

**An investigation into how grade 9 learners make sense of prior everyday  
knowledge and practical learning through exploring tooth decay problems  
in *Onangalo* Village: A case study**

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**By**

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### **Declaration**

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and has not previously in its entirety or in part been submitted at any university for a degree.

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(Signature)

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(Date)

## **Acknowledgements**

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## **Abstract**

The main goal of this study was to investigate how grade 9 learners make sense of prior everyday knowledge and practical learning through exploring tooth decay problems in their local context. The study was conducted at a deep rural Junior Secondary School situated in Onangalo Village, Tsandi constituency in Omusati political region, northern part of Namibia. My research was triggered by the transformation in the Namibian curriculum, which now recognizes a need to contextualize science and make it relevant to the learners' everyday life experiences.

An interpretivist paradigm informed this study. Within this paradigm, a qualitative case study approach was employed. The unit of analysis was the various activities undertaken by my grade 9 learners with a view to make meaning of prior everyday knowledge and practical investigations in chemistry. A variety of data generating techniques were used in this study, namely, brainstorming and discussion sessions, questionnaires, practical activities with worksheets and semi-structured interviews. A video recorder was used to capture events throughout.

Analytical categories emerged as a result of a coding system called pawing. From the analytical categories, analytical statements were formulated. The generated data was validated by a critical friend who was a Life Science teacher at the same school at which I did this study. Further validation was done through learners watching the video recordings and through focus group interviews. Methodological triangulation was also used to validate the data.

The study revealed that the use of learners' prior everyday knowledge and experiences in teaching and learning promoted active learners' participation and enhanced meaning making. Thus, the study recommends the adoption of well-structured science lessons which take into consideration learners' prior everyday knowledge. The study recommends that these science lessons be used in conjunction with practical activities to promote active learner engagement and conceptual development. Despite the benefits of integrating learners' prior everyday

knowledge during teaching and learning, the study however also revealed some challenges such as limited time and difficulties of English language proficiency amongst learners.

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## **Abbreviations and acronyms**

<b>GRN:</b>	Government Republic of Namibia
<b>IK:</b>	Indigenous Knowledge
<b>LCE:</b>	Learner Centered Education
<b>LoTL:</b>	Language of Teaching and Learning
<b>LTSMs:</b>	Learning and Teaching Support Materials
<b>MEC:</b>	Ministry of Education and Culture
<b>MoE:</b>	Ministry of Education
<b>NDP:</b>	National Development Plan
<b>NOS:</b>	Nature of Science
<b>PCK:</b>	Pedagogical Content Knowledge
<b>PEEOE:</b>	Predict-Explore-Explain-Observe-Explain
<b>SCK:</b>	Subject Content Knowledge
<b>SR:</b>	Stimulated Recall
<b>TCE:</b>	Teacher Centered Education
<b>UNESCO:</b>	United Nation Educational Scientific and Cultural Organization
<b>USAID:</b>	United State Agency for International Development
<b>ZPD:</b>	Zone of Proximal Development

## CHAPTER ONE

### SITUATING THE STUDY

#### 1.1. Introduction

According to the Namibian Curriculum for 2010 known as C2010, teaching and learning is supposed to be organized in such a way that:

- The starting point is the learners' existing knowledge, skills, interests and understanding derived from previous experiences in and out of school;
- The natural curiosity and eagerness of all young people to learn to investigate and to make sense of the widening world must be nourished and encouraged by challenging and meaningful tasks;
- The learners' perspectives need to be appreciated and considered in the work of the school;
- Learners should be empowered to think and take responsibility not only for their own, but also for one another's learning and total development, learners should be involved as partners in education rather than receivers of educational growth (Ministry of Education and Culture, 1993: 60).

