Chu, 2011) and enables the learners to visualise their knowledge structures (Novak, 2002).

In this study, mind maps and concept maps were used in order to find if the learners can write down and connect the scientific concepts that emerged from the practical activities using easily accessible everyday materials (Asheela, 2017). They were also used in order to encourage the learners to share ideas about the concepts that were learned and discuss how these concepts are related to each other. In the next section I discuss the theoretical framework, which is the lens that was used in this study to analyse my data.

2.8 Theoretical framework

A theoretical framework is an important component of the research that guides the entire process of the research. It is the structure that can hold and support a theory of a research study (Swanson, 2013). The theories are developed to explain, predict and understand phenomena (Abend, 2008). This study is informed by Vygotsky's (1978) socio-cultural theory.

According to Vygotsky (1978), human activities take place in a cultural context and are mediated by language and other symbols. John-Steiner and Mahn (1996) explain that the development of an individual relies on the transmitted experiences of others. This means that learning does not take place in isolation. Stott (2016) adds that cognitive development is the result of collaboration in the construction of knowledge. That is, meaningful learning takes place when people learn through social interactions and with the materials from their cultural background (Mavhunga & Kibirige, 2018; Mavuru & Ramnarain, 2017). Oakley (2004) emphasises that there are three main components of socio-cultural theory, which are culture, language, and the Zone of Proximal Development (ZPD). This study focused on *mediation of learning*, *culture*, *ZPD* and *self-regulation*.

Mediation of learning refers to the use of cultural tools in order to achieve goals and make learning meaningful (Vygotsky, 1978). Tools can be conceptual, material, organizational, as well as language (Martin, 2008). Through mediation a teacher can explain difficult concepts to the learners. In this study, the cultural tools that were used to mediate learning of acids and bases were the materials from the environment of learners as well as language. Learners were given an opportunity to interact with each other and with the materials available. The teacher helped the learners understand the topic of acids and bases with the assistance of materials from the immediate environment as well as with what they know from their cultures.

Culture affects the way the learner learns through interactions with others, as well as through the immediate environment. It plays an important role in the construction of knowledge. Weiten (2008, p. 417) explains that “children acquire most of their culture’s cognitive skills and problem solving through collaborative dialogue with experienced members of their society”. Meaningful learning is culture-bound and develops from social encounters (Erinosho, 2013). Moreover, Lemke (2001) points out that all human activity functions are based on the upbringing, the community where the individual lives, the region and the person’s culture. In social contexts the learners are provided with hints that help in the construction of knowledge.

Furthermore, Korsager (2015) explains that in socially constructed learning the learners take an active part in learning. He further explains scientific knowledge as being socially constructed and learning as a social process of knowledge construction involving both individual and collaborative activities. Hence, cultural settings are one of the factors that determine the development of human mental activity. What is known through culture determines how the learner will grasp the science content in the classroom. Culture and social context can influence the prior knowledge and experiences of the learners. Thus, knowledge is first acquired via the inter-psychological plane (the interactions with people and the immediate environment) and then later via the intra-psychological plane (assimilation and internalising of the knowledge which is acquired) for personal value (McRobbie & Tobin, 1997; Stott, 2016; Turuk, 2008; Vygotsky, 1978).

In light of this, acknowledging learners' prior knowledge and using IK (see Sections 2.5 and 2.6.) may enable them to be immersed in their social practices in the classroom and acquire new knowledge. The acquired knowledge may help them to successfully solve problems as well as being engaged in the practices, norms and discourses of their community, which in turn may lead them to high development of concepts (Billett, 1996). IK can be seen as the cultural knowledge and community where IK is seen to respond to cultural needs of the community in order to understand and solve the problems (Mukwambo, 2012). IK practices can be used to mediate learning of science (Mukwambo et al., 2014) and this can be done by using the cultural resources as teaching and learning aids. Nicodemus (2017) adds that the inclusion of IK in the curriculum helps the learners to appreciate their culture. It may also help their cognitive development in relation to their Zone of Proximal Development (ZPD). ZPD is further elaborated hereunder.

Vygotsky (1978, p. 86) defines the ZPD as "the distance between the actual development level as determined through independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers". Brown, Ash, Rutherford, Nakagawa, Gordon and Camplone (1993) suggest that the active agents in the ZPD can be people - adults or children - with various degrees of expertise. However, they can also include artefacts such as books or videos. The responsibility of the teacher is to aid and guide the learners to successfully learn and internalise new scientific concepts that emerge from their discussions in the classroom and from the practical activities that are carried out in the classroom. The teacher helps to refine the understanding and interpretations of the learners so that the learned knowledge can improve (Schreurs & Dumbraveanu, 2014). In this study, the materials from the environment were used in order to shift the learners' ZPD. However, Stott (2018) prefers to use the Zone of Proximal Learning (ZPL) rather than ZPD, since in her view, it is easier to measure learning than development.

Similarly, using IK may have an impact on the ZPL of the learners as they were using familiar resources. As a result, learners were engaged in discussions in order to understand the concepts emerging and in return this might have shifted their understanding of science concepts. Above all, mediation took place using materials from the environment and with learners helping each other through self-regulation (Harrison & Muthivhi, 2013). This may have increased their level of development through the help of the teacher as well as their peers**.** Schreurs and Dumbraveanu, (2014) explain that self-regulation involves setting learning objectives, self-observation, self-assessment, and self-reinforcement. This theory enabled me to establish how the learners were learning when using materials from their environment and using the materials that they are familiar with from their culture to mediate learning of acids and bases and shift their level of learning.

In relation to theoretical framework and conceptual framework, using cultural material and prior knowledge of the learners to teach acids and bases, may enable learners to make sense of these concepts. This means that prior knowledge mediates learning by using IK in order to make sense and understand the concepts of acids and bases. Prior knowledge can be used as the foundation to increase or shift the ZPL of the learners. The interaction of the learners with their peers might also enable them to make sense of the concepts and may increase their participation. This may help them to be self-independent and learn these concepts with the help of each other through self-regulation as emphasised by Vygotsky (1978).

2.9 Concluding remarks

In this chapter, I discussed literature relevant to my study. Firstly, I discussed the expectations of the NCBE in relation to LCE which emphasises the use of prior knowledge of learners. Secondly, I discussed acids and bases since these concepts are central to this study. I discussed how this topic is taught based on different models and how it causes confusion among learners when these models are used simultaneously. This was followed with a discussion on how practical activities can enhance teaching and learning of science and what are the shortcomings associated with them. Fourthly, I also discussed literature on prior knowledge. Thereafter, I discussed IK, exploring its pros and cons. Finally, I discussed the conceptual and theoretical frameworks as lenses this study.

In the next chapter, I discuss the research design and methodology employed in my study.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

Methodology is the broad approach to scientific inquiry specifying how research questions should be asked and answered (Teddlie & Tashakkori, 2009, p.21).

3.1 Introduction

The main goal of this study was to explore whether or not the inclusion of indigenous knowledge (IK) in the teaching of acids and bases influenced Grade 10 Physical Science learners' conceptions, dispositions and sense-making. In this chapter, I first discuss the research design of this study and its orientation. Secondly, I discuss the research paradigm, case study and research methods used, including a discussion of the research goal and research questions. Thirdly, I explain where the research was conducted, who the participants were and how they were selected. Fourthly, I discuss the tools that were used to collect data which were: questionnaires (pre- and post), tests (pre-test and post-test), observations, journal reflections and the semi-structured interview. Fifthly, I explain how I have analysed my data, starting with the quantitative data and then the qualitative data. Lastly, I discuss the validity and trustworthiness of the data collected as well as the ethical issues that had to be considered during the research process. The chapter ends with some concluding remarks.

3.2 Research Design and Methodology

Research design is the procedure for gathering and exploring data in the manner that aims to combine the research purpose (Kothari, 2004). Bertram and Christiansen (2015) explain that the research design is the plan of how the research should be carried out and how the data collected should be analysed in order to answer the research question(s). It focuses on the evidence that the researcher has collected in answering the research question(s), and how the researcher has collected the data.

The research design is needed in facilitating the research operations in assuring that the research yields maximum information that is needed in answering the research question with minimal expenditure and effort (Kothari, 2004). It constitutes the foundation for the entire research process. Creswell (2014) also explains that research design provides the direction of the procedure to be followed in carrying out the research. It guides how the research question should be asked and answered (Teddlie & Tashakkori, 2009) as is highlighted in the epigraph above. However, it is not a linear procedure (Betram & Christiansen, 2015). The next section discusses the paradigm that underpinned this study.

3.2.1 Research paradigm

This study is underpinned by an interpretive paradigm. According to Cohen, Manion and Morrison (2018), the interpretive paradigm views the social world as an emergent social process which is created by the individuals concerned through experiences. Creswell (2014) explains that an interpretivist believes that individuals seek understanding of the world they live and work in. It is through social interactions that people construct meaning and make sense based on their historical and cultural perspective (Crotty, 1998; Vygotsky, 1978). Creswell (2014) further states that in the interpretive paradigm the research relies on the participants' views of the situation being studied. That is, participants share their experiences in order to understand their values, beliefs and meaning of their social phenomena (Hussain, Elyas & Nasseef, 2013).

Similarly, Mertens (2010) asserts that humans understand the world as it appears to them. Thus, it was hoped that this paradigm would help me to understand how learners view the use of indigenous knowledge (IK) in the classroom and how its inclusion influenced (or not) their conceptions, dispositions and interest toward learning of acids and bases. Put differently, the paradigm afforded me an opportunity to understand the views of learners in terms of the use of IK in the classroom. Learners were also able to share and express their views about materials that come from their environment and how these were used in the classroom to teach this topic (acid and bases). Within the interpretive paradigm, a case study approach was employed.

3.2.2 Case study

This study adopted a case study approach. According to Bertram and Christiansen (2015), a case study is an organised and detailed study of one particular case in its setting. Gay, Mills, and Airasian (2011, p. 444) also define case study as a "qualitative research approach in which researchers focus on a unit of study known as a bounded system". To Creswell (2008), it is a comprehensive investigation of a confined system. It enables the researcher to gain a comprehensive understanding of the phenomenon under scrutiny (Bertram & Christiansen, 2015). I deemed a case study appropriate in this study since it enabled me to explore in detail how learners made sense of acids and bases when IK is integrated in the teaching and learning process. It allowed me to explore in-depth what influence the integration of IK has on teaching of acids and bases and how it influences or does not influence their conceptions, dispositions and sense-making of this topic. Hence, my case in this study is the integration of IK in the lessons to establish whether it influences learners' conceptions, disposition and sense-making in learning acids and bases. My unit of analysis was how Grade 10 Physical Science learners respond to the integration of IK in the lessons. Since both quantitative and qualitative data were collected in this study, a mixed method approach was used.

3.2.3 Research methods

A mixed method approach was used in this study in order to collect both quantitative and qualitative data. Creswell (2008) explains that using both quantitative and qualitative data provides a better understanding of a research problem than when one of the approaches is used on its own. Creswell (2014, p. 4) defines mixed method as “an approach to inquiry involving collecting both quantitative data and qualitative data, integrating the two forms of data and using distinct designs that might involve philosophical assumptions and a theoretical framework”. Christensen, Johnson and Turner (2015) explain that mixed-methods can be concurrent or sequential. The study can employ the quant $\rightarrow$QUAL design (where study is dominated by qualitative data) or QUANT $\rightarrow$qual design (study dominated by quantitative data) (*ibid*).

In this study, data were collected through the explanatory sequential mixed method. According to Creswell (2014), in the explanatory sequential mixed method, quantitative data are collected first and then qualitative data are collected to explain further the numerical data. This study employed the quant $\rightarrow$QUAL design, where the quantitative data are dominated by qualitative data. The next section discusses where the research was carried out, who the participants were and how they were selected.

3.3 Research site, participants and sampling

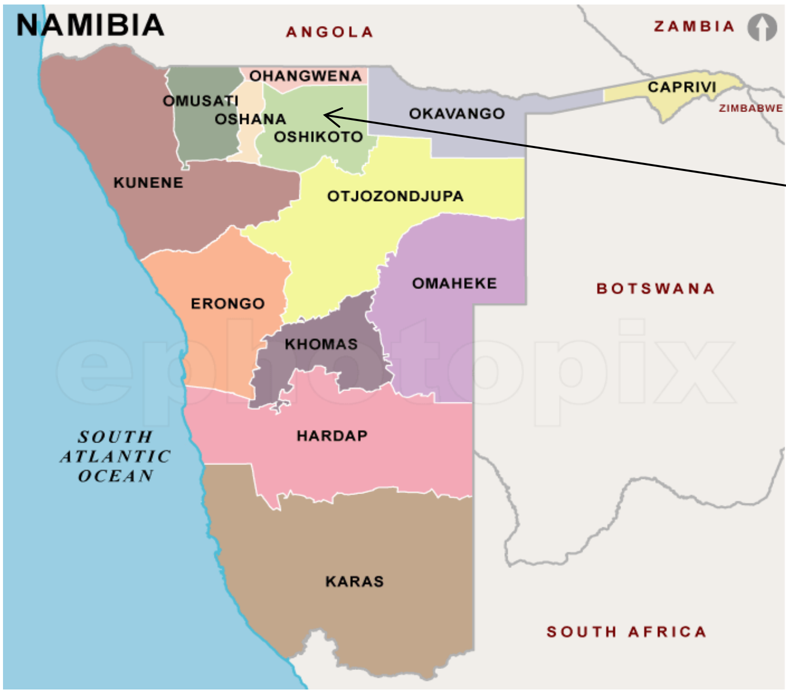
This section provides the information on where the study was carried out, the participants who took part in the study and how they were selected. I also discuss positionality in research as I have conducted the research in my own classroom.

3.3.1 Research site

The study was conducted at Namaela Secocondary School (pseudonym) a rural non-boarding secondary school where I teach, which is situated in the northern part of Namibia in the Oshikoto region. The school has an enrolment of 409 learners in classes from Grades 8 to 12. The school has 20 teachers who speak different languages such as Oshindonga, Oshikwanyama and Subiya. However, the dominant language spoken by both teachers and learners is Oshindonga. The teacher: learner ratio at this school is 1:20. The school receives funds from the government through the Universal Secondary Education (USE). In addition, the school also sources funds through fundraising and other school activities such as during cultural days and

Valentine days. Parents are also encouraged to voluntarily support the school financially. This school does not have laboratory or laboratory materials that can be used to carry out the practical activities during science lessons. As a result, in most cases these learners are not exposed to practical activities due to the lack of these facilities.

The map shows the location of the school in the Namibian map.



The location of Namaela SS in the Oshikoto region

Figure 3.3.1.1: The Namibia Map *(https://www.edu.glogster.com/glog/namibia/2d2bah956ea*

3.3.2 Research participants

The participants were 33 Grade 10B Physical Science learners consisting of 16 boys and 17 girls. At the time of this study, their age ranged from 16 to 21 years old. These learners come from the same Oshindonga tribe and started their schooling at this school from Grade 8.

They were selected as this grade consists of learners who performed poorly from Grade 9 and most of them have been progressed to Grade 10 (even though they did not reach the passing requirements).

3.3.3 Sampling

According to Bertram and Christiansen (2015), sampling is all about selecting the people, setting or behaviour that have to be included in the study. There are different types of sampling, namely, random, purposive, stratified, and convenience sampling (Bertram & Christiansen, 2015). In this study, purposive sampling was used since it focused only on those learners who did not perform well in Grade 9, and who are all placed in Grade 10B. Purposive sampling is about selecting a small unit of the population that can provide sufficient and valuable information that can answer the research question(s) (Teddlie & Tashakkori, 2009). However, positionality can also play a role in the collection of data. The next section explains how the issue of positionality was handled in this study.

3.3.4 Positionality

Since this study was conducted in my own classroom, the issue of positionality may arise. According to Merriam, Johnson-Bailey, Lee, Kee, Ntseane and Muhamad (2001), positionality is determined by where one stands in relation to the others in terms of studying his or her own culture or other's cultures. Positionality, power, and representation play a role in conducting research. Thus, the researcher may be considered as either an insider or an outsider. Mercer (2007) defines an insider as when the researcher shares particular characteristics with the participants such as ethnicity or culture, while the outsider does not share any particular characteristics with the participants.

The issue of positionality (since I am teacher at this school) was addressed by assuring my participants that they should not feel obliged or be forced to participate in the study. First, I explained to them the purpose of the study. Since I had a good communication with my participants through the everyday teaching, there was trust between us. My participants have that freedom to express themselves without being intimidated to do so. I also managed to talk to the parents of the participants during the parent meeting, to which all agreed. They also signed the consent form, which indicates that they have agreed for their children to take part in this study. In addition, Merriam et al. (2001) point out that to be an insider might mean being accused of bias; therefore, during the collection of data a critical friend was also involved. The critical friend observed the lessons; thereafter, we reflected together and discussed so that the data that were collected were objective and this prevented bias.

3.4 Research goal and research questions

The goal of this study was to explore whether or not the inclusion of indigenous knowledge (IK) in the teaching of acids and bases influences Grade 10 Physical Science learners' conceptions, dispositions, interest and sense-making. To achieve this goal, the study was guided by the following research questions:

Research questions

1. What are Grade 10 Physical Sciences learners' conceptions, dispositions and interest towards learning science?
2. What prior knowledge on acids and bases do Grade 10 Physical Science learners have?
3. How does the integration of IK in lessons on acids and bases influence (or not) the conceptions, dispositions, interest of learners toward science learning?
4. How does the integration of IK influence (or not) learners' sense-making of the concepts on acids and bases?

3.5 Data collection techniques

Various tools were employed to collect data in this study, namely, questionnaires (pre- and post-intervention questionnaires), tests (pre-test and post-test), observations (videotaped lessons), learners' journal reflections and semi-structured interviews. I used various data collection techniques for triangulation and hence validation purposes.

3.5.1 Questionnaires

According to Bertram and Christiansen (2015), a questionnaire is a list of questions that have to be answered by the participants. There was a pre- and post-intervention questionnaire. All the Grade 10 B learners answered these questionnaires (see Appendix C1). The reason for using the pre-intervention questionnaire was to have an understanding of how the learners view science in general, their conceptions, interest and attitudes (disposition). On the other hand, the purpose of the post-intervention questionnaire was to understand their views after they had been exposed to the lessons with IK integrated. These questionnaires were given to learners to answer in their own time. The questionnaires were translated into the local language (Oshindonga) for all learners to have an understanding of what was being asked. This questionnaire was adapted from Fraser's (1981) Test of Science- Related Attitudes (TOSRA). It consisted of 50 items, where the learner had to tick the level of agreement for each item as strongly agree, agree, not sure, disagree or strongly disagree. For the pre-intervention all questionnaires were returned. Unfortunately, for the post-intervention questionnaire only 15 were returned. For this reason, only 15 questionnaires were analysed for those who completed both pre- and post-intervention questionnaires.