Upon my reading of such statements as these, I was inspired to reflect on my own teaching practice. I decided to learn more about the prior everyday knowledge, the possible elicitation methods and how to incorporate such knowledge into practical activities with a view to support learners to make sense of scientific concepts. I realized I could do this by associating prior everyday knowledge and practical learning through exploring tooth decay problems in Onangalo Village, in Namibia where I live and teach.

In this chapter, I briefly outline the Namibian curricular issues; the problem statement; the potential value of my study; definitions of key concepts; a brief overview of the chapters and lastly some concluding remarks.

## **1.2. Curricular issues in Namibia**

In 2010, the Ministry of Education in Namibia introduced a new curriculum for all schools in the country known as Curriculum 2010 (C2010) with an emphasis on learner-centered education (LCE). According to Nyambe (2008), Learner-Centered Education is philosophically oriented with its ontological (view about reality) and epistemological (view about knowledge) implications. Due to the nature of its underlying philosophy, LCE gives a rise to learner centered pedagogy that “presupposes teachers to have a holistic view of the learners valuing life experiences as the starting point for their studies” (MEC, 1993: 83). Learner-centered pedagogy is also an approach in which teaching begins with the interests of learners, their existing knowledge, skills and understanding (Nyambe, 2008: 28).

Furthermore, LCE is explained in MEC (1993:60) as follows:

Our teaching methods must allow for the active involvement and participation of learners in the learning process. Teachers should structure their class to facilitate this active role. Often that will mean organizing learners in smaller or larger groups or pair, or working with them individually. It will mean as well using teaching techniques that fit the purpose and content of the lesson and that at the same time encourage active learner participation, for example, explaining, helping, and providing for active practice and problem solving

Thus, the newly implemented curriculum demands a shift from content-based to skills-based education with the view to realize Namibia’s “Vision 2030”. This Vision sees Namibia as developing from a literate society to knowledge based society where knowledge is constantly acquired and renewed, and used for innovation to improve the quality of life for all Namibians. The Vision is further aiming for a caring, healthy, democratic, productive and environmentally literate society (Namibia. MoE, 2009: 2).

Furthermore, the curriculum emphasizes the use of learners’ prior everyday knowledge in conjunction with practical activities for learners to learn better. However, the curriculum does not clearly indicate how the two strategies should be incorporated. The Namibian curriculum is described in detail in the next chapter (Chapter Two).

### **1.3. Rationale for the study**

The standard of performance in science as a school subject has caused alarm in the Namibian education system. Many educational officers labeled science as a ‘subject of concern’ during workshops and educational meetings. They even went to the extent of calling science teachers, teachers of concern, advisory teachers of concern, principals of concern, and so on in the region. This was done as a strategy to improve the performance of science in schools. This is supported by speeches of the founding father of the Namibian nation (former president Sam Nuyoma) in his attempts at educational and socio-political gatherings, to promote understanding in science.

With this call from the founding father and the labelling or treatment that we (science teachers) are getting from regional Education officers, I was forced to think of how to improve my subject performance at my previously disadvantaged Junior Secondary School which is situated in a rural area.

In my journey I came across a paper by Hodson (1996:756) who argues that:

“In science enquiry, a student achieves three kinds of learning. Firstly, enhanced conceptual understanding of whatever is being studied or investigated. Secondly, enhanced procedural knowledge, learning more about experiments and related studies, thirdly, enhanced investigative expertise”.

With this understanding, I considered that I needed to do something which might bring change in my school. I thought of coming up with my own ways of approaching some of the basic competencies outlined in the curriculum and syllabus. I thought of developing my own learning and teaching support materials (LTSMs) from the local environment rather than relying on textbooks as proposed by Czerniewicz, Murray and Probyn (2000). In addition, I thought of incorporating prior everyday knowledge with practical activities.

Wilkinson and Ward (1997:49) suggest that practical activities help learners to acquire skills such as making predictions, manipulating equipment, observing, recording and analyzing data and drawing conclusions. They add that practical activities help learners to acquire better understanding in science. This is conceived by Hodson (1990: 33) differently though. He believes that practical work is ill-conceived, confused and unproductive in most schools. That

is, cookbook approaches are used during practical activities resulting in little or no learning taking place. During the education reform in Namibia, the pedagogy was not given adequate attention; for example the first guide book in education reform titled “Toward Education for All” (1993) did not consider these pedagogical issues (the know-how).

The Ministry of Education publications ‘Towards Education for All’ (1993) and ‘The Pilot Broad Curriculum Guide for formal Education (1996)’ are in favour of Learner Centered Education (LCE) and indigenous knowledge (IK). According to these documents, IK and LCE can only be realized if learners’ background knowledge is recognized and this forms the basis of their everyday teaching and learning. Learners hopefully feel proud and become curious because they investigate their practices and come to see themselves as owners of the knowledge. “Owning a type of knowledge brings joy and satisfaction to learners and it is highly likely that such learning would increase their retention of the new knowledge” (Kibirige & Van Rooyen, 2006: 8).

#### **1.4. Context of the study**

This research was conducted in my school in Mwaala Cluster Centre, Tsandi Circuit, Omusati education region, where I have been teaching Physical Science for the past 8 years. I developed a unit of work on chemical reactions which I implemented to my grade 9 learners of 2012. The topic of chemical reactions was chosen as it seems problematic and because learners are failing to answer national examination questions related to it (Namibia, Ministry of Education Examinations Report 2010, 2011).

Thus, my intention in this study was to discover the type of learning taking place when learners’ prior-everyday knowledge is incorporated with practical activities. I also realized that it is of great advantage when learners operate in their mother tongue (but this is not the focus of my study). Thus, code switching played a major role in this research. By doing this, I wanted to access the learners’ inner feelings but not necessarily to improve their English proficiency.

The language profile of the school is that all learners are *Oshiwambo* home speakers and yet they are being taught in English as their medium of instruction. This implies that they are

being taught in their second or third language and this makes communication difficult. Among the eleven teachers teaching at this school, there is only one *Silozi* first speaker. Others are *Oshiwambo* home speakers.

### **1.5. Problem statement**

Soon after independence, the Namibian Government and its departments including the Ministry of Education underwent a reform process. Many policies and directives were released, for example, *Toward Education for All: A development for Education, Culture and Training* (Namibia, MEC, 1993).

As in many other developing countries, the drive for political and social self-confidence has encouraged building science curricula based on learners' everyday experience (Kasanda, Lubben, Gaosed, Kandjeo-Marenga, Kapenda & Campbell, 2005). The emerged curriculum changes were; Curriculum 1993, Curriculum 1995, Curriculum 2000, Curriculum 2005 and Curriculum 2010.

The rhetoric surrounding the introduction of the new education system highlighted the pride in building sociocultural achievement of the diverse Namibian society aiming to improve the quality of education in Namibia. It criticized the apartheid education system of teacher-centeredness and replication of ideas which it contrasted with disposing learners to greater autonomy to construct meaning.

The current science curricula highlights local cultural achievement, the use of rural learners' everyday experiences as a means of widening access to education and so provide meaningful learning. However, the curriculum goal and implementation was not well understood by the teachers, they referred it as group work (Nyambe, 2008). It is against this background that science teachers failed to fully implement learner centered pedagogy as required by the curriculum (Namibia MoE, 2010).

International studies have shown that inclusion of learners' everyday knowledge and experiences in the teaching and learning of science is ignored (Kibirige & Van Rooyen, 2006). Therefore, my research sought to investigate the use of tooth decay as an example of

prior everyday knowledge and experience in the teaching science concepts. The central research goal was:

**An investigation into how grade 9 learners make sense of prior everyday knowledge and practical learning through exploring tooth decay problems in *Onangalo Village*.**

Over my eight years of science teaching experiences, I have developed an interest in finding ways to incorporate learners' prior everyday knowledge and experiences in the teaching of science. Therefore, this research is significant for me as a science teacher seeing that it involves a real life situation applicable to the school science.