3.5.2 Test (pre-test and post-test)

According to Mertens (2015), participants are given a pre-test and a post-test (see Appendix D1) to find out what they know about a certain subject. Firstly, the purpose of employing the pre-test in this study was to find out the learners' prior knowledge on acids and bases, as this topic has been taught in the previous grades (baseline data for planning the lessons). Afterwards, when the intervention had been carried out, a post-test was administered to check if the learners had make sense of acids and bases after they had been exposed to the lessons that integrated IK. The test consisted of two sections, A and B. Section A comprised of five multiple choice questions, each worth one mark, and Section B consisting of structured questions worth a total of 25 marks. For validation purposes, the questions were moderated by a science teacher (expert) from neighbouring school. The purpose for giving this test to the expert teacher was to check if the questions were up to standard. The questions were also piloted with the Grade 9 learners who are repeating in order to find out their prior knowledge and to see if they were able to answer these questions. These Grade 9 repeaters were in the same position as these Grade 10 learners as they had all been taught this topic the previous year. The piloting helped me to change some questions.

All Grade 10B Physical Science learners wrote the pre-test. After the test the learners were then taught the lessons on acids and bases in which IK was integrated. A total of three lessons with the duration of 2 hours 30 minutes were taught. The lessons were co-developed with my critical friend who also observed my lessons since it is impossible to observe your own practice. After each lesson, there was a session of reflection and feedback with my critical friend in order to discuss how the lesson went and how to improve in the next lesson. After the theme (acids and bases) in the syllabus was completed, the post-test was then administered. Both marks for pre-test and post-test were recorded so that they could be analysed. All learners wrote both tests and their answer scripts were marked. Thus, the marks for all these learners were analysed using mean, standard deviation and paired *t*-test. According to Cohen et al. (2018), paired *t*-test is used to determine the significant difference between the means of data measured.

3.5.3 Observation (videotaped lessons)

Maree (2010) defines observation as a systematic process of recording the behaviours of the participants without interacting or questioning them. According to Bertram and Christiansen (2015), observation entails the researcher going to the research site in order to collect first-hand information from the participants. This involves collecting the information as events are happening in the actual setting. In this study, observations enabled me to observe the behaviours of the learners as they were interacting with the materials that they had brought from their homes. It also gave me an opportunity to note their dispositions toward these materials. I taught the class after planning the model lessons with a critical friend (science teacher), who observed the lessons and then we reflected thereafter. A total of three lessons were observed and learners completed worksheets (see Appendix E1). The role of the critical friend in the study was to assist in the reflective inquiry (Kember, Ha, Lam, Lee, Ng, Yan & Yum, 1997).

All these lessons were videotaped by my critical friend so that we could later watch them together. The following aspects were observed in the lessons: the expressions of the learners as they were carrying out the hands-on practical activities using IK, as well as their participation in the practical activities. Observation gave me an opportunity to see how the learners were engaged in the activities and how they were working with their peers (Vygotsky, 1978). It also gave me an overview of how the learners were interacting with each other (sharing of ideas). During the lessons the learners completed the worksheet and answered questions based on what they were experimenting. For instance, all the materials brought from home were tested and learners wrote down the nature of each material, that is, acidic, alkaline or neutral. During these lessons the learners were tasked to create mind maps and concept maps as explained in Section 2.6.4. It is through observation that I was able to note the attitudes of learners and their willingness to use IK as it was one of the indicators described in Section 2.6.3.

Before the lessons were carried out, the learners were asked to bring the materials from their homes. However, these lessons were not carried out on the planned days as learners failed to bring the materials. Only a few brought the materials. In order to ensure that all learners brought materials from their homes, these materials were collected for three days.

All lessons were successful. However, they required more time: even though I had planned to teach for one hour, all lessons took almost two hours and 30 minutes to conclude them. The advantage though was that these lessons were conducted in the afternoon. Learners were participating as well as taking turns in testing the materials. During the testing, some substances did not give the corresponding colours as indicated in the textbook. For example, toothpaste is regarded as a weak alkali which has the colour of blue; however, it turned purple when the universal indicator was added. From this experiment, the learners were able to distinguish between acids and base in terms of colour change. This means that, when doing practical experiments, you might find a different result which is not the same as with what is stated in the textbook. Learners were also given opportunity to express themselves by reflecting after the lessons.

3.5.4 Journal reflections

McMillan and Schumacher (2014) explain that journals are a personal account of the learning experienced. It gives an opportunity to learners to express themselves regarding the lessons. In this study, learners were thus required to keep journals in order to reflect on their personal views of how the lessons went, and what experiences they encountered from those lessons. Learners were given a guide on what to reflect (see Appendix F1).

All learners' journals were read and analysed in order to give me a picture of how they viewed IK and how it enhanced or constrained their learning of acids and bases. This provided me with an opportunity to understand learners' personal views, their dispositions and their reflections of the lessons carried out. Additionally, the journals enabled me to determine the conceptions, interest and attitudes (dispositions) of learners toward the use of IK in the classroom through their reflections as to whether or not they valued the use of IK in the teaching of this topic. For the familiarisation, the learners were encouraged to write the journals before the research process. It was in this stage that I noticed that not all learners had reflected and some explained to me that they experience difficulty in expressing themselves in English. For them to express themselves I allowed them to write in their mother tongue (Oshindonga). After the teaching of these three lessons all learners had written reflections.

3.5.5 Semi-structured interviews

Maree (2011) points out that a semi-structured interview requires a participant to answer a set of pre-determined questions and allows for clarification of answers through follow-up questions from the interviewee. This is the conversation between the researcher and the respondent (Bertram & Christiansen, 2015) (see Appendix G1). In this study, I used semi-structured interviews to interview three learners (based on the results of the tests: below average, average and above average). The reason for using the semi-structured interviews was to give me an opportunity to probe for more information and have a deep engagement with the learners. In addition, semi-structured interviews provide freedom for the use of follow-up questions where necessary (Thomas, 2013) as well as for triangulation for the data collected from reflective journals.

To Ary et al. (2010), triangulation seeks to examine the convergence of evidence from different sources that study the same phenomenon. For validity, interview questions were piloted with the fellow Masters' students. It was a one-on-one interview in order to give an opportunity for these learners to express themselves individually. Initially, only three learners were to be interviewed, however, another learner volunteered to be interviewed too. The longest interview lasted for 15 minutes. The interview sessions were audio recorded so that they could be transcribed.

Table 3.5.3.1: Shows a summary of data-gathering techniques

Stages	Techniques	Purpose
1.	Questionnaires (a) Pre intervention questionnaire Learners complete the questionnaires before the intervention.	To provide the general views of learners about science and the methods used to teach science.
	(b) Post- intervention questionnaire Learners complete the questionnaire after the intervention.	To provide the general view about science after being exposed to lessons where IK was incorporated.
2.	Testing (a) Pre-test Wrote by learners before the intervention.	To determine the prior knowledge of learners about acids and bases.
	(b) Post-test Wrote by learners after the intervention.	To determine if the learners had make sense of acids and bases after they had been exposed to IK.
3.	Observations Done by me (researcher) and my critical friend.	To determine if the use of IK in the class had impacted on the disposition of the learners toward the topic acid and bases.
4.	Reflective journals Wrote by learners after each lesson	To allow the learners to express themselves about the use of IK in the lesson.
5.	. Interviews Between me and the learners	To understand the conception of learners about IK that is used in the lesson to teach acids and bases.

3.6 Data management

Data collected from these tools will be stored for a minimum of five years in a lockable cupboard and on external hard drives (for example, data that were collected from the observations and interviews). In addition, extra copies of data collected will be kept for backup reasons.

3.7 Data analysis

After collecting data, the next step is to analyse data. According to Bertram and Christiansen (2015), data analysis is a process of reducing data collected in order to organise it so that it is understandable and makes sense. The sections below discuss how data from the quantitative and qualitative research were analysed.

3.7.1 Quantitative data analysis

This section explains how quantitative data were analysed.

3.7.1.1 Pre-and post-intervention questionnaires

The questionnaires were analysed by checking the learners' conceptions, interest and attitude (disposition) toward science in general. The questionnaires were analysed by dividing 50 items into categories (conceptions, interest, and attitudes). Based on the items that could be found in the questionnaire, the rubric was designed so that learners' responses are placed in groups such as low, moderate or high. The averages of learners' responses are calculated in order to determine in which group (low, moderate or high) each learner should be placed, for both pre- and post- questionnaire. The responses for learners were converted to percentages so that they can be presented on the bar graph and then be analysed (see table 4.2.1.3 & table 4.2.1.4).

3.7.1.2 Pre-and post-tests

The learners' pre-test and post-test results were analysed through the descriptive statistics, inferential statistics and *t*-test. Descriptive statistics summarise the data in simple numerical expression (Gall, Gall, Borg & Walter, 1999). Firstly, the mean (central measurement), the sum of all scores divided by the number of scores is calculated, and then secondly the standard deviation (measure of variability) is calculated. The standard deviation is calculated to determine the spread distribution of scores from the mean (Connolly, 2007). The larger the standard deviation the wider the distribution is spread. I used the descriptive statistics because the learners' test marks were averaged and presented on the graphs in order for these marks to be summarised. The inferential statistics are "used to make inferences or predictions about the similarity of a sample to the population from which the sample is drawn" (McMillan &

Schumacher, 2014:142). In inferential statistics, *t*- test was used to establish the significant difference of data collected.

3.7.2 Qualitative data analysis

Qualitative data were analysed using some constructs from Vygotsky's (1978) sociocultural theory and the conceptual framework. Data were analysed inductively and deductively to come up with themes. Bertram and Christiansen (2015) explain that inductive analysis is whereby the researcher works from specific observations (data collected) to generalisations by identifying the themes or categories that emerge from data collected. Furthermore, Bertram and Christiansen (2015) explain that deductive analysis is whereby the researcher works from generalisations that arise from data to specifics. This means that the data were analysed thematically. The audio recorded during interviews were transcribed verbatim so that information was not lost (see Appendix I1). Transcription is a process of converting the audio recording or field notes into text data (Creswell, 2008). The learners' journal were collated and colour coded to identify themes (see Appendix H1)

Merriam (2009) explains that qualitative data can be analysed by placing it into themes and categories. In this study, the data were reduced using the thematic network by Attride-Stirling (2001) so that it could be placed into categories and themes (see Figure 3.7.2.1). The textual data were first coded in order to identify the patterns. According to Creswell (2008), coding is all about making sense out of the textual data. The coded data are collapsed into the broad theme (*ibid*). The basic themes (themes that are derived from textual data) and organising themes (organises the basic themes into similar issue) were formulated to derive the global themes (themes that conclude or summarise the whole idea which is supported by the data). The data were then analysed using the theoretical and conceptual framework. By using my theoretical framework, I was able to see how the IK has influenced teaching and learning of acids and bases. I was able to note the interaction (engagement) of the learners among themselves when they were using the materials from their environments (willingness).

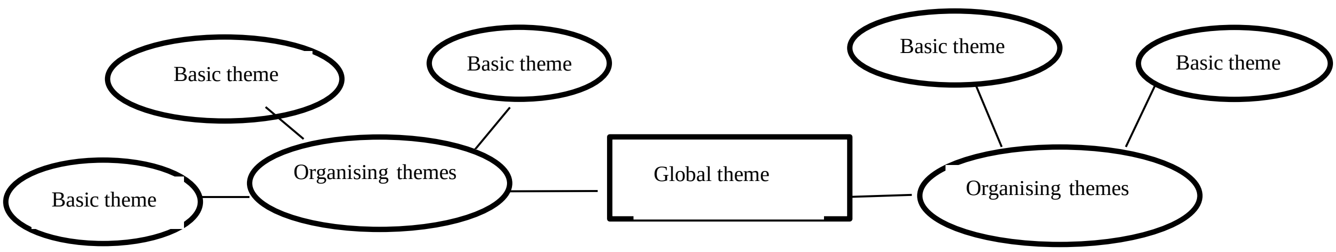


Figure 3.7.2.1: The structure of a thematic network (Adopted from: Attride-Stirling, 2001, p.388)

3.8 Validity and trustworthiness

Validity is how we know that the data we collect is believable, accurate and appropriate. The data collection instruments were piloted beforehand to ensure their validity. According to Bertram and Christiansen (2015), piloting refers to the testing of instruments before they are used. The reason is to check if they will give the results that they are intended to give. It provides an ample chance to make changes to the questions that are to be asked so that the participants answer the research questions. The interview schedule was validated by interviewing my fellow Master's students and later I discussed the results with our supervisors. Different data collection instruments were employed such as observations, interviews and reflections and this validated the data through triangulation. Teddlie and Tashakkori (2009, p. 27) define triangulation as "the combinations and comparisons of multiple data sources, data collection and analysis procedures, research methods, investigators and inferences that occur at the end of the study". The interview sessions were recorded and then transcribed verbatim.

3.9 Ethical considerations

Ethics is an important aspect of research. It has to do with the behaviour that is considered right or wrong (Bertram & Christiansen, 2015). This is crucial since it involves humans. Before the resuming of the data collection process, the ethical clearance certificate was obtained from Rhodes University, Department of Education (see Appendix A1). The permission letters were also obtained from the Director of Education and the school principal (see Appendix B1). Since this research involved learners who are regarded as minors, the letters of consent were obtained from the parents and guardian of these learners (see Appendix B2). Throughout the research process, the following ethical issues were taken into consideration:

Respect and dignity

Before the beginning of the research all procedures were explained. The participants were informed about their voluntary participation in the study and that they had the right to withdraw from being part of the study at any time. The identity of participants was treated with a high degree of anonymity and confidentiality.

Transparency and honesty

A letter of consent was obtained from the parents that explain the aims of the research. Permission to carry out the study was requested from the school principal and the Director of Education and their responses were positive. The participants were informed about the videotaping of lessons and audio recording of the interviews and these video/audio records are kept confidential and in a safe place.

Accountability and responsibility

I had to assure my participants that the information they provided would be treated as confidential. I did not misuse my position as a teacher in this study for my personal gain and any conflict of interest was disclosed. All the codes of ethics were observed during the entire research process.

Integrity, academic professionalism and researcher positionality

This study is my own work, using my own words and, where I have drawn from other people's work, I have referenced it according to the Department of Education's protocols. There are no fabrications, manipulations and misreporting of data.

3.10 Concluding remarks

In this chapter, I discussed the research design and methodology. I started with the research design. I explained the paradigm used in this study as well as the research method which was mixed method. I also discussed the research site, participants, the sampling and positionality. The research goal and questions were also highlighted. I described the methods used to collect data and how data sets were analysed. The validity and trustworthiness were also explained. Lastly, ethical issues considered in this study were also discussed.

In the next chapter, I present the analysis and discussion of the quantitative data obtained from the pre- and post- intervention questionnaire and from pre- and post-test.

CHAPTER 4: PRESENTATION, ANALYSIS AND DISCUSSION: QUANTITATIVE DATA AND REFLECTIONS

If students find science content that they learn relevant to their daily life and to the society in which they operate, there is a good chance that they will develop a positive attitude toward the subject (Hofstein & Mamlok-Naaman, 2011, p.93).

4.1 Introduction

The aim of this study was to explore whether or not the integration of indigenous knowledge (IK) in the teaching of acids and bases influenced Grade 10 Physical Science learners' conceptions, dispositions, interest and sense-making. In the previous chapter, I presented the research design and methodology informing this study. In this chapter, I thus present, analyse and discuss the quantitative data that were derived from pre-and post-intervention questionnaires as well as from pre-and post-tests. The chapter ends with some concluding remarks.

These quantitative data were analysed using frequency tables and graphs in order to answer my research questions one and two.

- What are Grade 10 Physical Sciences learners' conceptions, dispositions and interest towards learning science?
- What prior knowledge on acids and bases do Grade 10 Physical Science learners have?

4.2 Analysis of quantitative data

In this section, I present, analyse and discuss the quantitative data obtained from pre-and post-intervention questionnaires as well as from pre-and post-tests. I now start with the pre-and post-intervention questionnaires. The excerpts from learners' journal reflection were also interwoven.

4.2.1 Presentation, analysis and discussion of pre-and post-intervention questionnaires

Although there were a total of 33 learners in the class, these quantitative data were analysed based only on the 15 learners who completed both pre- and post-intervention questionnaires. Data sets were analysed using frequency tables and percentages. The learners' responses derived from the frequency tables are shown on the bar charts. Furthermore, their responses were analysed based on the following categories: conceptions, interest and attitudes (dispositions) which emerged from my conceptual framework (see Section 2.7). These categories were used to measure the conceptions, dispositions and interest of learners towards science (Agunbiade, 2015).

Table 4.2.1.1: Shows the items in each category

Category	Items
Conceptions	1,2,17,21,23,24,25,26,29,30,31,40,42,43,44,45,
Interest	5,7,8,13,14,27,32,37,38,39,41,47,49,50
Attitude	3,4,6,9,10,11,12,13,15,16,18,19,20,22,28,33,34,35,36,46,48

Table 4.2.1.1 shows how the 50 items from the questionnaires were divided among the three identified categories.

I started by designing a rubric based on the items that can be found in the questionnaire, to analyse the quantitative data from the questionnaires. The learners' responses were then placed in levels such as low, moderate or high for each category as shown in Table 4.2.1.2.

Table 4.2.1.2: Shows the rubric used to place learners in groups

Category	Low (1)	Moderate (2)	High (3)
Conceptions	Learner does not see the relevance of learning science	Learner views science as important try to learn it	Learner is able to establish the relevance of learning science
Interest	Learner is not interested in learning science concepts	Learner tries to take part in science activities even though they do not really understand them	Learner enjoys science activities and tries to understand science concepts.
Attitude	Learner gives up easily when the content is difficult	Learner tries to seek help when the content is difficult	Learner does not give up and tries to find a solution to a given problem.

Table 4.2.1.3 below shows the summarised results (average) for each learner in these categories for both pre- and post- questionnaire.

Table 4.2.1.3: Shows the summary of results

Learner	Conceptions		Interest		Attitude	
Questionnaire	Pre-	Post-	Pre-	Post-	Pre-	Post-
L1	1	3	1	2	2	2
L2	2	2	2	2	2	2
L3	2	3	2	3	1	3
L4	1	2	1	2	2	2
L5	2	3	2	3	2	3
L6	1	2	1	3	2	3
L7	2	2	2	3	1	2
L8	2	3	1	3	2	3
L9	3	3	3	3	2	2
L10	2	3	1	3	3	3
L11	2	2	2	3	2	2
L12	3	3	2	3	3	3
L13	2	2	2	2	1	2
L14	2	3	3	3	3	3
L15	2	2	2	3	2	2

Table 4.2.1.3 indicates how the learners' conceptions, attitude and interest shifted after the intervention. These results are further converted into percentage for clear comparisons in the graphs below. The table below shows the percentage of learners for each category.

Table 4.2.1.4 shows the percentage of learners' responses in each category. That is, it indicates the percentage of learners before and after the intervention.