#### **1.6. Potential value/significance of the study**

This study would be a valuable source of information to learners, teachers, educational planners and the community. The research helped me to improve my pedagogical content knowledge (PCK), in particular, how to integrate learners' prior everyday knowledge into my science lessons and how to deal with the difficulties of doing so, specifically in the area of chemical reactions.

Since education planners are responsible for formulating education guidelines, and this research could be useful to them to make appropriate decisions. This includes the shaping of the curriculum and other educational policies. The curriculum should not be based on rote learning but rather on understanding through the use of learners' prior everyday knowledge. Hopefully, the lessons I learnt might be of use to other teachers who are teaching, Physical Science, in particular, chemistry.

The community at large should make use of this study to see the significance of their everyday knowledge for science education. Their legacy of knowledge and skills are vital in the Namibian current educational system.

I also hope that learners would also realize the importance of their everyday knowledge. Furthermore, addressing the community problem of tooth decay, learners might go back to the community to share their classroom science experiences with the community.

## 1.7. Definition of concepts

The followings are key concepts used in this research;

*Sense making-* is the ability for learners to relate scientific concepts to their existing knowledge /real life experience.

*Prior everyday knowledge-* is the knowledge, skills and interests that learners acquired daily from their experiences in and outside the school.

*Indigenous knowledge-* is a local, tacit and traditional ecological knowledge that science learners use as a ladder to cross over to classroom science.

## 1.8. Thesis outline

This thesis documents the findings from an investigation into how grade 9 learners make sense of prior everyday knowledge and practical learning through exploring tooth decay problems in Onangalo Village. It comprises six chapters.

**Chapter 1** discusses the background of the research study. This describes what triggered me to research the particular topic. The relevance of the research to learners, teachers and educational policy makers are also discussed.

**Chapter 2** investigates what literature says about the subject of my thesis. It focuses on what other researchers have said about the cause of tooth decay, the role of indigenous knowledge (IK) and practical work in the science lessons.

**Chapter 3** focuses on the research design, methodology, research goals and questions in more detail. The research goals are what I set out to achieve whereas the research questions are the lenses that assist with the realization of the research goals. Furthermore, the data gathering tools are also discussed in this chapter. I also discuss validation of the data gathered as well as ethical issues with regard to the research.

**Chapter 4** presents and analyses findings from brainstorming sessions and questionnaires, which constituted phase one of the data research instruments. Here raw data sets are

presented, analysed and immediately discussed. This helps to organize the findings and ideas in a logical way and keep focus.

**Chapter 5** presents and analyses findings from data research instrument phase two, which comprised discussion; practical observation activities and work-sheets; focus group interview with learners and informal discussion with a critical friend. The data presented and analysed in this chapter are those from the practical activity which is the main data gathering tool.

**Chapter 6** consists of interpretation and discussion of data presented and analysed in Chapters 4 & 5. A critical scrutiny and the development of analytical statements are also provided in this section.

**Chapter 7** pulls together ideas from the thesis findings to form a conclusion. The summary of the main findings of the research are presented. It ends with recommendations highlighting how this research could be improved.

## **1.9. Concluding remarks**

This first chapter served to situate my study. It further provided some motivation for the research in education, specifically science education. The goals and research questions were outlined. The last part of this chapter gives a brief overview of the thesis chapters. In the following chapter, a detailed literature review will be provided.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1. Introduction

The goal of this research study was to investigate how grade learners make sense of prior everyday knowledge and practical learning through exploring tooth decay problems in *Onangalo* Village. In this chapter, I review the literature relevant to my study, namely; the Namibian curriculum itself, learners' prior everyday knowledge as advocated by the Namibian curriculum, the nature of science and digestive system. This existing information acts as a catalyst for pursuing my research goal.