Table 4.2.1.4: Shows the percentage of categories per group

Category	**Low (%)**		**Moderate (%)**		**High (%)**	
	Pre-	Post-	Pre-	Post-	Pre-	Post
Conceptions	20	0	67	47	13	53
Interest	33	0	53	33	13	67
Attitude	20	0	60	53	20	47

The following bar graphs show the results of each category for pre-and post- intervention and I started with the learners' conceptions.

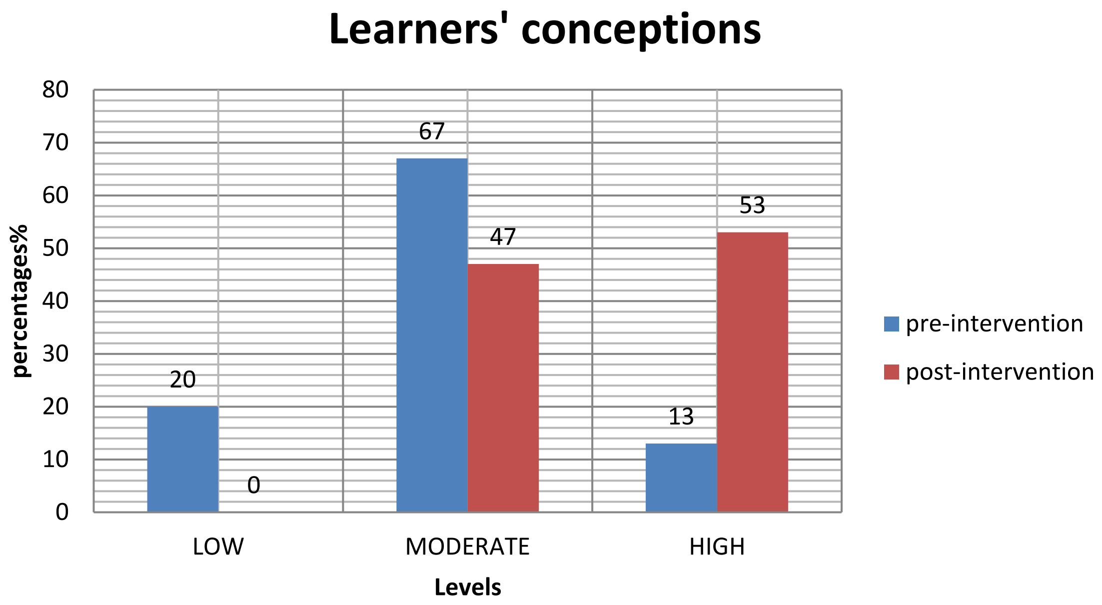


Figure 4.2.1.1: Shows learners' conceptions towards science

Figure 4.2.1.1 shows that before the intervention, 3 out of 15 learners (20%) had low conceptions, 10 learners (67%) had moderate conceptions and 2 learners (13%) had high conceptions towards science. After the intervention there were no learners who had low conception. 7 out of 15 learners (47%) had moderate conception and 8 out of 15 learners (53%) had high conception toward science.

This suggests that after the intervention some of the learners who were having low conceptions towards science shifted to moderate or high conceptions as shown in Table 4.2.1.3 and 4.2.1.4 above. This is also evident in Figure 4.2.1.1, where there are no learners (0%) with low conceptions after the intervention. In addition, the number of learners who have high conception increases after the intervention. Further evidence appeared in the learners' reflections. For instance, one learner reflected that "*……when we are teach using the materials this topic become the easiest chapter than in other terms"* (L14JM).

Dart et al. (2000) explain that learners' conceptions of learning are related to their approaches to learning and to the quality of their educational outcome. For this reason, it could be surmised that some learners used the integration of IK in the lesson as their starting point to learn science (Simasiku et al., 2017). It also indicated that the views that learners had toward science has shifted positively as it is shown in Figure 4.2.1.1. Since conceptions are the views of the learners about science, it can also have an effect on their interest toward science. Thus, in the next graph I present learners' interest in science before and after the intervention.

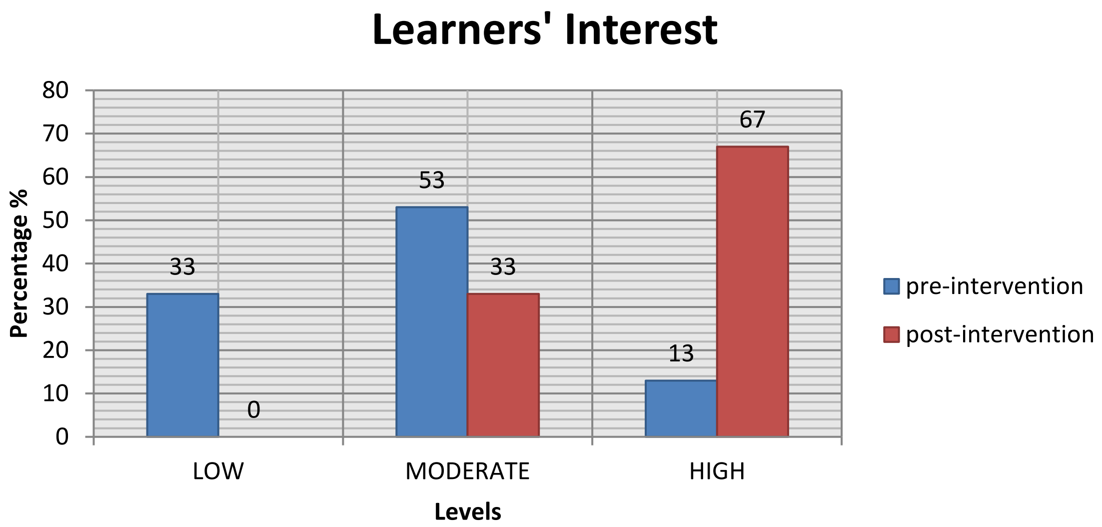


Figure 4.2.1.2: Shows learners' interest in science

In Figure 4.2.1.2, before the intervention 5 out of 15 learners (33%) had low interest in science, eight learners (53%) had moderate interest and two learners (13%) had high interest in science. After the intervention there were no learners who had low interest in science, there were five learners (33%) who had moderate interest in science and 10 learners (67%) who had high interest in science. This shows that after the intervention the interest of learners in science had increased. The data in Figure 4.2.1.2 concur with the learners' reflections. For example, some learners reflected that:

> *"...the use of local materials have an influence on my learning of science especially acids and bases because it inspire me to like science and ....."*(L23JF).
>
> *"It was an eye catching lesson because we did a lot in science lesson"* (L19JF).

It could be interpreted that, the use of everyday materials to do hands-on practical activities aroused the learners'' interest in this study Wellington (1998) reiterates that practical activities enable learners to generate interest and enthusiasm towards science. Concurring, Agunbiade et al. (2017) emphasised that, application of concepts in everyday situations has a positive effect on the learners' interest. Hofstein and Mamlok-Naaman (2011) suggest that there is a relationship between the relevance, attitude and interest toward the subject learned. In other words, if the learners could establish that connection they are likely to develop a positive attitude toward science as it is explained in the epigraph above (Hofstein & Mamlok-Naaman, 2011). Bybee and McCrae (2011) advocate that learners' interest in science depends on how they perceive the relevance of science to their lives and immediate environment.

Lastly, I present the graph on learners' attitudes.

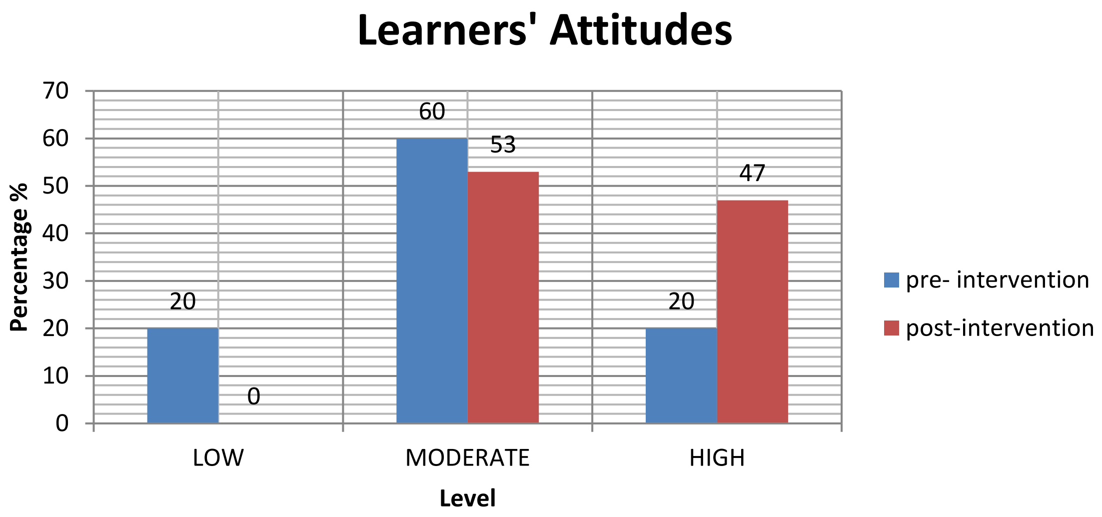


Figure 4.2.1.3: Shows learners' attitudes towards science

From Figure 4.2.1.3, before the intervention, 3 out of 15 learners (20%) had low attitude towards science, and this decreased to 0% after the intervention. Those who had moderate attitude towards science before the intervention were nine learners which is (60%). This number decreased to eight learners (53%) after the intervention. Learners who had high attitude toward science were only three which is (20%) of the total number of learners. After the intervention, however, the number increased to seven learners which are (47%) of the total number of learners. This shows that after the intervention the attitude of learners towards science shifted positively. For instance, one learner reflected that:

> *"it have a strong influence on my learning of science especially acids and bases because if we were not showed how the acids and bases are being tested we could not know it and it could be hard for us to get it"* (L25JF).

This shows that after the intervention learners' were able to see how these materials are being tested. This make learning easy as it could be difficult if they were not shown. This finding resonates with Lynos's (2006) study that integrating experimental activities enables the development of positive attitudes toward science. Thus, Raved and Assaraf (2011), explain that attitude towards science is subjected to the social interactions (Vygotsky, 1978) between learners and teachers, the relevance of the topic taught as well as the range of teaching approaches. For this reason, Dart et al. (2000), posit that learning is all about developing learning and understanding. Moreover, learners' attitudes influence their willingness to be engaged in science related issues as suggested by Bybee and McCrae (2011). Having discussed these categories, in the next section, I will discuss the summary of these results.

4.2.2 Summary of results from the pre- and post-intervention questionnaires

Based on the data obtained, after the intervention, all these categories (conceptions, interest and attitude) showed a positive shift. In the post-intervention questionnaire, the learners who showed interest had the highest percentage of 67% followed by conceptions with 53% and lastly the attitude with 47%. It could be inferred that the use of everyday materials may had influence on conceptions of the learners and Richardson (2011) reported that the conceptions of learners are influenced by the use of learning strategies.

This study also reported similar findings to those of Agunbiade (2015) on the nature of the learners' attitudes. In addition, Agunbiade et al. (2017) explained that enabling learners to be engaged in hands-on practical activities and other variety of science activities influences their interest and enjoyment. Hence, before the intervention there were five learners who had low interest. However after the intervention there were no learners with low interest in science as shown in Figure 4.2.1.2. It could be deduced that learners were more interested in the lesson when IK was integrated as they might have seen the link between science and their surroundings (Agunbiade et al., 2017). It is for these reasons that, drawing on the seminal work of Vygotsky (1978), Mavuru and Ramnarain (2017) emphasize the importance of taking into consideration learners' socio-cultural contexts. These scholars believe that context based teaching enhances the interest of the learners and I concur.

In the next section, I present, analyse and discuss the data obtained from the pre- and post-test.

4.3 Presentation, analysis and discussion of data from pre-and post-test

I administered the pre-test before the classroom intervention using easily accessible materials. The purpose of the pre-test was to establish learners' prior knowledge about acids and bases. Elicitation of prior knowledge enable teachers to understand what learners already know and where the learners are in terms of the topic to be learned (Moore & Van Rooyen, 2002; Okanlawon, 2012; Roschelle, 1995). Concurring, Graven and Schafer (2013) posit that it is important to know what learners already know as they acquire new knowledge by relating to what they already know. Thereafter, the post-test was administered after the intervention in order to find out if learners could make sense of the concepts on acids and bases or not. Unlike the pre-and post-intervention questionnaires, all the marks for the 33 learners who wrote the tests were analysed. Learners are coded as learner 1-learner 33 (L1-L33) throughout the analysis. Learners' marks were converted to percentage and results are presented in Table 4.3.1 below.

Table 4.3.1: Shows results of the pre-test, post-test and the shifts in the tests

Learner	**Pre-test**	**Post-test**	**Shift**
Learner 1 (L1)	10	17	+7
Learner 2 (L2)	23	50	+27
Learner 3 (L3)	20	57	+37
Learner 4 (L4)	27	33	+6
Learner 5 (L5)	20	30	+10
Learner 6 (L6)	67	93	+26
Learner 7 (L7)	30	43	+13
Learner 8 (L8)	30	43	+13
Learner 9 (L9)	40	57	+17
Learner 10 (L10)	20	53	+33
Learner 11 (L11)	17	37	+20
Learner 12 (L12)	33	37	+4
Learner 13 (L13)	30	50	+20
Learner 14 (L14)	17	40	+23
Learner 15 (L15)	17	43	+26
Learner 16 (L16)	10	27	+17
Learner 17 (L17)	37	37	0
Learner 18 (L18)	27	27	0
Learner 19 (L19)	37	27	-10
Learner 20 (L20)	50	50	0
Learner 21 (L21)	27	33	+6
Learner 22 (L22)	30	53	+23
Learner 23 (L23)	27	60	+33
Learner 24 (L24)	40	37	-3

Learner 25 (L25)	23	40	+17
Learner 26 (L26)	47	50	+3
Learner 27 (L27)	43	33	-10
Learner 28 (L28)	27	17	-10
Learner 29 (L29)	30	37	+7
Learner 30 (L30)	40	57	+17
Learner 31 (L31)	47	70	+23
Learner 32 (L32)	30	27	-3
Learner 33 (L33)	43	20	-23
Total	**1016**	**1385**	**+369**

The results from Table 4.3.1 above show that 24 learners performed better in the post-test compared to the pre-test. Even though the overall shift has shown a score of 369, there were however six learners who performed worse in the post-test than the pre-test and three learners did not show any shift in their performance. According to Helliar and Harrison (2011), not all learners learn from hands-on practical activities. In addition, Millar (2004) points out that some learners might not know the reason why they are carrying out the practical activities. This might be the case with these learners who scored lower marks in the post-test in this study. From the pre-test results, it is evident that learners have prior knowledge of the topic acid and bases.

The learners' marks were further presented in intervals based on the marks that they had obtained. The pass requirement for Physical Science in Namibia is that learners are expected to obtain 40% or above. These percentage intervals are as shown in Figure 4.3.1 below.

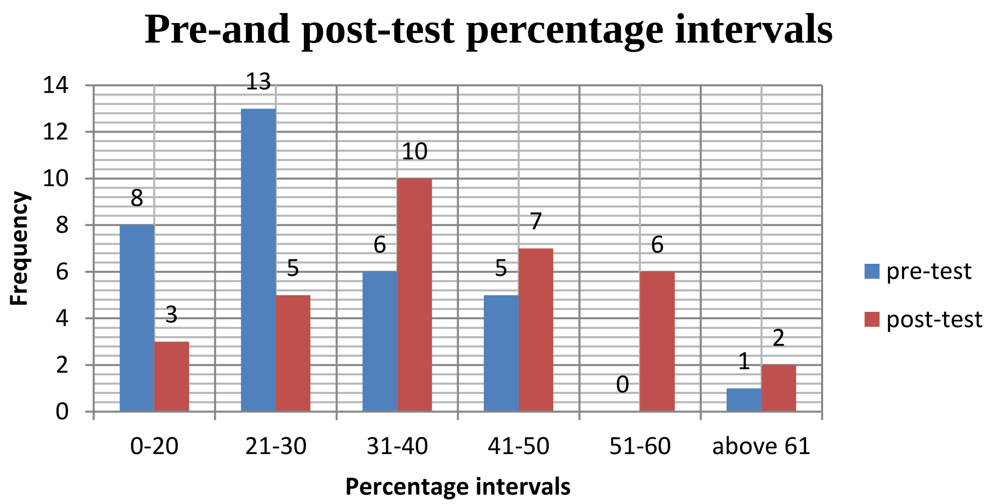


Figure 4.3.1: Shows percentage intervals for pre-and post-tests

As stated earlier, 33 learners wrote the pre-and post-test. Figure 4 shows that in the pre-test 27 learners (82%) scored less than 40% whereas only six learners (18%) scored above 40%. However, in the post-test 18 learners (55%) scored less than 40% and 15 learners (45%) scored above 40%. This suggests that after the intervention the performance of the learners had increased. As a result, the number of learners who scored below 40% decreased from 27 learners to 18 learners (82% to 55%) while for those who scored above 40% increased from six learners to 15 learners (18% to 45%). From these results, it could be inferred that the intervention had an influence on the learners' performance.

The average percentages of marks were also calculated. Figure 4.3.2 below shows the average scores of the learners in the pre-test and post-test.

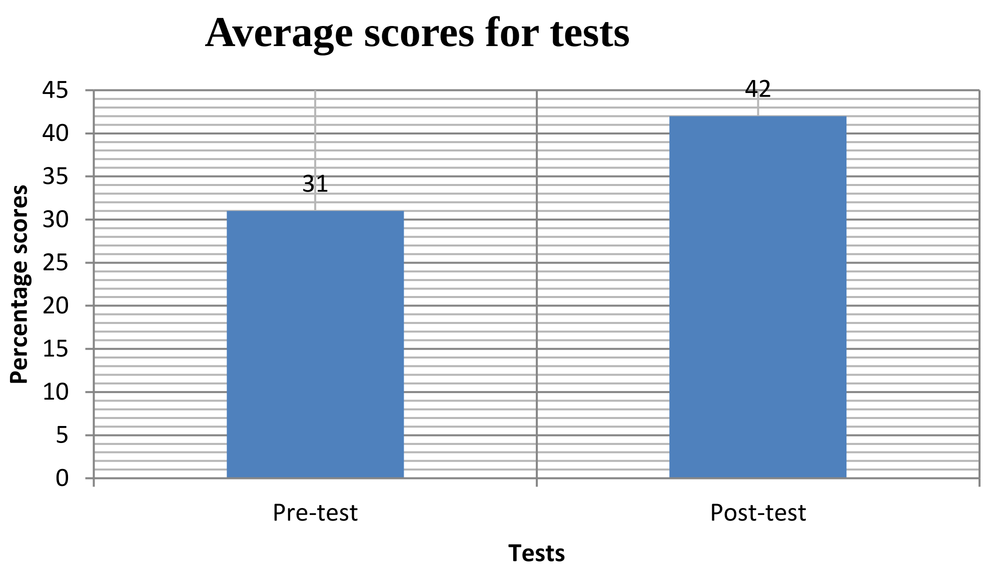


Figure 4.3.2: Shows average percentage scores for the pre-and post-tests

The results in Figure 4.3.2 indicate that the average performance of learners in the pre-test was 31% while in the post-test it was 42%. This shows that the performance of the learners have increased due to the intervention that was carried out.