The chapter further extends to the role that indigenous knowledge (IK) plays in classroom science. I also explore the relevant theories related to the phenomenon under this study. These theories are central for my research study as they provide the conceptual frame work. According to Burton, Brundrett and Jones (2008), literature review is a process involving reading, understanding and forming conclusion about theories in a particular topic.

#### 2.2 The Curriculum in Namibia

Before independence, the Namibian curriculum was framed in terms of content-based and teacher-centred education (TCE) (Nyambe, 2008). In such a teaching approach, learners were viewed as passive receivers of knowledge from the teacher. Also, learners were not encouraged to use their background knowledge or to construct their own knowledge (Ministry of Education and Culture, 1993). Instead, learners were required to learn through rote and memorization. Furthermore, in such teacher-centred pedagogy, the teacher is regarded as the only source of knowledge.

This pre-independence curriculum was not widely accepted because it was examination driven, not skills oriented, it encouraged learners' passivity, was racially and ethnically segregated and not in the interest of Namibia and her people (Amukugo, 1993; Nyambe, 2008). With this curriculum, Gosling (2004) argues that learners were taught by way of lectures, non-participative demonstrations, and 'cook book' laboratory exercises. As a result,

learners left the science classroom with only a vague understanding of the subject content. Understandably, learners did not like science and did not pursue science-related careers. Gosling (2004) noted that former science learners who were taught in the colonial era can remember physical science as their ‘worst subject’ and that their negative memories included their image of lecturers and laboratory experiments.

Soon after independence in 1990 and based on this situation, a paradigm shift towards learner-centred education (LCE) pedagogy was adopted whereby learning was seen as an active process. LCE was regarded as an education for all. During the period of transformation, the education system underwent a major overhaul in line with the political imperatives of access, equity, quality and democracy (Pomuti, LeCzel, Liman, Swarts & van Graan, 2003). As Nyambe (2008: 15) noted, LCE has a pedagogy underpinned by “emancipationist and liberation ideals that was adopted as part of political imperative to transform, democratise and humanize teaching and learning in post-apartheid Namibia”

LCE is a democratic pedagogy characterized by learning as an interactive, shared and productive process. Kasanda, Lubben, Goaseb, Kangeo-Marenga, Kapenda and Campbell (2005: 1807) too explain LCE as:

- *The starting point is the learners’ existing knowledge, skills, interests and understandings, derived from previous experience in and outside the school; and*
- *Learners should be empowered to think and take responsibility not only for their own but also for one another’s learning and total development.*

LCE aims to recognise the local knowledge available within the socio-cultural environment of learners. It also aims to widen accessibility of education in the face of teacher’s complaints that they do not have teaching and learning materials to promote learner engagement (Angula & Grant-Lewis, 1997). In this pedagogy, learners have to take responsibility of their own learning and that of other learners. Knowledge is viewed as socially constructed through active participation, interactions and dialogue. The learner view in the above education system is described as:

Even very young children have a store of rich experiences. Building on learners experiences is a sound way to stimulate interest and to lead into new and more significant and practical learning. A learner-centred curriculum seeks to do just that:

to begin with learners' interest and experiences and to use them to lead learners toward what is less familiar and not yet familiar (Namibia, Ministry of Education and Culture, 1993: 61)

Furthermore, in this approach a learner is viewed as someone who is highly motivated, with enthusiasm and eager to learn from teachers and from other learners as well as from the environment. Nyambe (2008) notes that the learner is viewed as an acquirer, a problem solver, and as someone who is critically and constantly posing questions to better understand the learning task at hand. This implies that a learner is an active partner in the learning process who can be involved in decision making and implementation of the curriculum.

On the other hand, the LCE has been criticised as a call to chaos and anarchy in schools as it is disempowering teachers. It is said to have a hidden agenda of being a political artefact or ideology that facilitates westernization and capitalist penetration under the guise of democratisation (Nyambe, 2008: 37). LCE is seen by some as a tool used by westerners to drive for capitalist penetration of developing countries. Nyambe states that in case of Namibia, "LCE is a political agenda driven from political imperative of democracy, empowerment, social justice and equity" (ibid).