Learners' results were also analysed based on the types of questions that were asked such as the examples (E), indicators (I), theory (T) and reactions (R). Table 4 below shows how many learners correctly answered these questions, that is, multiple choice (MC) and structured questions (SQ).

Table 4.3.2: Shows the analysis of each question in the pre- and post-test (N represents number of learners)

Question	Item and code	Pre-test (N=33)	Post-test (N=33)
MC1	Examples (E)	20	20
MC2	Examples (E)	14	21
MC3	Indicators (I)	6	20
MC4	Theory (T)	12	12
MC5	Indicators (I)	4	4
SQ1a	Indicators (I)	17	23
SQ1b	Examples (E)	21	28
SQ1c	Theory (T)	1	5
SQ1d	Theory (T)	16	16

SQ1e	Theory (T)	1	4
SQ2a	Indicators (I)	5	18
SQ2b	Theory (T)	5	9
SQ2c	Theory (T)	27	29
SQ2d	Examples (E)	23	22
SQ2e	Theory (T)	5	8
SQ3ai	Reactions (R)	14	21
SQ3aii	Indicators (I)	8	4
SQ3aiii	Theory (T)	4	19
SQ3b	Theory (T)	4	4
SQ4a	Examples (E)	10	10
SQ4b	Reactions (R)	16	23

4.3.1 Examples of acids and bases

In the tests (Appendix D1), there were five questions that required learners to identify examples of acids and bases. There were two (2) questions from multiple choice (MC1, MC2) and three questions from structured questions (SQ1b, SQ2d, SQ4a).

MC1: the results showed that 20 learners (61%) from both pre-test and post-test knew an example of an acids that is commonly found in household materials.

MC2: the results indicated that only 14 learners (42%) in pre-test knew that sodium hydroxide is an example of alkalis compare to 21 learners (64%) in the post-test.

SQ1b: the results showed that 21 learners (64%) in pre-test knew the examples of acids in everyday life and after the intervention the performance has increased to 85% in the post-test.

SQ2d: the results indicated that 23 learners (70%) in pre-test knew the examples of bases in everyday life however after the intervention only 22 learners (67%) were able to write down examples of bases in everyday life.

SQ4a: a total of 10 learners (30%) in both pre- and post-test were able to identify the name of the acid that is used to react with copper.

From the analysis above, the results indicated that learners were more familiar with acids that can be found at home than bases.

4.3.2 Indicators

There were five questions that tested the effects of acids and bases on the indicators, using both litmus paper and universal indicator. There were two questions from multiple choice (MC3, MC5) and three questions from the structured questions (SQ1a, SQ2a, and SQ3aii).

MC3: the results indicated that six learners (18%) in pre-test knew the effect of acids on litmus paper and after the intervention the number of learners increased to 20 (61%).

MC5: this question tested the learners’ ability to identify the colour change of water, vinegar and toothpaste when universal indicator is added. Only four learners (12%) in both pre-test and post-test were able to give the correct answer.

SQ1a: from the results 17 learners (52%) in pre-test knew the effects of acids and bases on litmus paper and after the intervention 23learners (70%) were able to write the effect of acids and bases on litmus paper.

SQ2a: the results indicated that only five learners (15%) in the pre-test knew the effects of lemon juice on litmus paper compare to 18 learners (55%) in the post-test.

SQ3aii: the results showed that only eight learners (24%) knew the effects of universal indicator when added to magnesium chloride but this decreased to four learners (12%).

From the analysis above, it indicated that learners had some prior knowledge about the effects of acids and bases on litmus paper and this was also strengthened after the intervention. However, learners were not able to identify the effect of acids and bases on universal indicator. This might be due to the fact that universal indicator can undergo many colour changes unlike litmus paper which only changes to either red or blue. With universal indicator the colour changed based on the strength of the substance. For instance strong acids tend to change red on the universal indicator while the weak acids change to orange or yellow.

4.3.3 Theory

This test comprised of nine questions that test theory. These questions required learners to identify or differentiate whether the substances were acids or bases based on the information provided. There was one multiple choice (MC4) question and eight structured questions (SQ1c, SQ1d, SQ1e, SQ2b, SQ2c, SQ2e, SQ3aiii, SQ3b).

MC4: for this question only 12 learners (36%) in both pre-test and post-test were able to identify that if the substance has the pH 11 is regarded as the strong base.

SQ1c: the results showed that only one learner (3%) in pre-test knew the pH range of weak alkalis which was increased to five learners (15%) in post-test.

SQ1d: the total number 16 learners (48%) in both pre-test and post-test were able to answer correctly the pH of the neutral substance.

SQ1e: the results showed that only one learner (3%) in pre-test was able to differentiate between acids and bases in terms of their pH values and the number of learners has increased to four (12%) in the post test.

SQ2b: the results indicated that five learners (15%) in pre-test were able to predict if lemon is a weak or strong acid while in the post-test there were nine learners (27%) who answered correctly.

SQ2c: results from the pre-test indicated that 27 learners (82%) were able to suggest the possible medicine that can be used to neutralise the acid and in the post-test 29 learners (88%) answered correctly.

SQ2e: the results indicated that only five learners (15%) in pre-test knew what soluble bases are called and there were 8 learners (24%) in post-test who answered correctly.

SQ3aiii: only four learners (12%) in pre-test knew the testing of water and this number of learners was increased to 19 learners (58%) in post-test.

SQ3b: from the results four learners (12%) in both pre-and post-test knew the application of neutralisation in everyday life.

Of all the questions that tested the theory about acids and bases, only the question that asked the use of *“antacid”* to neutralise acid (SQ2c) was correctly answered by many learners. This is echoed by Oloruntegbe and Ikpe (2011), who explain that in order to effectively educate the learners, teachers need to build on what they already know from their everyday lives. However, in most of the questions that tested theory, only a few learners were able to give the correct answers. This shows that the learners had less prior knowledge on these types of questions that tested theory and the intervention had less influence on their performance.

4.3.4 Reactions

There were two structured questions that tested the reactions of acids and bases (SQ3ai and SQ4b).

SQ3ai: the result indicated that 14 learners (42%) in pre-test were able to identify the type of reaction between hydrochloric acid and magnesium oxide and the performance has increased to 21 learners (64%) in a post-test.

SQ4b: the result shows that 16 learners (48%) in the pre-test were able to complete the chemical equation and balance it and it has increased to 23 learners (70%) in post-test.

From the analysis above it shows that learners have prior knowledge about the reactions of acids and this was also strengthened by the intervention.

In order to identify the trend in these types of questions; examples, indicators, theory and reactions the averages are calculated and presented in Figure 4.3.3.

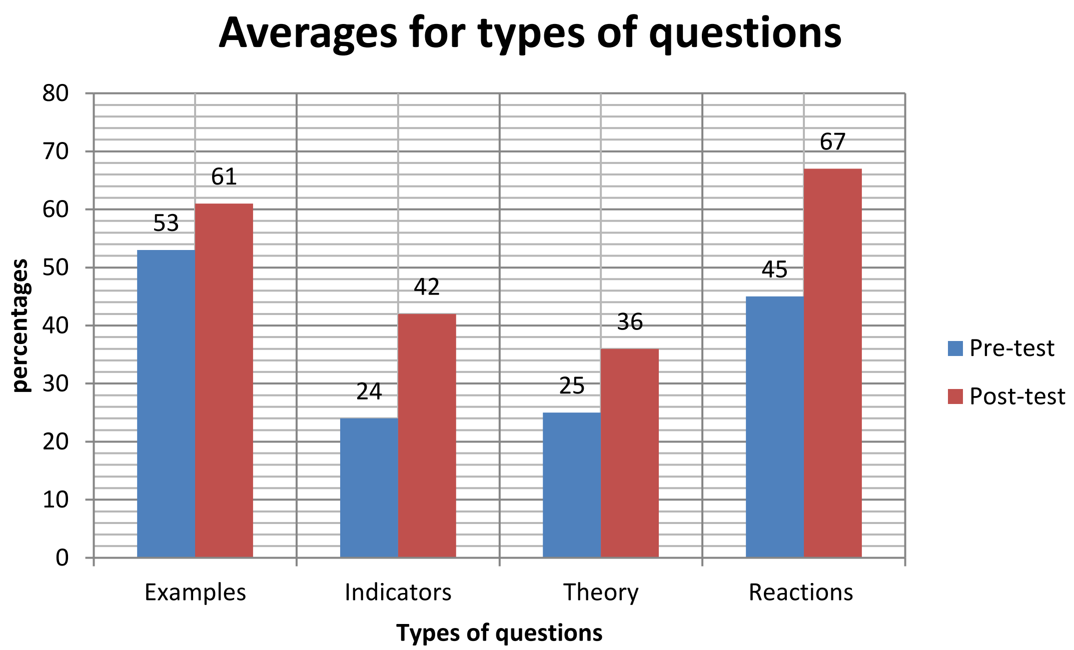


Figure 4.3.4. 1: Shows averages for each type of question

Figure 4.3.4.1 shows that learners obtained higher averages in the post-test compared to the pre-test in all types of questions that were asked. It could be argued that after the intervention learners were able to make sense of this topic. Additionally, Stears et al. (2003) argued that, using the materials that are familiar to the learners enabled them to make sense of the concept being taught.

These learners showed fairly good results in the questions that tested the examples and reactions of acids and bases. However, it can be seen that learners were still struggling to grasp the content of questions that tested indicators and theory.

In calculations involving statistics, it is important to determine the standard deviation of the results (Creswell, 2008). This is used to determine the distribution of the marks from the mean (Cohen, Manion & Morrison, 2018). For instance, the average of the learners in the pre-test is 31% and the post-test is 42%. However, the average does not show how the marks of the learners are distributed. For this reason, standard deviation is calculated to show the distribution of the marks obtained by learners as shown in table 4.3.4.1.

Table 4.3.4.1: Shows mean and standard deviation of the results

Tests	**Mean ($\bar{x}$)**[1]	**Sample Standard deviation (STDEV.S)**[2]
Pre-test	31	12.27
Post-test	42	15.85

Table 4.3.4.1 above shows that there was an improvement in the results since in the pre-test the average was 31%, whereas in the post-test it increased to 42%. It could be surmised that the integration of indigenous knowledge (IK) in the lesson might have an influence on the learners' performance. Hence, Mavuru and Ramnarain (2017) explain that, IK makes science to be localised and contextualised so that the learners are able to make sense of the content to be learned.

Before the integration of IK, the sample standard deviation for the pre-test was 12.27 and after the intervention the sample standard deviation increased to 15.85. This suggests that in the pre-test the marks of the learners were closer to the mean. In contrast, after the intervention the marks were more widely distributed. Connolly (2007) explains that the larger the standard deviation the wider the distribution is spread.

[1] The sum of percentages divided by the total number learners

[2] SD= $\sqrt{\frac{\sum(X-\bar{x})^2}{(n-1)}}$

To determine the mean difference between the content knowledge of pre-test and post-test a paired *t*-test was run on these 33 learners. The results are shown in table 4.3.4.2.

Table 4.3.4.2: Shows mean difference in pre-test and post-test

Variable	mean	std. error	std. deviation	t	df	sig (2 tailed)
Pre-test	30.78	2.14	12.27	-4.49	32	.05
Post-test	41.96	2.76	15.85			
Difference	-11.18	2.49	14.28			

Table 4.3.4.2 shows the results of the *t*-test. To determine the mean difference between the content knowledge of a pre-test and post-test, a paired t-test was administered to the results of 33 learners. The result shows that after the intervention the learners obtained on average high marks of 41.96 % (42%) compared to 30.79% (31%) before the intervention. The mean difference in pre-test and post-test was -11.18 with a standard error (std. error) of 2.49. Statistical significance was conducted with a t value (critical value) equal to -4.4984. It was obtained from 32 degree of freedom (df). The significance of the t value was tested under the null hypothesis of no difference in means (H_0: mean (diff) = 0) versus the alternative hypothesis that there is a difference in the means of two sets (H_a: mean (diff) $\neq$ 0). The significance level of the test was 0.05 used in a two tailed test. Thus it can be concluded that there was sufficient evidence to suggest that there was a significant difference in performance of learners in two tests. Hence the intervention was effective.

In the next section, I summarised the results of the pre- and post-test.

4.3.5 Summary of results from the pre-test and post-test

Before the intervention on integrating IK in the topic of acids and bases, the learners obtained low scores in all types of questions. The questions that were correctly answered that assessed the examples of acids and bases were the highest with 53% followed by types of reactions of acids and bases with 45%, theory followed with 25% and lastly was the indicators with 24%. These findings corroborate with Okanlawon (2012), who argues that before learners are engaged in formal instructions they already have information that they brought from home. For this reason, Simasiku et al., (2017) suggest that the inclusion of IK in the lesson serves as the starting point of learning science concepts. As a result, in this study many learners were able to identify the examples of acids and bases, since some of them can be found in their homes.

Notably, after the intervention the learners' marks increased. For instance, the results for questions assessing examples of acids and bases increased to 61%, types of reactions increased to 67%, theory 36% and indicators 42%. In addition, the average of the leaners has also increased from 31% to 42%. This shows that the intervention had an influence on the learners. In the same vein, the standard deviation showed that before the intervention the marks were closer to the mean and it became widely spread after the intervention as it is evident in the larger standard deviation as well as the results of the *t*-test.

4.4 Concluding Remarks

In this chapter, I presented, analysed and discussed quantitative data from pre-and post-intervention questionnaires as well as from pre-and post-tests. It also revealed that the intervention had a positive influence on the conceptions, interests and attitudes (dispositions) of learners towards science. This influence made the majority of learners to have a positive disposition towards science as shown in Figures 4.2.1.1, 4.2.1.2, and 4.2.1.3. From the test administered, the data revealed that learners had some prior knowledge about acids and bases. After the intervention the performance of the learners in this topic increased.

In the next chapter, I present, analyse and discuss data from classroom observation, journal reflections and semi-structured interviews.

CHAPTER 5: QUALITATIVE DATA PRESENTATION, ANALYSIS AND DISCUSSION

Good quality practical work can engage students, help them to develop important skills, help them to understand the process of scientific investigation, and develop their understanding of concepts (Woodley, 2009, p.49).

5.1 Introduction

In the preceding chapter I presented, analysed and discussed quantitative data from pre-and post-intervention questionnaires as well as from the pre-and post-test. These were based on establishing learners' conceptions and dispositions towards learning of science and learners' prior knowledge in acids and bases respectively. The data obtained from the questionnaires and tests helped me in planning and implementing the intervention on the integration of indigenous knowledge (IK) in the lessons.

In this chapter, I thus present, analyse and discuss the data obtained from observations, reflection journals and interviews. In my discussions of data, I interwove the literature presented in Chapter 2 as well supporting statements from the participants.

The following research questions were addressed:

- How does the integration of IK in lessons on acids and bases influence (or not) the conceptions, dispositions and interest of learners toward science learning?
- How does the integration of IK influence (or not) learners' sense-making of the concepts on acids and bases?

5.2 Analysis of qualitative data

Data from observation of lessons about the hands-on practical activities using the easily accessible materials (Asheela, 2017) were analysed. As discussed in Section 3.5, in addition to observations, seven learners' journals were analysed as well as transcripts from four learners' interviews. The learners' journals were coded as, for example, L5JM for learner 5 who is a male and L18JF for learner 18 who is a female and so forth. The semi-structured interviews were coded as, for instance L3SSIM, Learner 3 for the learners who is male or L27SSIF for learner 27 who is a female and so on.

The selection of learners for the interviews was based on the performance of the learners in the pre-and post-test. There were a total of four learners who were interviewed. Learners who were interviewed were; one learner who performed better than all other learners (highest performer), one learner who did not show any shift between the pre-and post-test (same marks in pre-and post-test), and two whose performance decreased in the post-test compared to pre-test (performed worse in post-test than pre-test). These different gathering techniques were used to gather data so that they could complement each other as well as for triangulation purposes (see Section 3.5).

Firstly, all the qualitative data (from observations, journals and interviews) were colour coded, in order to identify sub-themes (see Appendices C and D). After identifying similarities from the observations, journals and interviews, the descriptions of marked texts from the participants' responses and sub-themes were constructed and presented in Table 5.2.1 below.

Table 5.2.1: Shows the descriptions of marked texts, sub-themes and their sources

Description of marked texts	Sub-themes	Data sources
Learning with understanding	Construction of knowledge	Journal, interviews
Building on existing knowledge	Learners' prior knowledge	Observation, interview
Linking science to everyday life	Integration of prior experiences with school science.	Observation, Interview, Journal
Testing hypothesis	Sense making using familiar materials	Journal, interview
Active learning and learners participation Facilitation of learning through experiments	Social interactions Testing of materials Complete the worksheet Discussion of answers	Observation, Journal
Disposition of learners toward science.	Attitudes toward the everyday materials	Observation, Journal, interview

Thereafter, I combined the common sub-themes resulting in the following main themes:

1. Learners' views and experiences toward learning of science;
2. Participation in learning through social interactions;
3. Construction of knowledge using easily accessible and laboratory resources; and
4. Connection between the school science and the everyday life experiences.

The above mentioned themes are presented in table 5.2.2 with the supporting theory and literature.

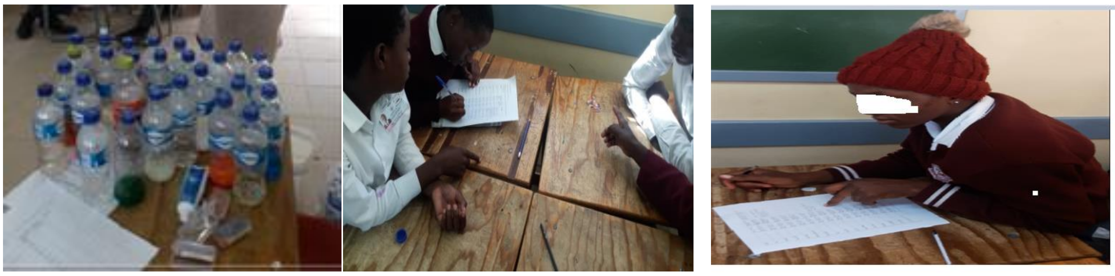
Table 5.2.2: Shows themes and supporting theory/literature

Themes	**Conceptual, Theoretical framework and Literature**
Views and experiences of learners on learning of science • Conceptions, disposition and interest towards learning science through experiments	Attalah, Bryant and Dada (2010), Welch (2010)
Participation of learners through social interactions • Learners' engagement; • Testing of materials for acids and bases; and • Completion of worksheets.	Vygotsky (1978), John-Steiner and Mahn (2008), Sedlacek and Sedova (2017), Erinosho (2013)
Construction of knowledge using the easily accessible and laboratory resources • Conceptual understanding through practical activities; • Facilitation of learning through experiments; and • Testing of hypothesis.	Sheldrake, Mujtaba and Reiss (2017), Millar (2004) Jokiranta (2014), Mandikonza (2006), Asheela (2017)
Connection between the school science and the everyday experiences • Integration of learners' prior knowledge; • Learning with understanding • Links to real life; and • Use of familiar objects for sense making.	Vygotsky (1978), Roschelle (1995), Kuhlane (2011), Mukwambo, Ngcoza and Chikunda (2014), Oloruntegbe and Ikpe (2011) Mavhunga and Kibirige (2018), Aikenhead and Jegede (1999)

Below I gave an overview of the three lessons that were conducted. Thereafter, in sections 5.2.2, 5.2.3, 5.2.4 and 5.2.5, I explain in detail the themes identified in Table 5.2.2.