This transformation process is further influenced by international forces and forces of contestation (USAID, 2006). Thus, the introduction of LCE has side lined and labelled TCE as a bad approach blamed for failures in schools (UNESCO, 2006: 45). Teachers who went through the training of LCE commented "*LCE is the most useful form of approach for becoming a better teacher*". They over judge TCE that it views learners as empty buckets which need to be filled with the 'true' knowledge from the teacher. Yet, the learner's mind is not a *tabula rasa* (Odora-Hoppers, 2001).

However, I believe the two methods could be both beneficial when used effectively. They should be seen as complimenting one another during teaching and learning in the classroom instead of being seen as being mutually exclusive (Schraw, Olafson & Lori, 2002: 94). Schraw, Olafson and Lori (2002) further reiterate that there is nothing wrong with teacher-centeredness; both approaches (LCE & TCE) are as good when used to their best for the benefit of learners.

During this transformation process the Namibian curriculum was revised three times (C1993; C2000 and C2010). Syllabi and policies were created and implemented to meet the needs of the society as stipulated in the country's Vision 2030. To realise this vision, it is emphasised that teaching and learning should be planned in such way as to prepare and orient the future generation towards development (G R N, 2004).

Thus, the Namibian education system currently operates as a totally integrated, unified flexible and high quality education and training system that aims to enable all Namibian learners to take advantage of a rapidly changing global environment, including developments in science and technology, and so contributes to the economic and social development of the citizens (NDP 1 & NDP 2; GRN 2004). Moreover, the curriculum emphasizes that;

*A knowledge-based society takes its place in a context of globalization, where it is important not only to have knowledge and skills but also to strongly identify and value individual's culture as a nation. The concept of knowledge thus embraces indigenous and local national culture as well as international and global culture. Only with a strong cultural and individual identity and positive values that it is possible to influence globalization and not be overwhelmed by it (Ministry of Education, 2010: 8).*

In addition to this, the cultural ways of doing things should be fore-grounded and recognized in the teaching and learning across the curriculum. Similarly, the syllabus emphasizes that the learning of content should be based on the local Namibian context. The syllabus urges science teachers to use local materials and examples to explain concepts and processes (Namibia Ministry of Education, 2007).

To apply this in my study, I took the function of teeth in digestion which is a universal and common experience associated with eating. Mechanical digestion is the breaking down of larger particles of food into smaller particles without any change in their chemical composition. During mastication (the chewing and grinding of food by teeth), the bacteria in our mouths act on food remaining on our teeth after swallowing to produce acids. These acids react with calcium to destroy the enamel and start a cavity.

Despite this common experience, the topic of chemical reactions is regarded by most science teachers as one of their concerns because learners are not performing well in answering external examination questions related to this topic (Ministry of Education, 2009). For

example, learners cannot explain clearly the difference between exothermic and endothermic reactions and they cannot write the correct equations or balance them.

As a result, a suggestion was made during a teachers' conference to give science teachers' workshops on how to teach this topic because it seems most teachers lack the subject content knowledge (SCK) as well as the pedagogical content knowledge (PCK) (Shulman, 1986/1987). Shulman refers to PCK as the capacity of a teacher to transform the content knowledge s/he possesses into forms that are pedagogically powerful and adoptive to the background of the learners. In the same context, teachers are encouraged to know all their learners well and render proper subject assistance whenever possible.