5.2.1 An overview of the lessons

During the intervention, a series of hands-on practical activities as proposed by Maselwa and Ngcoza (2003) and Asheela (2017) were planned. During those interventions, learners had to complete worksheets as they were doing their observations. For all three lessons, learners were working in groups of four and they had to complete the worksheets in their groups. In the first lesson, the learners had to complete worksheets (see Appendix E1 (a)) by writing the colour change of the litmus paper as they dipped into different liquids. They had to observe how the red and blue litmus paper changed its colours. The learners tested the materials that they brought from their home as shown in figure 5.2.1.1 below.



Some of the everyday materials tested

Learners completing a worksheet

A learner discussing what was observed during the lesson

Figure 5.2.1.1 : Shows learners completing the worksheets

In lesson two, learners made the observations and wrote if the liquid (materials that were brought from their homes) should be regarded as a strong acid or base, weak acid or base or neutral (see Appendix E1 (b)). This was done by looking at the colour changes of the universal indicator against a pH scale. The learners also wrote their observations made on the production of the gas when Zinc reacted with Hydrochloric acid. They also described the testing of this gas produced as well as writing the word equations of these reactions.

One of the liquids tested

Reaction of Zinc with HCl

Testing of H_2 gas

Figure 5.2.1.2: Shows some of the experiments carried out

In lesson three, the learners had to write the names of the reactants. Moreover, they had to write the colour changes of the products when added to universal indicator (see Appendix E1 (c)). The aim of the investigation was to identify the type of reaction between acids and bases as well as the nature of the products produced during these reactions.

The learners also made an observation of the heating of copper sulfate which can be used to test for the presence of water. The learners made observations of the colour of the copper sulphate before and after heating. They also had to make observations when pure water is added to the copper sulphate after it is heated. They were also asked to describe the testing of water based on the experiment carried out.

In the final experiment, leaners had to make observations on the three ways of producing carbon dioxide. For instance, carbon dioxide was produced by reacting calcium carbonate ($CaCO_3$) with hydrochloric acid (HCl), by using a fizzy drink (Coke) as well as using the exhaled air from one of the learners. These experiments were intended to enable the learners to see that in everyday life we have activities that can be used to test for carbon dioxide. For instance, the carbon dioxide from fizzy drinks and exhaled air, are found in our everyday lives. Thus Le Grange (2007) and Nyika (2017) pointed out that use of IK in the classroom consolidate the connection between learners' everyday experiences and school science. They also described the testing of carbon dioxide produced through different ways as shown in Figure 5.2.1.3 below.

Reacting $CaCO_3$ with HCl

CO_2 from fizzy drink

CO_2 from the exhaled air

Figure 5.2.1.3: Shows the production of carbon dioxide in three different ways

In figure 5.2.1.3 above, the learners were exposed to different ways of the producing carbon dioxide. According to Millar (2004), practical activities enable learners to be confidently participate in the activities. This also exposes learners to concrete materials and affords them an opportunity to make their own observations (SCORE, 2009a). To this end, Sheldrake et al. (2017) argued that practical activities enable learners to reflect on the observed nature of science rather than being taught theoretically. In addition, integrating IK in the lessons consolidates the connection between the learners' everyday life and scientific world (Nyika, 2017; Shizha, 2007). Since I have provided an overview of the lessons that were carried out, I now discuss each of these themes below.

5.2.2 Learners' views and experiences toward learning of science

Observations were made as explained about an overview of the lesson in Section 5.2.1. The indicators for conceptions and dispositions suggested by Attalah et al. (2010) were observed during the intervention (see Sections 2.7.1 and 2.7.2 respectively). These indicators are in relation to the ability of learners to learn acids and bases when IK is integrated in the lesson, the attitude toward the materials used, willingness to use these materials and the value they had for these materials.

Additional to the observation, most learners reflected in their journal reflections that they enjoyed using easily accessible materials in learning science. From the learners' journals it seems that the use of easily accessible materials influenced their dispositions towards science. They indicated that they enjoyed the lessons which could be interpreted that they appreciated the integration of IK in the lessons. Some learners stated that:

> *"I enjoyed a lot in this lesson, because I was happy when we was testing our local products on the litmus paper"* (L18JF).
>
> *"I don't enjoy very very that lesson because when we start that I was not understand what is going to be done. I was knowing that we just wasting time now I know it's very important to be know that what is an acid and base"* (L5JM).

The excerpts above indicate that the use easily accessible materials positively influenced conceptions and dispositions of these learners. The enjoyment of science is the positive view that shows that there was a positive disposition in the learners (Agunbiade, 2015). For this reason, Sheldrake et al. (2017) reiterate that in order to foster the attitudes of the learners teachers need to apply different teaching and learning approach that inspire and engage the learners. Agunbiade (2015) asserts that, lack of positive feelings and enthusiasm may lead to decrease in engagement and participation in the subject. Corroborating with this is Katz (1993) who argued that in the process of selecting curriculum and teaching activities, the focus should be on strengthening the desired dispositions and weakening the undesired dispositions. To this end, Hofstein and Mamlok-Naaman (2011) explained that, learners' attitudes toward science depend on their participation in the learning process.

Another learner explained that:

> *"Oolesson dhino odhali oombwaanawa shaashoka omuntu otwali ta tu longitha iinima yaza momagumbo getu. Sha hala okutya momagumbo getu namo omuna ee acid nee base dhoo taningi o lesson dhikale tai hokitha" (Translation: "all lessons were good because we were using the materials that come from our houses. This means that in our houses there are also acids and bases and this makes the lesson to be interesting"* (L24SSIM).

In support of the attitudes of learners, Attalah et al. (2010) pointed out that use of real life experiences promotes the interest and confidence in the learners. Hence, nurturing positive disposition in learners towards science could be another way to improve science achievement

(Agunbiade, 2015). This could be done by connecting real life situations with classrooms experiences.

Despite carrying out this intervention there was also some dissatisfaction. Some learners complained that the time was short and the lesson needed to be longer. Some said that they need more materials that can be tested. For instance, they commented that:

> *"I did not enjoy the lesson because we was not having lot of products to test them. I did not also enjoy because the lesson was very short"* (L18JF).
>
> *"I did not enjoy having not to taste anything, one thing that I don't like. I also did not enjoy having only blue litmus paper changing in most cases even if I liked it"* (L25JF).

These excerpts show that learners enjoyed the lesson thus they wanted them to be longer. This shows a positive disposition toward the lessons that were carried out as is supported by Sheldrake et al., (2017). In this case study, materials used and the activities that were carried out inspired and motivated the learners so that they can be actively engaged. To this end, Papanastasiou and Papanastasiou (2002) add that attitude can be shaped by teaching and school climate.

5.2.3 Participation in learning through social interactions

Learners participated and felt valued when they were allowed to use these materials. As a result, some learners commented that

> *"Otwa mono ompito yokwiilonga kuyakwetu shoo tatwiilongo mogroup shoo tatu nyola omayamukulo getu moombapila". (Translation: "we got an opportunity to learn from each other in the group when we were completing our worksheets)"* (L24SSIM).
>
> *"I was enjoyed the lesson because I was there everyone in 10B was available to asky the question about the lesson. I was enjoyed because I was taken part on this lesson I was free to tolk. They was free to touch litmus paper to see what is materials are bases or acid"* (L6JF).

From the excerpt above it could be deduced that learners enjoyed working with their peers in completing the worksheets. This is also proposed by Vygotsky (1978), that knowledge is constructed through social interactions. Korasger (2015) also adds that knowledge can be constructed through individual and collaborative activities. Throughout these hands-on activities, learners actively participated and manipulated the materials. Sedlacek and Sedova (2017) assert that learners' participation in the classroom is a one of the determinants for quality of teaching and learning process. In addition, Nikodemus (2017) emphasises that inclusion of IK in the lessons enhances the learners' engagement, participation and sense- making of the concepts. The participation of learners was high when learners were testing different materials that they had brought from their homes and they were given an opportunity to test and identify the materials as acids or bases as it is presented in Section 5.2.1.

Figure 5.2.3. 1: Shows learners discussing in a group

As it can be seen in Figure 5.2.3.1, learners were discussing in their groups something which afforded them an opportunity to learn from each other as it is suggested by Vygotsky (1978). It also enabled them to take responsibility for their learning based on what they had observed and drew conclusions on. It is through these discussions that learners were able to share ideas so that they could complete their worksheet in their respective groups. This is akin to Vygotsky's (1978) concept of self-regulation. Harrison and Muthivi (2013) explain that through self-regulation learners can learn from each other and help one another. It also allows for the thoughtful progress as it provides an opportunity for learners to learn and take responsibility for their own learning. Additionally, this helps them to make their own observations and to help one another. Since these learners were working in groups they were also able to come up with the scientific concepts in the form of mind maps and concept maps as shown in Figure 5.2.3.2.

Mind maps enable learners to organise their ideas that they have learned during the teaching and learning process (Hwang, et al., 2013). These mind maps and concept maps were written after the intervention using the local materials by writing down the scientific concepts that emerged.

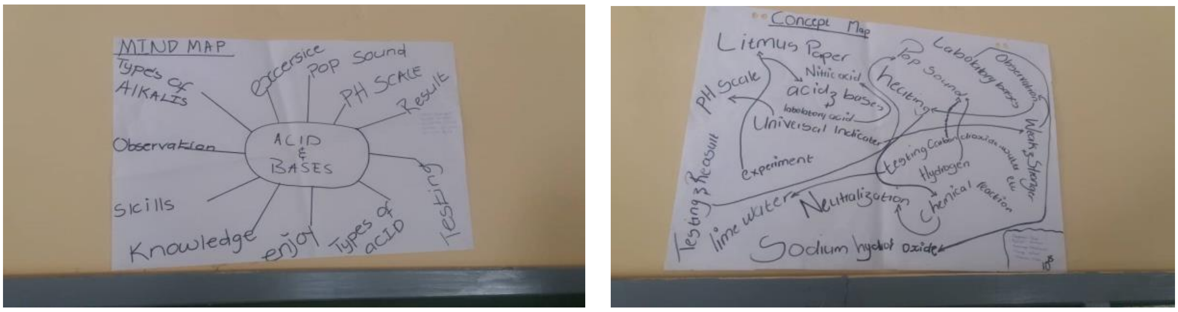


Figure 5.2.3. 2: Shows an example of a mind map and a concept map

Figure 5.2.3.2 shows an example of a mind map and a concept map that were written by learners after the intervention. This suggests that after the intervention the learners were able to come up with the scientific concepts and most importantly how those concepts were related to each other. This shows that learners were able to think critically in order to come up with these concepts (Budd, 2004). It could be argued that this intervention has helped the learners to have a conceptual understanding of the concepts that are being used in this topic on acids and bases. The use of easily accessible materials enhances the conceptual development of learners as advocated by Asheela (2017).

5.2.4 Construction of knowledge using easily accessible and laboratory resources

The purpose of the intervention was to ascertain learners' conceptions, disposition and interest toward learning of acids and bases when using everyday materials as explained above in section 5.2.2. From the observation above, learners were expected to discuss their answers, so that they could share ideas. According to Asheela (2017), hands-on practical activities improve the learners' understanding and promote their conceptual understanding by visualising the laws and theories of science. That is, learners are able to make sense of the concepts when they are actively involved (Millar, 2004).

Learners were required to make some observations so that they could draw some conclusions. According to Millar (2004), when learners are carrying out practical activities they develop the scientific inquiry skills which enable them to acquire scientific concepts. To this, SCORE (2009b) reports that carrying out practical activities makes the situation real.

From the observations made from all the three lessons conducted, there were noticeable participations among the learners, including their interest and engagement during the hands-on practical activities. These observations resonate well with the study carried out by Jokiranta (2014), SCORE (2009a) and Woodley (2009) who postulate that practical activities help the learners to develop important skills, scientific investigation and conceptual understanding as highlighted in the epigraph above. There was also social interaction and discussions among the learners in their respective groups, which is in line with the proposal by Vygotsky (1978) that learning occurs during social interactions.

Learners indicated that the use of everyday materials enabled them to make sense of science concepts. As a result, they were able to follow the laboratory procedures. Similarly to Asheela's (2017) study, the use of easily accessible resources in this study enabled learners to differentiate between the materials that were used as strong or weak acid or base. To triangulate the results from the observations, learners were given opportunity to express themselves through journal reflections and interviews as discussed in the following excerpts. For instance, one learner said that:

> *"That was the best way to make sure that we do not forget. But if only we could have just made the experiments without any testing done after that we could have forgotten by now as this lesson was a bit containing too much of the difficult things but now that we have done some activities it is difficult for us to easily forget that is why my learning for acids and bases becomed easy"* (L25JF).

From the statement above, it indicated that, with the use of hands-on practical activities, learners are easily able to recall what was done in the class. It make this topic to be easy, hence the learning will only be easy if they have an understanding of what is being taught. This study also revealed results similar to those of the study carried out by Asheela (2017) that indicated that the use of easily accessible materials enables learners to have conceptual understanding of the topic taught. Some learners commented that:

> *Ohandi uvuko nawa ngele taku longithwa ee experiment" (Translation: "I understand better when I carry the experiments")* (L24SSIM).

> *"Aantu otundji ohatu tseyele ala moo experiment" (Translation: "Many people learn well through the experiments")* (L3SSIM).

From these excerpts, learners explained that including science experiments helped them to learn better. It also helped them to prove what they had learnt. For this reason, Uushona (2013) also supports the view that integrating hands-on practical activities in teaching and learning helps the learners to develop an understanding of abstract concepts. Additionally, learners expressed that it helped them to test their hypothesis.

> *"ondali ala ndi yishi shoo tatu longwa ndee konima shoo ndeimono ngaye mwene opo nee nda proving kutya oshili. (Translation"I only know that about what we were taught, but after seeing it my self is when I prove it that it is true")* (L27SSIF).

> *"Ondali ala handi yi uvu nale o acid no base ndee shoo twa ningi o experiment opo nee nda mono o effect yawo". (Translation: I only heard about the effect of acids and bases but after carrying out the experiment myself I now know the effects)* (L6SSIF).

From the learners' explanation, it can be interpreted that the hands-on practical activities enabled them to make observations and enhance their understanding rather than when they are being taught in abstract. Jokirata (2014) explains that learners are able to enhance their understanding through practical activities. This also enable learners to be exposed to both theory and practice (*ibid*). It is also advocated by Sheldrake et al. (2017), that practical activities reflect the observed nature of science since learners are exposed to concrete evidence. This idea concurs with that of Mandikonza (2006), who affirmed that learners need to have both conceptual and procedural understanding.

Even though these hands-on activities were not carried out in a laboratory but in the classroom, one learner stated that:

> *Ondi ilongamo kutya ngaashi ngele to longele molaboratory ouna oku kala twii yutha komilandu opo kuumone oshiponga". (Translation: "I learn how to follow the procedures and rules in the laboratory and how to test the materials)* (L27SSIF).

It is advocated by SCORE (2009b) that carrying out the practical activities afford the learners an opportunity to be able to apply this in the laboratory procedures. It exposes the learners to the procedures that have to be followed when they are in the laboratory. In addition, it helped in facilitating learning through hands-on activities. Learners pointed out that learning was better when they are exposed to science experiments. It also helped them to be exposed to laboratory experiments when there were no chemicals that could be used to carry out the science experiments. One learner stated that:

> *"ota vulu okuilonga tatu ningi e experiment atu longitha iinima yomomidhingoloko dhetu uuna twaana iinima mbyo yomolaboratory." (Translation: We can learn science through experiments using materials from our environment when there are no laboratory materials")* (L27SSIF).

This suggests that even though there were not many laboratory materials, learners were able to identify the scientific concepts that emerged from the experiments.

5.2.5 Connection between the school science and the everyday life experiences

Learners were enthusiastic to learn science using the materials that they use in their everyday lives. For instance, the learners pointed out that the use of everyday materials changed their way of learning. They enjoyed being involved doing the activities, for instance, when they were testing the materials that they brought from their homes as explained in Section 5.2.1. They further explained that the inclusion of materials from their local environment changed how they learn science for they were able to understand what they were doing. For example, one learner commented that

> *"I think it will be possible for learners to remember it in a test or in activities when asked it can also contribute to the knowledge of a learner"* (L23JF).

Other learners pointed out that:

> *"It is possible to recall in the examination in the test and in activities".* (L17JM)

> *"Ngele twa longwa okwali hatu dhimbwa mbala but paife ita tu dhimbwa wee nuupu" (Translation: previously once we were taught we can forget easily, but now we will not forget easily)* (L6SSIF).

The statements above indicate that the use of hands-on practical activities might help the learners to store the learnt concept for a long time. These findings are similar to Millar's (2004) study in which he found out that knowledge learned during practical activities is usually stored in the long-term memory of the learners. In addition, learners were also able to make connections between their everyday experiences and what they learned in the classroom. Kuhlane (2011) reiterates that relating learning to learners' everyday knowledge allows learners to learn scientific concepts in a comfortable and non-threatening environment.

Roschelle (1995) explains that learning mostly starts from prior knowledge and then learners learn from the presented materials. Teaching should start with the thoughts that are familiar to the learners (*ibid*). This is in the same vein that most of the materials that were used during these hands-on activities were those that can be found from the learners' immediate environments. In this way, they were able to link learning of science to their real lives.

> *"I learn that our local material we have acids and base".* (L5JM)

> *"I did not know that in our environment there are acids and bases. Sometimes we use these materials and we do not know if they are acids or bases"* (L19JM)

From the excerpts above, it could be argued that learners were not aware that they could find acids and bases from their environment which could be used to teach these topics. Thus, bringing the materials in the classroom that these learners were familiar with enabled them to learn scientific concepts. This is also supported by Kasanda et al. (2005) who contend that using everyday context supports LCE as learners are manipulating materials that they know from home.