Evidently the basic competencies for the topic of chemical reactions are not being met as stipulated by the science curriculum. The competencies in the Grade 9 syllabus entail that learners should be able to:

*Give everyday examples of chemical reactions; observe and explain how chemical reactions occur; explain and classify reactions as exothermic and endothermic; write chemical reactions in words and symbols; and write balanced equations for simple chemical reactions (Namibia. Ministry of Education Physical science syllabus 2010: 45)*

I also find it challenging to teach this topic on chemical reactions. I can remember one of my learners (a boy in grade 10, 2011) saying this to me during the introduction phase of the topic on chemical reactions: [*Sir, honestly, I hate that topic you rather excuse me (from the class)*].

Perhaps, the reason for this boy being in such a situation was that I divorced this topic from their everyday life experiences (Stears, Malcolm & Kowlas, 2003; Oloruntegbe & Ikpe, 2011; Rennie, 2011). All these scholars contend that relating science to learners' real life experiences has the potential to make it meaningful to them. Rennie (2011) argues that pedagogical knowledge is required for teachers to incorporate authentic community issues into the classroom. Home activities can also provide meaningful, experiential based teaching and learning and in-depth understanding of science concepts.

In planning the activities, a good teacher should always make an effort to link the activities to learners' everyday experiences. Yet, in most cases teachers ignore these opportunities as they do not wish to deviate from the planned lessons and their focus on school science.

As an example of everyday experiences from my cultural ways of doing things, we are encouraged by parents from a young age to chew a small branch of mopane tree or palm leaves (*Oshikamusino*) after eating supper and early morning. This was done to remove food remains (after supper), and bad smell (in the morning). This might well slow down the action of bacteria in our mouths. This would involve chemical reactions yet I never used it as an example during teaching and learning.

Henze-Rietved (2006) too posits that learning is integrally situated in the everyday world of human activities. It could be argued that some of practices might imply some scientific knowledge. We only need skills to unpack this useful knowledge to use it in our classrooms. For example, we are told by our grannies to clean our mouths every morning apparently to remove the bad smell of the night. Behind this idea, there is a lot of scientific knowledge which we need to unravel and make use of in our science lessons.

O'Donoghue, Lotz-Sisitka, Asafo-Adjei, Kota and Hanisi (2007) argue that human learning activities are social processes and learning is enhanced when related to real life contexts. This suggests that knowledge is constructed socially in a social setting. That is, real life situations can be used as a catalyst to foster meaningful learning.

This resonates with the pedagogy of LCE, which views learning as occurring through social interaction, between learners themselves, with the teacher or with the materials or environment in which they live. In addition, learners learn best when they apply what they learn in class in their real life situation.

The predicament, however, is that most physical science textbooks that teachers and learners are using as resource materials describe chemical reactions as happening when two or more atoms and/or elements combine together chemically. This can be represented by means of a chemical equation. For example, when magnesium reacts with oxygen in the air, magnesium oxide is formed. From this reaction, emerge concepts of equation, symbolic equation balancing of equation. This seems to be too abstract for learners to understand and make

sense of. What learners know from home and their environment is not recognized or foregrounded during teaching and learning. Many home experiences can be used and shared in conjunction with school science.

With this in mind I used a community problem that learners are familiar with to mediate the teaching of the topic of chemical reactions. Most of the people who live in *Onangalo* village experience tooth decay problems, which obviously involves chemical reactions. This may lead to the exploration of biology (digestive system) and chemistry around this topic.

Oloruntegbe and Ikpe (2011) and Rennie (2011) suggest that motivation and performance in basic science can be enhanced by building on the relevant experiences of learners from whatever background through a 'place-based' approach to learning within a framework of experiential education. From this perspective, the context of the learning which is the background surrounding the learner is an all-important factor for learning and that is the focus of my study.

### **2.3 The role of prior everyday knowledge in learning**

According to Roschelle (1995: 1), learning proceeds primarily from prior everyday knowledge and only secondarily from the presented materials. Learners only make use of the materials presented to them to enhance their understanding once their prior knowledge is elicited. If learners' prior everyday knowledge is neglected, the intended outcomes of the learning process cannot be realized.