Learners further explained that using these materials helped them to remember science concepts that can be assessed in the examination. For this reason, Mukwambo et al. (2014) emphasise that teachers need to use local materials and africanise the content so that science can be relevant to learners. Aikenhead and Jegede (1999) argue that using materials that are familiar to the learners contextualises science so that learners do not feel the foreignness of science. This also helps the learners to move between their everyday life and school science (border crossing) and to manage the conflicts that might arise between these two worlds (*ibid*). Some learners commented that:

> *"We use the materials that we know well from our environment than using the materials in the laboratory that we do not know"* (L25JF).
>
> *"Omuntu oho dhimbulukwa nande oto shange ekonakono oto dhimbulukwa shi ushi lela to vulu okushi totomona. Iinima mbii kaatushi ohatui dhimbwa mbala". (Translation: "You remember well even in the examination you can able to explain well because you know those materials. We easily forget things that we are not familiar with"* (L3SSIM).

This suggests that, in order for the learners to make sense of the science concepts, teachers need to use everyday material in teaching science; these materials are known to learners. Hence, Dart et al. (2000) explain that teachers should make their teaching relevant to the learners by providing examples that learners can easy identify. Stears et al. (2003) also posit that learners relate their learning to their everyday context for them to learn science in the classroom.

5.3 Concluding remarks

In this chapter, I presented, analysed and discussed the data generated from classroom observations, reflective journals and semi-structured interviews as shown in Table 6. Data generated from the observation showed that these learners were interested being engaged in the hands-on practical activities whereby everyday materials were used. From the journals and semi-structured interviews, the learners indicated that they enjoyed the lessons. Most importantly, this helped them to learn science easily as they were able to easily recall what they had observed in the classroom. It also enabled them to test their hypotheses through their observations. In addition using the everyday materials influenced their conceptions, disposition and interest towards science.

In the next chapter, I present a summary of my findings, recommendations and conclusions.

CHAPTER 6: SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSIONS

Teaching which does not build on that experience and learning limits the learners' thinking and learners will not see the connection between world outside school and what is taught and learnt in school (NCBE, 2016, p. 39).

6.1 Introduction

In the previous chapters (Chapters 4 and 5), the findings of the study were presented, analysed and discussed. The discussions were based on the data generated from questionnaires (pre-and post-intervention), tests (pre-and post-), classroom observation, learners' journal reflections, and semi-structured interviews. In addition, some literature from Chapter 2 was interwoven together with the supporting statements from the participants. In this chapter, I summarise the findings of my study. I provide some recommendations; the limitations of the study as well as the some proposed areas of future research and the chapter ends with some personal reflections.

The study sought to answer the following research questions:

1. What are Grade 10 Physical Sciences learners' conceptions, dispositions and interest towards learning science?
2. What prior knowledge on acids and bases do Grade 10 Physical Science learners have?
3. How does the integration of IK in lessons on acids and bases influence (or not) the conceptions, dispositions, interest of learners toward science learning?
4. How does the integration of IK influence (or not) learners' sense making of the concepts on acids and bases?

6.2 Summary of findings

The data were gathered and analysed in order to answer my four research questions. Hence, the summary of my findings is in relation to these research questions. The study was undertaken to get some insights on how the integration of IK in the lessons of acids and bases influenced (or not) the learners' conceptions, disposition, interest and sense-making.

6.2.1 Research question 1

What are Grade 10 Physical Sciences learners' conceptions, dispositions and interest towards learning science?

Before administering a test and engaging in the intervention, learners were given the pre-intervention questionnaires. The aim was to find out their conceptions, dispositions and interest toward science in general. After the intervention, they were given post-intervention questionnaires to find out how their conceptions, dispositions and interest towards science had shifted or not as a result of the intervention. Agunbiade (2015) explains that attitudes are views that are developed by learners based on their experiences of science in different situations. The study reveals that the learners' conception, interest and attitude shifted after the intervention.

In response to this question, it emerged that after the intervention learners developed positive conceptions, interest and attitude towards science. For instance, the percentage of learners who were in a low level were 20% for both conception and interest, and 33% for attitude, however after the intervention the numbers decreased to 0% of learners in this level. The high set showed the biggest shift after the intervention. For instance, the number of learners' conceptions for the high group increased from two (13%) learners before intervention to eight (53%) after the intervention. It could be surmised that the learning approach used might be the reason for this shift. Looking at the same context, the number of learners placed in high group for interest has increased from two (13%) learners to 10 (67%) learners after the intervention. It seems that the use of easily accessible materials as alluded by Asheela (2017) has influenced their interest. Additionally, this interest might be also aroused as the learners were able to relate science to their everyday experiences as suggested by Wellington (1998). For the attitude, the number of learners also increased in the high group from three (20%) learners to seven (47%) after the intervention. It can be inferred that the integration of hands-on practical activities enables the learners to develop the positive attitude (disposition) toward science. It can be summarised that, for the overall responses in all the three categories identified, there was a positive shift after the intervention.

6.2.2 Research question 2

What prior knowledge on acids and bases do Grade 10 Physical Science learners have?

This research question was intended to access an overview of the learners' prior knowledge on the topic of acids and bases. It was evident that learners have prior knowledge of topic acids and bases. Thus, they got an average of 31% in their pre-test. The results indicated that, 24 out of 33 learners who wrote the test obtained higher marks in the post-test compared to the pre-test. Six learners obtained lower marks in the post-test compared to the pre-test whereas three learners did not show any shift in their performance. The results also show that the learners performed poorly in the pre-test with an average of 31% compared to the post-test where they had an average of 42%. Even though these learners performed poorly in the pre-test there were some indications that they had some prior knowledge in this topic. Based on the questions that were analysed after the intervention the learners scored more marks in the questions that are assessing the reactions of acids and bases with an average of 67%. The questions that are asking examples of acids learners obtained 61%. For the indicators they obtained 42% and lastly in questions testing theory they obtained an average of 36%. Many learners were able to correctly answer these questions by giving the reactions and examples of acids and bases.

These findings are similar to those of Le Grange (2007), whose study revealed that by using everyday materials, the learners were able to make the connections between their everyday life experiences and the school science. However, they performed poorly in the questions that tested the theory on acids and bases. This seems that some of the learners were not able to use their everyday experience to answer these questions. Subsequently, even after the intervention they still performed poorly in these questions. Perhaps, this illustrated what Helliar and Harrison (2011) cautioned that not all learners learn from the practical activities. In this study, it seems that not all the learners learn from these hands-on practical activities.

6.2.3 Research question 3

How does the integration of IK in lessons on acids and bases influence (or not) learners' conceptions, dispositions and interest towards science learning?

After the pre-test was administered, three lessons were conducted. The aim was to find out the extent to which the integration of IK in the lessons influenced learners' conceptions, dispositions and interest. The observed indicators are the ability, attitudes, willingness and values. The study revealed that the use of easily accessible resources influenced learners' conceptions, dispositions and attitudes positively. The learners enjoyed science as they were working with their peers. This enhances the social interactions among the learners who learn from one another as espoused by Vygotsky (1978) that learning takes place in a social context. The use of materials from their immediate environment also increased their interest. To this end, Agunbiade et al. (2017) assert that the use of everyday materials promote learners' interest and confidence towards learning science.

Being interested in science also increased the participation of learners in the lessons. Similarly, the use of the easily accessible resources enabled learners to develop the positive attitude toward science. The learners indicated that they have enjoyed the lessons; hence it could be surmised that learners developed positive attitude towards science. This agrees with Hofstein and Mamlok-Naaman (2011), who explain that learners who have an interest in science and understand scientific concepts tend to have a positive attitude toward science compared to those who are not interested in science.

After the analysis of the data gathered in this study, I came to the conclusion that integration of IK in the lessons contextualises science as advocated by Erinosho (2013). It also addresses the lack of laboratory materials as is experienced at some schools (Asheela, 2017).

6.2.4 Research question 4

How does the integration of IK influence (or not) learners' sense making of the concepts on acids and bases?

The aim of this research question was to find out how the integration of IK during the lessons influence learners' sense-making on the topic of acid and bases. This was administered after three lessons were conducted.

In these lessons, learners were able to complete the worksheets based on the hands-on practical activities. The findings revealed that learners were able to make sense of the concepts taught in the class. For instance, learners indicated that the use of easily accessible resources helped them to recall the concepts easily. This was made possible because the learners were using the materials that they were familiar with. The findings resonate with Roschelle's (1995) findings that learning should start from the prior knowledge. Lending support to this is Kuhlane (2011), who posits that the use of prior knowledge facilitates learning. Prior knowledge thus acts as the foundation on which learners are building their scientific concepts.

The results also indicated that learners were able to make sense of the topic of acids and bases when they were exposed to these practical activities. They were also able to write mind maps and concept maps using the concepts that emerged from the lessons (see Section 5.2.3). This shows that learners might have the conceptual understanding of these concepts after being exposed to hands-on practical activities as suggested by Asheela (2017). Thus, some learners explained that they had only heard of effects of acids and bases on litmus paper and after the experiment they were able to make their own observations. It could be summarised that the integration of IK in the lessons afforded the learners the opportunity to make the connection between their everyday lives and school science.

6.3 Recommendations

Based on the findings of this study, I thus recommend that:

- Teachers should integrate IK in their teaching and allow learners to use their everyday experiences in learning science;
- The teachers should also expose learners to hands-on practical activities as often as possible so that the learners can develop the positive conceptions, interest, and dispositions toward science.

For the teachers to successfully implement and integrate IK in their teaching:

- Curriculum developers should be explicit on how IK should be integrated in the lessons;
- Teacher- training institutions need to integrate in their teacher-training on how teachers should disseminate IK in the classroom;
- Parental involvement should also be encouraged in the educational matters. This might strengthen the community and their cultural identities (O'Donoghue, et al., 2007).

In conclusion, learners should be encouraged to use their everyday experiences so that they can use these experiences to learn science in the classroom. Hence, the NCBE (2016) points out that teaching that does not build on the knowledge of the learners inhibits learners' thinking and they will not be able to see the connection between everyday experiences and classroom experiences as highlighted in the epigraph above.

6.4 Limitations of the study

This study is a case study located within the interpretive paradigm. This suggests that its findings cannot be generalised as they are only limited to Grade 10 B Physical Science learners at Namaela SS. They cannot, therefore, be generalised to the whole region or country. Notwithstanding, some useful insights were generated on the integration of IK in science lessons.

However, if I were to do this study again, I would use the Predict, Explain, Explore, Observe and Explain (PEEOE) approach as suggested by Maselwa and Ngcoza (2003) in order to enhance some inquiry skills amongst my learners. Additionally, it would have been useful if I had had an audio-recorder at each table so that I could capture the learners' discussions and arguments. In hindsight, I realise that these were lost opportunities in this study.

6.5 Areas for future research

I would recommend that a further research in the same topic should be conducted in Grade 11 to see how learners are learning this topic after they had been taught it in Grades 9 and 10.

6.6. Reflections

I started this journey in 2015, when I was registered as a post-graduate student at Rhodes University for a degree of Bachelor of Education with honours. During this period I was introduced to basic research as well as to Indigenous Knowledge. Since I was a novice researcher then, I did not really understand what was meant by doing research. In 2017, however, I was accepted to read for my Masters. I had mixed feelings when I joined the Master's class for science education; it was a great joy to be admitted, yet I was nervous about facing this Master's journey head-on. I started with my proposal that I wrote for the whole year (2017). Even though it was less than 15 pages, it required a lot of time and critical thinking about what to put into this proposal. I had thought it would be an easy exercise, which was not the case.

I was excited to receive my ethical clearance certificate. This meant that I was given permission to resume with the actual research process; putting into practice what I wrote in the proposal. It was an exhausting exercise, being a full time teacher, it was a challenge to strike the balance between my study and my everyday school work. My thanks go to the *Ubuntu* among my Masters colleagues and the continuous support from my two supervisors. There were times I felt like giving up, but with the help rendered during this process it kept me going. It helped me to proceed until I produced this final project. If I was working in isolation I doubt very much if I would have reached my destination.

6.7 Conclusion

This study provides the importance of integrating IK in the teaching and learning process. It revealed that IK has an influence on the learners' conceptions, interest, attitude and sense-making. Learners explained that they enjoyed lessons when they were using the materials from their immediate environment. They were able to learn scientific concepts when they were relating it to the materials that they are familiar with. To this end, this study concluded that the integration of Indigenous Knowledge in the topic of acids and bases influences the learners' conceptions, disposition, interest and sense-making. In addition, the conceptions, disposition and interest of learners shifted positively through the use of easily accessible resources during the intervention. This study concluded that the connection between the learners’ everyday experiences and school science promote learners’ engagement and participation and it should be encouraged.

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Appendices

Appendix A1 (Ethical clearance Approval)

RHODES UNIVERSITY
Grahamstown • 6140 • South Africa

EDUCATION FACULTY • PO Box 94, Grahamstown, 6140
Tel: (046) 603 8385 / (046) 603 8393 • Fax: (046) 622 8028 • e-mail: d.wilmot@ru.ac.za

PROPOSAL AND ETHICAL CLEARANCE APPROVAL

Ethical clearance number 2018.02.14.01

The minute of the EHDC meeting of 05 December 2017 reflect the following:

2018.02.14 ***CLASS B RESTRICTED MATTERS***
MASTER OF EDUCATION RESEARCH PROPOSALS

To consider the following research proposal for the degree of Master of Education in the Faculty of Education:

Ms Johanna Haimene (15A8714)

Topic: Exploring whether or not the inclusion of indigenous knowledge during lessons on acids and bases influences Grade 10 Physical Science learners' dispositions and sense-making.

Supervisor: Professor K Ngcoza and Mrs Kuhlane

Decision: *Approved*

This letter confirms the approval of the above proposal at a meeting of the Faculty of Education Higher Degrees' Committee on the 5 December 2017.

The proposal demonstrates an awareness of ethical responsibilities and a commitment to ethical research processes. The approval of the proposal by the committee thus constitutes ethical clearance.

Sincerely

Ms Zisanda Sanda
Secretariat of the EHDC, Rhodes University
14th February 2018

Appendix B 2 (Permissions and responses)

Johanna S. Haimene
PO Box 16242
Onayena
Cell: +264 81 229 2980

To: Mr Lamek Kafidi
The director of Education
Oshikoto region

Dear Sir

Re: Request for permission to conduct education research at [redacted] SS in Oshikoto region.

I, Johanna Shetulimaba Haimene, student number 15A871, currently am doing masters in Science Education at Rhodes University. I am planning to carry my research as from February 2018 at [redacted] in Oshikoto region with grade 10 learners.

My research topic is ***Exploring how the inclusion of Indigenous Knowledge during lessons on acids and bases influences (or not) Grade 10 Physical Science learners' dispositions and sense making.***

This letter serves to seek permission to conduct the research at the above-mentioned school.

I am looking forward to hearing from you.

Yours sincerely

Johanna S. Haimene
15A8714
Rhodes University

REPUBLIC OF NAMIBIA

OSHIKOTO REGIONAL COUNCIL
DIRECTORATE OF EDUCATION, ARTS AND CULTURE

Tel (065) 281900
Fax (065) 240315
Enq: Ms H Tende

Private Bag 2028
ONDANGWA
21 February 2018

Ref: 12/3/10/1

Ms Johanna Haimene
PO Box 16242
Onayena
Cell: 0812292980

Dear Ms Haimene

RE: PERMISSION TO CONDUCT EDUCATION RESEARCH AT [redacted] IN OSHIKOTO REGON

1. We acknowledge receipt of your letter, seeking for approval from the Office of the Director to conduct a research study at [redacted] in Oshikoto Region.

2. The writing of this letter therefore serves to inform you that permission has been granted to you on the following conditions:

   - You have to consult the school principal well in advance to make proper arrangements.
   - The research should not interfere with the normal teaching and learning process at the school.
   - And participation by either teachers or learners should be on voluntary basis.

3. With that in mind, it is our wish that your research study will yield satisfactory results, towards the completion of your qualification.

Yours Faithfully

OSHIKOTO REGIONAL COUNCIL
Director
21 FEB 2018
PRIVATE BAG 2028
ONDANGWA
OF EDUCATION, ARTS AND CULTURE

MR LAMEK T. KAFIDI
DIRECTOR OF EDUCATION
OSHIKOTO REGION

CC: Principal, Joseph Simaneka Asino SS

Johanna S. Haimene
PO Box 16242
Onayena
Cell: +264 81 229 2980

To: Ms Hilma Hamunyela
The school principal
[redacted]

Dear Madam

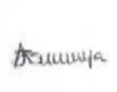
Re: request for permission to conduct education research at [redacted] SS in Oshikoto region.

I, Johanna Shetulimba Haimene the undersigned, hereby requesting for permission to conduct a research at your school. The research topic is ***Exploring how the inclusion of Indigenous Knowledge during lessons on acids and bases influences (or not) Grade 10 Physical Science learners' dispositions and sense making***. I am planning to conduct this research in February 2018.

This letter serves to seek permission to conduct the research at the above-mentioned school.

Thank you very much for your understanding

Yours sincerely



Johanna S. Haimene
15A8714
Rhodes University

P.O.Box 16294 Ona[illegible]
Tel/Fax 065-2493[illegible]

Principal: Ms. H. N. Ham[illegible]

15 February 2018

Dear Mrs Haimene

This letter serves to inform you that my office has no hesitation or whatsoever in granting you the opportunity in carrying your research at my school. As per our communiqual you are to carry out the research in Grade 10 in the subject Physical Science.

It should be noted however that, doing your research should not interfere in our day-to-day activities of the department.

Wishing you all the best in your endeavors.

Your Sincerely

Hilma N. Hamunyela
Principal

Consent form

I____ (full name of parent/guardian), the father/mother/guardian of _______________________________________ (full name of child) hereby confirm that I understand the content of this document and the nature of the research, and I consent to my child participating in the research study. I also understand that my child is at liberty to withdraw from participating at any time without any disadvantage.

I agree and authorise my child to participate in the research and I understand that my child can withdraw from participation without any effect.

Parent's/Guardian's Name____

Parent's/Guardian's signature____

Date__________________________

Contact numbers____

Appendix C 1(Pre- and Post- Questionnaire)

WHAT DO YOU THINK ABOUT SCIENCE?
Pre- and post-intervention questionnaire

This survey is completely confidential and your participation is voluntary.

Gender: Male _____ Female _____ Religion:______________________
Name:_____________________ False Name:___________________
What does your False Name mean?_____________________________
Grade:_________

Please indicate your level of agreement with each of the following statements by putting a cross (X) in your best response.

	ITEMS	RESPONSE				
		Strongly Agree/ *Onda zimina noonkondo*	Agree/ *Onda zimina*	Not Sure/ *Kandi shiwo naana*	Disagree/ *Inandi zimina*	Strongly Disagree/ *Inandi zimina noonkondo*
1	Even though science is regarded as a difficult subject, I am sure I can understand it. *Nande oshilongwa shuunongononi osha talikako oshidhigu, ondi ineekela otandi shi uvuko.*					
2	I am not confident about understanding difficult science concepts. *Kandina omukumo okui longa iinima/iitya iikukutu yuunongononi.*					
3	I am sure I can do well in science tests. *Ondi shi shi kutya ota ndi mono iitsa iiwanawa motsutsu dhoshilongwa shuunongononi.*					
4	No matter how much effort I put in, I cannot learn science with understanding. *Nande ndi tulemo omuthindo mokwiilonga, ihandi ilongo oshilongwa shuunongononi neuveko*.					
5	When science activities are too difficult, I give up or do the easy parts *Ngele iilongadhalwa yuunongononi iidhigu, **ohandi** etha oku i ninga nenge tandi ningi mbi iipu*					
6	When science activities are too difficult, I do not give up. *Ngele iinyangadhalwa yo science iidhigu, **ihandi** etha oku longa iinyangadhalwa mbika*					
7	During science activities I prefer to ask other people for the answer rather than think for myself. *Pethimbo lyiinyangadhalwa yo science ondi hole oku pula aantu yalwe shi vule ndi dhiladhile kungame mwene.*					
8	During science activities I prefer to think for myself first rather than ask other people.					

	Pethimbo lyiinyangadhalwa yo science ondi hole okudhiladhila kungame mwene shi vulithe oku pula yalwe.					
9	When I find science content knowledge difficult, I do not try to learn it. *Ngele nda mono uunongo woshikalimo sho science oshidhigu ihandi kendambala oku shi ilonga.*					
10	When I find science content knowledge difficult, I try to learn it. *Ngele nda mono uunongo woshikalimo sho science oshidhigu ohandi kendambala oku shi ilonga.*					
11	When learning new science concepts, I attempt to understand them. *Ngele tandi ilongo iitya iipe yo science ohandi kendambala oku yi uvako.*					
12	When learning new science concepts, I try to memorize them. *Ngele tandi ilongo iitya iipe yo science ihandi kendambal okuitula momutse.*					
13	When learning new science concepts, I connect them to my previous experiences. *Ngele tandi ilongo iitya iipe yo science ohandi kendambala okui kwatakanitha nontseyo yandje ya pita/ yon ale.*					
14	When I do not understand a science concept, I find relevant resources that will help me. *Ngele kanduuviteko iitya yo science ohandi kongo oonzo dhilwe dhi kwathelendje*.					
15	When I do not understand a science concept, I discuss it with the teacher to clarify my understanding. *Ngele kandi uviteko iitya yoscience, oha tu ikundathana nomulongi opo ndi yi uveko hwepo*.					
16	When I do not understand a science concept, I discuss it with other learners to clarify my understanding. *Ngele kandi uviteko iitya yoscience, oha tu ikundathana naalongwa aakwetu opo ndi yi uveko hwepo*.					
17	During the learning process, I attempt to make connections between the concepts that I know. *Momukokomoko gwokwiilonga iha ndi kambadhala okuninga ekwatathano pokati kiitya mbi ndishi naambi tandi ilongo.*					
18	When I make a mistake, I try to find out why. *Ngele nda ningi epuko ohandi kambadhala ndi mone kutya omolwashike.*					
19	When I make a mistake, I give up easily. *Ngele nda ningi epuko ohandi si uunye mbala nde ta ndi etha.*					
20	When I meet science concepts that I do not understand, I still try to learn them.					

	Ngele nda tsakaneke iitya yo science mbyoka kandi uviteko ohandi kendambala oku yi ilonga.					
21	When new science concepts that I have learned do not agree (conflict) with my previous understanding, I try to understand why. *Ngele iitya iipe yo science mbi ndi ilionga itai tsu kumwe neuveko lyandje ohandi kambadhala okuu uvako kutya omolwashike*.					
22	When new science concepts that I have learned do not agree (conflict) with my previous understanding, I give up. *Ngele iitya iipe yo science mbi ndi ilionga itai tsu kumwe neuveko lyandje ohandi si uunye ee tandi etha*.					
23	I think learning science is important because I can use it in my daily life *Onda dhiladhila kutya osha simana okuilonga o science opo ndi yi longithe monkalamwenyo yandje yesiku kehe.*					
24	I think learning science is important because it stimulates my thinking *Otandi dhiladhila kutya oku ilonga o science osha simana oshoka otashi kwathele oku pendulapo omadhiladhilo gandje.*					
25	Science is important for our daily lives. *O science oya simana moonkalamwenyo dhetu dhesiku kehe.*					
26	I think it is important to participate in inquiry/investigative activities in science. *Otandi dhiladhila osha simana oku kutha ombinga momapulapulo giinyangadhalwa yo science.*					
27	It is important to have the opportunity to satisfy my own curiosity when learning science. *Osha simana oku mona ompito opo ndigwanene komapulo gandje ngele tandi ilongo o science.*					
28	I participate in science class only to get good marks. *Ohandi kutha ombinga motundi yo science opo ndi mone iitsa iiwnawa.*					
29	I participate in science class to perform better than other students. *Ohandi kutha ombinga motundi yo science opo ndi mone iitsa iiwanawa yivule yaalongwa aakwetu.*					
30	I participate in science class so that other students think I am smart. *Ohandi kutha ombinga motundi yo science opo aanaskola aakwetu yadhiladhile kutya ondi shishi.*					
31	I participate in science class so that the teacher pays attention to me. *Ohandi kutha ombinga motundi yo science opo omulongi apulakenendje.*					

32	During a science class, I feel most fulfilled when I attain a good score in a test. *Pethimbo lyotundi yoscience ohandi kala nda nyanyukwa no nda gwanenwa ngele nda mono iitsa iiwanawa motsutsu.*					
33	I feel most fulfilled when I feel confident about the content knowledge in a science. *Pethimbo lyotundi yoscience ohandi kala nda nyanyukwa no nda gwanenwa kondjundo yuunongono wo science.*					
34	During a science class, I feel most fulfilled when I am able to solve a difficult problem. *Pethimbo lyotundi yoscience ohandi kala nda nyanyukwa no nda gwanenwa ngele nda kandulapo uudhigu.*					
35	During a science class I feel most fulfilled when the teacher accepts my ideas. *Pethimbo lyotundi yoscience ohandi kala nda nyanyukwa no nda gwanenwa ngele omulongi ta taambako omadhiladhilo gandje*					
36	During the science class I feel most fulfilled when other students accept my ideas. *Pethimbo lyotundi yoscience ohandi kala nda nyanyukwa no nda gwanenwa ngele aanaskola ooyakwetu ta ya taambako omadhiladhilo gandje.*					
37	I like hands-on science practical activities because they enable me to understand science concepts better. *Ondi hole oku kutha ombinga miilongadhalwa yo science oshoka ohai kwathelendhe oku uvako o science hwepo.*					
38	I do not like hands-on science practical activities because they do not help me to learn science concepts. *Kandi hole oku kutha ombinga miinyongadhalwa yo science oshoka ihai kwathelendje oku uvako o science hwepo.*					
39	I am willing to participate in the science practical activities because it stimulates my mind. *Onda hala okukutha ombinga miinyangadhalwa yo science oshoka ohai pendulapo omadhiladhilo gandje.*					
40	I am willing to participate in the science activities because I want to become an expert in science. *Onda hala oku kutha ombinga miilongadhalwa yo science oshoka onda hala oku kala enyakwa moscience*.					
41	I am willing to participate in the science activities because it involves learning outside the classroom. *Onda hala okukutha ombinga miinyangadhalwa yo science, oshoka ohai longwa kondje yonguluskola.*					
42	I like working alone in science class. *Ondi hole okwiilongela ongame awike mongulu.*					

43	Science open doors for job opportunities. *O science otai egulula omiyelo dhoompito dhiilonga.*					
44	Our country needs scientists to improve people's lives. *Oshilongo shetu osha pumbwa aanongononi mokulundulula oonkalamwenyo dhaantu.*					
45	The way science is taught at school is boring. *Omukalo gokulonga o science moskola ina gu djanga.*					
46	I sometimes have a negative attitude towards science. *Thimbo limwe ondina omadhiladhilo geli ompinge no science*					
47	I would like to understand more about scientific explanations for things. *Onda hala oku uvako mule omafatululo gopaunongononi.*					
48	I would like to study science more deeply than I do now. *Onda hala oku ilonga o science mule shi vulithe shoo handii longo ngashingeyi.*					
49	I will seriously consider doing a career in science after I leave school. *Otandi dhiladhila oku kutha eithano mo science konima ngele nda mana oskola.*					
50	I like learning new things and being involved. *Ondi hole okuli longa iinima iipe noku kutha ombinga*					
	Total:					

Appendix D 1 (Pre- and Post-Test)

Name: …………………………………………………… Grade 10
Physical science test Marks: 30

Topic: Acids and Bases

Instructions

- Answer all questions
- This question paper consist of two sections, Section A and Section B
- In section A: There are four possible answer A, B,C and D
  Choose the one you consider correct by **circling**
- In section B: Answer the questions in the spaces provided.

Section A
Multiple choices

1. Acids are commonly found in substances such as….
   A. Dishwashing liquid
   B. Water
   C. Vinegar
   D. Metals

2. Which compound is an alkali?
   A. Sulphur dioxide
   B. Hydrochloric acid
   C. Sodium hydroxide
   D. Water

3. The effect of acids on litmus paper is….
   A. Turn red litmus paper blue
   B. Turn blue litmus paper red
   C. Turn red litmus paper green
   D. Turn blue litmus paper green

4. Sam uses a pH scale to determine the pH of solution Y in the school laboratory. He finds that solution Y has a pH between 11 and 12. What can be said about solution Y?
   A. It is a strong acid
   B. It is a strong alkali
   C. It is a weak acid
   D. It is a weak alkali

5. The table below gives the colours of the universal indicator at different pH levels.

pH	1	2	3	4	5	6	7	8	9	10	11	12	13	14
colour	Red	Pink	Orange	Yellow		Yellow-green	Green	Blue-green	Blue	Violet	Purple			

Water is neutral, vinegar is a weak acid and toothpaste is a weak base. What would the universal indicators' colour be in water, vinegar and toothpaste?

	Water	Vinegar	Toothpaste
A.	Yellow	Orange	Blue
B.	Green	Yellow	Blue-green
C.	Green	Pink	Violet
D.	Blue	Red	Purple

Section B
Structured questions

Instructions

- Answer **all** questions on the spaces provided.
- Legible handwriting is essential.

1. The sentences below are used in relation to acids and bases. Fill in the missing information.
   (a) Alkalis are substances that turn ………... litmus paper to ……… while acids turn …………….. litmus paper to ………….……… (4)

   (b) Two (2) examples of everyday acid are ….……. and ……………….. (2)

   (c) The pH range of weak alkali is……………………….. (1)

   (d) The neutral substance has a pH value of ……………….. (1)

   (e) Differentiate between acids and bases in terms of pH values.
   ………………………………………………………………………………………
   ………………………………………………………………………………………
   ……………………………………………………………………………………… (2)

2. Acids and bases play a major role in our everyday life. Ndamona ate a lot of lemons and as a result, she developed a stomach ache.

(a) Predict the effect of lemon juice on litmus paper.
……………………………………………………………………………………… (1)

(b) Predict, whether lemon juice is a strong or weak substance.
……………………………………………………………………………………… (1)

(c) Suggest the possible medicine that Ndamona should take to overcome stomach-ache ………………………………………………………………………………………. (1)

(d) Give two examples of weak bases used at home.

…………………………………………………………………………………………………

……………………………………………………………………………… (2)

(e) Some of the bases are soluble in water. State the name given to soluble bases.

…………………………………………………………………………………….. (1)

3. The table below shows the pH scale and corresponding colours of a universal indicator.

Universal indicator														
	Red		Orange		yellow		Green		Green-blue			Blue	Purple	
pH	1	2	3	4	5	6	7	8	9	10	11	12	13	14

Hydrochloric acid reacts with a base, magnesium oxide to form magnesium chloride and water

(a) Both products have a pH of 7.

(i) Suggest the type of reaction

.... (1)

(ii) State the colour of the universal indicator when added to magnesium chloride solution.

……………………………………………………………………………… (1)

(iii) Outline the test to confirm the presence of water.

………………………………………………………………………………

………………………………………………………………………………

……………………………………………………………………………… (2)

(b) Give two applications in everyday life of the reaction mentioned in 3 (a) (i)

…………………………………………………………………………………………………

……………………………………………………………………………… (2)

4. Salts can be prepared by reacting a metal with acid.

Copper (II) sulfate is a salt which can be prepared by reacting copper with acid X.

(a) Identify acid X.

…………………………………………………………………………….. (1)

(b) Complete the equation for the reaction by filling the missing information

Cu + ………… $\longrightarrow$ CuSO4 + ………………. (2)

Memorandum

Section A

Multiple choice

1. C
2. C
3. B
4. B
5. B

Section B

Structured questions

1. (a) Blue, red, red, blue

   (b) acetic acid, citric acid

   (c) 12-14
   (d) Water
   (e) Acids pH 1 to less than pH 7
   Bases : Above pH 7 to pH 14

2. (a) it turns blue litmus paper to red

   (b) weak

   (c) Antacid (eg ENO)

   (d) soap water, Toothpaste

   (e) alkalis

3. (a) (i) Neutralisation

   (ii) green

   (iii) it will turn to blue

   (b) To make salt, to remove scales off kettles

5. 4. (a) Hydrochloric acid
   (b) H_2SO_4 , H_2

Appendix E 1 (lessons layout)

Lesson 1 Objectives: Learners should be able to compare the properties of acids and base by using the indicators (red and blue litmus paper).
Teaching and learning activities: Learners are expected to identify the acids and bases that are commonly found in homes. The materials that are brought from home will be tested with the litmus papers
Working activities: Learners complete the worksheet to identify the substance if it is an acid or a base. They will write colour change of the litmus paper after the object is dipped in the substance (liquids). See Appendix E1 (a) 1.

Lesson 2 Objectives: Learners should be able to measure the pH of a variety of solutions and place them on the pH scale and classify them as strong or weak acids, alkalis or neutral using the universal indicator. Learners should know the reaction of acids and metals and test the gas produced.
Teaching and learning activities: Learners observe the colour change of the liquids when the universal indicator is added to it. Learners also observe the reaction of zinc with hydrochloric acid and test the gas that is produced.
Working activities: Place the object on the pH scale Measure the pH of substances and classify them as weak or strong bases (complete the worksheet). See Appendix E1 (b) 1. Describe the testing of gas produced when the metal reacts with an acid. Write down the word and chemical equations of the metal reacting with acid.

Lesson 3 Objectives: Describe the reaction between acids and bases. Suggest the preparation of salt.

Describe the reaction of acids and metal carbonates.
Teaching and learning activities: Learners investigate the reaction of acids with bases and acids with metal carbonates (observe). Measure the pH value of the products.
Working activities: Write the chemical and word equations for neutralisation. Describe the testing of water and gas (carbon dioxide) produced during neutralisation. See Appendix E1(c) 1. Write mind maps and concept maps from lessons 1 to 3.

Appendix E1 (a) 1 (worksheet 1)

Observation Sheet 1
Nickname/Group no: …………………….
Instructions:
1. Dip the litmus paper in the household substances and record your findings below

Substance	**Colour of the litmus paper before**		**Colour of the litmus paper after**	**Comment**
Body wash	Red			
	Blue			
Dishwashing liquid	Red			
	Blue			
Paraffin	Red			
	Blue			
Guava	Red			
	Blue			
Ombike	Red			
	Blue			
Omagadhi goontanga	Red Blue			
Omagadhi goombiliki	Red			

	Blue			
Olukula	Red			
	Blue			
Lemon	Red			
	Blue			
Brown sugar	Red			
	Blue			
Salty water	Red			
	Blue			
Washing powder	Red			
	Blue			
Oros	Red			
	Blue			
Tea	Red			
	Blue			
Ontaku	Red			
	Blue			
Sweet aid	Red			
	Blue			
Shampoo	Red			
	Blue			
Milk (gahikwa)	Red			
	Blue			
Hairspray	Red			
	Blue			
Jik	Red			
	Blue			
Sta soft	Red			
	Blue			
Coke	Red			

	Blue			
Soda water	Red			
	Blue			
Jelly fuel	Red			
	Blue			
Vinegar	Red			
	Blue			
Toothpaste	Red			
	Blue			
Fresh milk	Red			
	Blue			

2. What are the effects of litmus papers on:

(a) Acids

……………………………………………………………………………………………………

(b) Alkalis

……………………………………………………………………………………………………

Appendix E1 (b) 2 (worksheet 2)

Name: ………………………………………………………………………………………

Physical science worksheet (effects of acids and bases on the universal indicator)

Instructions

- Use the universal indicator to determine the strength of the following substances
- Put a cross in the appropriate column

Substance	Acid		Alkalis		neutral
	strong	Weak	strong	weak	
Rooibos tea					
Toothpaste					
Soda water					
Oros					
Coke					
Jik					
Salty water					
Brown sugar					
Sunlight dishwashing					
Mag washing powder					
Ombike					
Milk (gahikwa)					
Fresh milk					
Ontaku					
Vinegar					
Guava					

Answer the following questions

2. (a) What is produced when Zinc metal reacts with Hydrochloric acid?

…………………………………………………………………………………………………
…………………………………………………………………………………………………
……………………………………………………………………………..

(b) Describe the testing of gas produced

Test
…………………………………………………………………………………………………
…………………………………………………………………………………………………
………………………………………………………………………….

Result
…………………………………………………………………………………………………
…………………………………………………………………………………………………
……………………………………………………………………………..
(c) Write the word equation of the reaction above

…………………………………………………………………………………………

Appendix E1 (c) 3 (worksheet 3)

Name…………………………………………………………..……

Instructions

Answer all the questions

1. (a) Write down two reactants of the reaction based on the reaction done.

…………………………….…… and ……………………………………….

(b) How do we call this type of reaction?

……………………………………………………………………………………….

(c) What is the colour change when universal indicator is added to the products in the reaction above?

……………………………………………………………………………………

2. Observe the heating of copper sulphate

   What was the colour of copper sulfate

   (a) Before heating?

   ………………………………………………………………………………………

   (b) after heating

   ………………………………………………………………………………..

   (c) Add pure water to copper sulfate after heating. Write down your observation

   ………………………………………………………………………………

   ……………………………………………………………………………....

   (d) based on the experiment above, describe the testing of water

   Test

   ………………………………………………………………………………

   Result

   ………………………………………………………………………………

3. (a) Observe the preparation of carbon dioxide
   - reaction between hydrochloric acid and calcium carbonate
   - from the fizzy drink
   - exhaled air

   (b) Write your observation when carbon dioxide is bubbled through the clear limewater.

…………………………………………………………………………………………

…………………………………………………………………………………………

………………………………………………………………………………………

(c) Based on the observation above, describe the testing of carbon dioxide
Test

…………………………………………………………………………………………

Result

…………………………………………………………………………………………

Appendix F 1 (Journal reflection Guide)

1. What I enjoy in the lesson today is
2. What I did not enjoy in the lesson today is
3. Do you think it is important to use local materials to teach acids and bases? Explain your answer.
4. What have you learnt from the lesson
5. Any other comments?

Appendix G 1 (Semi-structured interviews)

These are my basic questions as I will probe for more.

1. Could you tell me any household materials that contain acids or bases?
2. Is there something that you know about acids and bases?
3. How was the lesson, when you were taught the teacher using materials from the local environments?
4. How do you feel when the teachers use materials from your environment to teach physical science?
5. Which part of the lessons was interesting or not interesting and why?
6. What are the scientific concepts (acids and bases) that you learn that comes from using the local materials?
7. Do you think that it is important for the teachers to use materials from the environment to teach physical science or not?
8. Anything else?

Appendix H 1 (Collated and Colour coded Journal reflections, lesson 1)

Question	Transcriptions	Similar statements	Sub-themes
1.	KM: I enjoyed looking at how litmus paper changes. I enjoyed also finding out when the red litmus paper changed and when the blue litmus changed. I also enjoyed finding out what changes the litmus paper and what does not. I enjoy knowing that we have acids and bases in our local environment and that we have many acids and bases and I like that. JU: I enjoyed this lesson because I learn that our local materials we have some acids and bases by using litmus paper and bkue litmus paper by finding which is an acid or base. AK: I enjoyed a lot in this lesson, because I was happy when we was testing our local products on the litmus paper. It was soo enjoyable when the litmus paper changes its colour expecially the blue litmus paper because it most substances it changes. I was also happy because Mrs	I enjoy knowing that we have acids and bases in our local environment I learn that our local materials we have some acids and bases test material from our local environment what we use at our houses every day. if there is no this lesson then we don’t know that some of our local material is acid and some are b sometime was use the material, but I did not know that is acid and bases. learnt that, in our local, there are more acid materials than bases (**blue** : connecting everyday life to school life substances are what they now well we are used to local materials, we know them well Orange:Sense-making	Connecting everyday life to school work Sense making using familiar materials

	Amutenya has told us about weak and strong acid. IC: the testing of different materials from our environment a liquid form to check whether they are acids or bases using the litmus paper i.e red and blue. When the substance is acidic has the effect on the blue litmus paper which turn to red while if the substance is basic has the effect on the red litmus paper which turns to blue litmus paper. KH: testing different materials from local environment with litmus paper. I also enjoyed testing jik because it changed to two types of colour. AA: I was enjoyed the lesson because I was there everyone in 10B was available to asky the question about the lesson. I was enjoyed because I was taken part on this lesson I was free to tolk. They was free to touch litmus paper to see what is materials are bases or acid.	For us to understand easily learners become more understanding the topic that will make it very easy to understand Red: mediation be possible for learners to remember it in a test or in activities to recall in the exame. Purple: learning with understanding : I have learn the material that can change blue litmus paper to red that is acid and what change re	Mediation/facilitation of learning Learning with understanding Testing hypothesis Positive disposition

	SM: to test material from our local environment what we use at our houses every day. The lesson was very enjoyable because we test everything.	don’t enjoy very very that lesson because when we start that I was not understand what is going to very important to be know that what is an acid and base. Green: disposition	

2.	KM: I did not enjoy having not to taste anything, one thing that I don't like. I also did not enjoy having only blue litmus paper changing in most cases even if I liked it. JU: I don't enjoy very very that lesson because when we start that I was not understand what is going to be done. I was knowing that we just wasting time it's very important to be know that what is an acid and base. AK: I did not enjoy the lesson because we was not having lot of products to test them. I did not also enjoy because the lesson was very short. IC: that we were wanted to be take photos but there were no memory card to store our photos. KH: there is nothing that I did not enjoy AA: I was not enjoyed because not free to tolk. SM: nothing I did not enjoy because we do everything nothing we left.		
3.			

	KM L1JF: yes, it is more than just important, because we are used to local materials, we know them well so, that will make it very easy to understan without having pass in many difficulties unlike using unknown materials that we are meeting for the first time. JU:L2JM yes I think that it is important to me to use local material because if there is no this lesson then we don't know that some of our local materi is acid and some are bases. AK:L3JF it is very important to use our local material because when we are testing we can learn something even to know what are strong acids or bas for us not to use them in a rwong way it is also important because when we are doing it at school we can teach our parents and relatives. IC:L4JM yes because the learners become more understanding the topic because these substances are what they now well to recall in the exame. KH:L5JF yes I think its important because I think it will be possible for learners to remember it in a test or in activities when asked it can also contribu to the knowledge of a learner. AA:L6JM it is important to use local materials for us because sometime was use the material, but I did not know that is acid and bases. For us t understand easily. To see the use of test and identify the bases and acid. SM:L7JM yes to see whether the material is acid or base because there are acids that is harmful to our health because some materials could not be eate that's why we learn something helping ourselves		

4.	KM: I learnt that, in our local, there are more acid materials than bases, because blue litmus paper was changing in most cases. I had learnt that the strong materials on blue litmus paper, the same materials are weak when it comes to red litmus paper. JU: I learnt that anything that use sometimes should maybe an acid or base and some acid or base are dangerous. AK: I have learnt how local material affect the blue and red litmus paper. I have also learned about weak acid and strong acid, strong and weak base. I have also learned materials that need to be used in the right amount because they are strong. IC: that we at home we also use substances of different nature. Some are strong acids, some are weak acids, some are strong bases and some a weak bases. KH: I have learnt that different materials have different strongness and in most cases a blue litmus paper changed to red litmus paper.		

	AA: I had learn many things that can going to learn in my life to know the acid and base. Some the strong acid or weak acid. SM: I have learn the material that can change blue litmus paper to red that is acid and what change red litmus paper to blue that is base.		

Appendix I 1 (Interview Transcription)

Teacher (T): iyaa, mee lesson nee dinya twa conductingeni dii, iinima ilipi oyo Nenge oto dulu oku lombwelange iinima oyo hatu hange momaumbo etu ina o acid nenge o base? To lombwelenge ngaa kutya aaye otuna mo eshi ngaha oshina o base nenge otunamo eshi oshins o acid. (*Translation: Iyaa, from those lessons that we conducted, are you able to tell me the household materials that we can found in our houses that contain acids or bases?*)

Learner (C): Ee (*Translation: yes*)

T: IIkwashike oyo (Translation:what are those)

C: otu na mooo (Translation:we have…)

T: ehee(Translation:yes)

C: otunamo ngaashi ontaku o acid (Translation: ontaku (traditional brew) it is an acid)

T: mmmm (Translation:mmmm)

C: mmm nooo Jik ndji ha tu longitha o base (Translation:mmm we have Jik that we use, it is a base)

T: mmmm (Translation:mmmm)

C: otuna mwiishe ooo ngaashi (*Translation:we have likeee)*

T: ngaashi? (Translation:Likee?)

C: ngaashi ombike nayo o acid (Translation: ombike (traditional brew) it is acid)

T: ee. Iinima oyo nee owali wiishi , owa kala wiishi nale kutya oina o base nenge o acid owei shiva eshi twa ningi eeclass? (Translation:yes. Were you aware of those materials that a bases or acids before these lessons or you came to know it after the lessons?)

C: oosho twa ningi eeclass (Translation:is when we conducted the lessons)

T: osho twa ningi ee class? (Translation:when we conducted the lessons)

C: ee (Translation:yes)

T: ta shiti nale ka kwali ushi ngele ontaku o acid nenge o base (Translation:meaning that previously you did not know that ontaku contain acid?)

C: Aaye (Translation:no)

T: mmm ee. Ka kele nee kwaayo opena vali shimwe ushi kombinga yo acid no base. Nenge oushipo shike kombinga yo acid no base? kuna ashike vali eshi vali ushi kombinga yo acid no base, naashi ngaa twa ningeni eelesson ino shi vaamosha nande nande. (*Translation:apart from that what else do you know about the acids and base? Or what else do you now about acids and bases)*

C: aaye, ondi shi kutya shampa o acid ya reacting nokaaa, o acid ohai reacting ko blue litmus paper ndjii hai shendjele kuu blua. Manga oshike o base ohai ningi ohai shendjele kuutiligane, ai o base ohai shendjele kuublua shaa wa longitha o red (*Translation: no, I know that when acids reacts with……acid it reacted to blue litmus paper, it changed to blue while the bases changed to red, it change to blue once you use the red.*

T: mmmm ok paife. Iinima oyo owei shiiva eshi twa ningi ee lesson nenge owa kala nale ushi kutya ngee owa longitha o acid otai shendjele oka blue ota ka shendjele ko red nenge (*Translation:now those things you came to know it when we conducted classes?)*

C: ossho twa ningi ee class (Translation: yes only when we conducted the classes)

T: oshoo twa ningi ningeni eeclass? Oolesson oyali nee ili ngiini? Eshi omulongi ali ta longitha iinima oyo yadja momidingoloko detu. Eshi mwee telela iinima inya mwadja nayo komaumbo oyo twa longifa mo class o lesson oyali ngiini? (*Translation:when we conducted those lesson, how was the lesson, when the teacher was using the materials from our environment? When you brought those materials from your house, how was the lessons?)*

C: aaye oyali ombwaanawa (Translation: they were good)

T: mmm (Translation:mmmm)

C: Oolesson dhino odhali oombwaanawa shaashokaaa omuntu otwali ta tu longitha iinima yaza momagumbo getu. Sha hala okutya momagumbo getu namo omuna ee acid nee base dhoo taningi o lesson dhikale tai hokitha" *(Translation: "all lessons were good because… we were using the materilas that come from our houses. This means that in our houses there are also acids and bases and this makes the lesson to be interesting*.

T: mmmm (Translation:mmmm)

C: oshoka nande otatu shanga ekonakono pomuntu oho dhimbulukwa molwiinima mbiya yali tai longithwa (Translation:because even when we are going to write the examinations, the person will able to recall the materials that were used)

T: mmm (Translation: mmm)

C: shaashi nayo owiishi nale (Translation:because you know it well)

T: mmm. Osha simana nenge inashi simana oku longitha oyo yomomidhingoloko dhetu okulonga (Translation:mmm. Is it important or not important to use these materials from our environment to teach?)

C: oya simana (Translation:it is important)

T: oya simana in which way? (Translation:important in which way?)

C: molwaashi aantu otundji oha tu tseyele aala mo experiment Ohandi uvuko nawa ngele taku longithwa ee experimen (Translation:because many people we learn well through experiments. I understand better when I carry the experiments")

)

T:mo experiment ngiini (Translation:in experiments how?)

C: ngele omulongi te tuulukile nenge ngele otse yene tatu ningi oo experiment tsee yene (*Translation:when the teacher is showing us or when we are doing it ourselves)*

T: mmmm (Translation: mmm)

T: oo owa hala okutya ngenge omulongi ta longifa ee experiment op hamu tseya nawa? (*Translation oo you mean when the teacher is using the experiments you learnt well*?)

C: ee (Translation:yes)

T: mmm eeee owu uvite ngiini ngele omulongi ta longitha iinima yomomalukalwa getu? (Translation:how do you feel when the teacher is using the materials from our environments)

C: Ohandi kala nduuvite nawa nonda pulakena nawa (*Translation:I feel good)*

T: mmm (Translation:mmm)

C: ndi kale ndishi kutya nande otandi ka longitha iinima mbyoka komagumbo , ondi wete kutya shino oshili poisonous inandi shi kwata noonyala. (*Translation:I will know even if I am going to use these at home, I know which one is poisonous so that I can avoid touching it with my bare hands?)*

T: sha hala okutya iinima mbi yeetelelwa ko class kegumbo kwali hoi kwata noonyala? (Translation:meaning that the materials those that were brought to the class you don't touch them with bare hands)

C: ohandi ikwata noonyala maar otashi ku longo nee ukale twiiyogo koonyala lela nande owe shi kwata. (*Translation: I do, but now it taught me that you have to wash your hands once you touch it)*

T: ohooo ok ee another thingis o part yini yo lesson yali ombwaanawa nenge yali ombwiinayi? (*Translation: ook. Another thing is, which part of the lesson was nice or not nice?)*

C: oolesson adhihe konyala odhali oombwaanaw (*Translation:all lessons were nice)*

T: mmm (Translation: mmm)

C: Oshoka otwa longithaala oo experiment omo atu tseyele (Translation:because we have used the experiments for us to know)

T: owa hala okutya olesson ohai kala ashike ombwaanawa ngee ta pu longithwa oo experiment? (*Translation:you mean the lesson are just good when people are using experiments?*

C: ee niinima mbii tushi lela okuza ngaa ando komagumbo (Translation:yes materials that we know well from our homes)

T: mmm. Iinima ei mushi okudja komagumbo otai kwafele shike (Translation:mmm, how does the materials you know can help you?)

C: omuntu oho dhimbulukwa kutya shino nande oto shange ekononakono oto dhimbulukwa shii ushi lela to vulu okushi totomona iinima yimwe mbii kaa tushi oha tui dhimbwa mbala nuupu. (*Translation :you can able to recall evan when you are writing the examination. You are able to explain it well. Things that we do not know we forgot it easily*.

T: mmm (Translation:mmm)

C: Otwa mono ompito yokwiilonga kuyakwetu shoo tatwiilongo mogroup shoo tatu nyola omayamukulo getu moombapila".*(Translation: we got an opportunity to learn from each other in the group when we were completing our worksheets*.

T: ouk. Mmm melesson nee odo twiilonga odo iinima ilipipo scientific nenge yopaunongononi wiilongamo? (*Translation:mmm in those lessons what are the scientific concepts that you have learnt?)*

C: ondiilongamo kutya, (Translation:I learnt that…)

T: inwiilonga mosha? (Translation: you did not learn anything?)

C: onda tseya kutya, ondi ilongamo kutya uuna tatu longitha iinima natu kale ngaa hatu tseya shi tuna oku ninga nokukala tuna uuyogoki. (*Translation:I learnt that, when we are using materials we should know what we have and keep it hygienic)*

T: meelesson nee omo opena iinima yimwe yopaunongononi ha tut i ee scientific concepts wediilongamo eshi a tu longifa . ndishi otweeteleleni iinima inya yadja komaumbo? (*Translation: from those lessons there are words that can be called scientific concepts, now what are those concepts that you have learnt when we were using these everyday materials?)*

C: mmmaaye, uu, oshike ngaa, o acid no base ngaa kutya nani komagumbo getu okuna , okuna nani o acid noobase. (*Translation:mmm like acid and base*

T: mmm Twafa twali atu testingeni ngaa iinima imwe mwinya? (*Translation:mmm, were testing materials?)*

C: mm (Translation:mmm)

T: ngaashi?otwa testingmo twali twa hala oku konga shike natu tye nee nande omo lesson yotete? (*Translation:like? What have we done in lesson 2?)*

C: otwa kongamo, tu tseye kutya shino o acid nenge o base (*Translation:we want to know if it is acid or base)*

T: mmm molesson ontiyali (Translation:mmm , in lesson 2)

C: mo lesson ontiyali otwiilongomo kutya otwali tatu testing ta tu longitha uushike tatu testing o hydrogen (*Translation:in the second lesson we used, what testing hydrogen)*

T: tatu testing ngiini (*Translation:testing how)*

C: atu testing ndishi otwa longitha oshike, o gas ndjiya. O zinc ya burningwa noshike, kutya ya reacting no hydrochloric acid. (*Translation:we tested a gas. Zinc burn with, I mean reated with hydrochloric acid).*

T: mmm (Translation:mmm)

C: tai shoo o hydrogen tai releasingwamo ta tui testing ngele oyo, twei tula meballoon ndee tatu ifike tai topa (*Translation:when hydrogen is released it was placed in the ballon and it busted)*

T: mmm mo lesson ontitatu otwali tatu testing shike? (*Translation:mmm what have we tested in lesson three?)*

C: mo lesson ontitatu otwali tatu testing mo o carbon dioxide (*Translation:in the third lesson we tested carbon dioxide)*

T: mmm twa longifa shike? (Translation:mmm what have we used?)

C: otwa longitha, oku longitha ndjino yomufudho nooshike noo (*Translation:we have used, we have used this one breathed out,)*

T: mmm (Translation:mmm)

C: noyonamunate. Noyo lab twa longitha o calcium carbonate ya reacting no acid. (Translation:for the cooldrink. And from the lab we used calcium carbonate reacted with acid)

T: ehee. Aishe oyo oye tupe shike (Translation:ehee, all those gave us what?

C: oye tupe o carbon dioxide, shaa shoka twei bubbling o clear limewater turn into milky white. (Translation:it gave us carbon dioxide, because when we bubble it , clear lime water turn into milky white)

T: Shaala okutya scientific concepts edi wiilongamo molesson omo owiilongamo acid and base nashike vali wiilongamo? (*Translation:meaning that the scientific concepts that you have learn are acid and base, what else?)*

C: no hydrogen, testing of hydrogen (Translation:and hydrogen, testing of hydrogen)

T: mmm testing of hydrogen (Translation:mmm, testing of hydrogen)

C:no testing of water (Translation:and testing of water)

T: testing of water. Mo water oha tu longifa shike ano kwali? (*Translation:what do we use to test for water?)*

C: o anhydrous copper sulphate (Translation:we used copper sulphate)

T: twa longifa o anhydrous copper sulphate? Ehee (*Translation:we used copper sulphate? And..)*

C: shaa wei gwedhamo o drop of water ohai shendjele kuumbulau. Yoo oyali ombulau kutya ontokele (*Translation:once you add a drop of water it change to blue. It was white)*

T: ohoo. Opena ali shimwe wa hala ku lombwelange u wedeko ko interview yetu kombinga yee lesson odo (*Translation: ohoo, is the anything that you want to add on our interview?)*

C: okutyaala (Translation: I just want to say…)

T: mmm (Translation:mmm)

C: omuntu ngee ta tu longo, tatu longwa natu kale hatu longitha nani ee experiment shaashi nadho ohadhi tu ningitha to be more understandable (*Translation:when we are being taught, we should use experiments because they make us to be more understandable.*

T: mmm (Translation:mmm)

C: Natu kale ishewe hatu longitha iinima okuza komudhilongo , komidhingoloko dhetu opo tu longwe niinima mbii tu shinale tu dhimbulukwe nawa shoo tatu ka nyola omakonakono. (*Translation:we need to use the materials from our environments, from our environments so that we can be taught with the things that we know already and be able to recall it in the examination*

T.: ohooo. Thank you very much.

Appendix J 1 (Attalah's six disposition indicators)

DISPOSITION	
D1	Describing their ability in the subject (themselves as learners)
D2	Describing their attitudes towards the subject
D3	Describing the expectations about the subject (what will it help them achieve)
D4	Describing the learning approaches used to study the subject (for example, deep/surface learning)
D5	Describing the perceived value of the subject
D6	Describing the evidence that they would provide to others as a "proof" that they have learned the subject