It is thus very important to understand the prior knowledge and the role it plays in bringing understanding of the scientific concepts in science classrooms. This helps learners to craft new experiences easily because they assimilate the new information into what they already know (Mwamwenda, 2004). The prior everyday knowledge that learners come with should be used as a foundation for classroom science study.

In this regard, the science subject content should be presented with the materials that are familiar to learners and then build on that. Roschelle (1995: 71) argues that learners only modify and re-structure what they already know into the required knowledge of the subject

content. Furthermore, she argues that “prior knowledge is best seen as raw materials to be refined” (ibid).

With the use of prior everyday knowledge, the position of the teacher is to mediate learning. This implies that the teacher’s role is not simply to transfer knowledge to learners, but to create conditions in the classroom where learners can construct different understanding of the concepts taught. Potenza (2002: 1) emphasizes that being a mediator “requires you to be sensitive to the diverse needs of your learners, construct appropriate learning environments and demonstrate sound knowledge of your subject”.

#### **2.4 The nature of science (NOS)**

For years, science education has been thought of as being characterized by the Nature of Science (NOS). According to Vhurumuku and Mokeleche (2009: 97), NOS is referred to as “the epistemology of science, science as a way of knowing or values and beliefs inherent to the development of scientific knowledge”. They explain that NOS is primarily understanding of western science. The NOS helps us to think and improve our own scientific way of doing things.

Since there are adequate resources in the teaching and learning of NOS, this makes its implementation relatively easy. “Teachers rely heavily on materials for teaching and there are not many resources that explicitly show the relationship between science and society in an everyday context” (Aldous & Rogan, 2009: 71). Therefore, teachers tend to focus on teaching NOS rather than indigenous knowledge that lacks materials and resources.

However, I believe that a good mediator is one who tries to create conducive learning environments for his/her learners by improvising with the available materials (Kasambira, 1993:107). That is, teachers are encouraged to make use of easily accessible materials, from home and environment to make their lessons enjoyable and meaningful for their learners. Teachers can also make use of rich resources of human materials, that is, the learners’ themselves are seen as sources of subject content knowledge.

However, what could be a challenge is that some teachers might not have adequate content knowledge, ideological, theoretical and practical experiences of the NOS. Aldous and Rogan

(2009:70) add that, “Teachers have been taught science as theory throughout their training and have for years taught it the way they learned it”. This is because teachers and learners believe that NOS is a foreign concept that is used by the dominant Western group to subordinate local people so as to maintain the status quo after colonization (Kocakulah, Kocakulah & Austuluoglu, 2005: 25).

NOS is seen as a very powerful tool of scientific knowledge. It is perceived as the only ‘true’ knowledge that makes meanings to real life situation. Ogunniyi and Ogawa (2008:7) argue that “science is right and done by the elite group”. They further claim “it is the only source of knowledge that liberates the society and is clean in all aspects” (ibid). I completely disagree with these authors. All persons at any age can learn science provided they are given the necessary conditions.

## **2.5 The role of indigenous knowledge in teaching and learning science**

Kibirige and Van Rooyen (2006: 2) define Indigenous Knowledge using four phrases; as “a legacy of knowledge and skills unique to a particular indigenous culture; as involving wisdom that has been developed and passed on over generation, as local knowledge derived from interactions between people and their environment and as a form of traditional wisdom, this knowledge is the product resulting from a community of practical engagement in everyday life”. These types of knowledge have been ignored for many years in the science curriculum. Cultural practice and prior every day experiences can be used as a ladder to the nature of science. Cultural principles should be used as a contextual lens through which learners gain an understanding of science.

Lending support, Ogunniyi (2007: 965) argues that IK is a way of knowing and interpreting experience to a particular cultural group. IK is a locally based knowledge which is rooted in a particular community and it is tacit knowledge. IK encourages constructive discussion and argument in the classroom situation. As we might be aware, classrooms or schools are societal structures which accommodate students from different cultural backgrounds. In other words, classrooms are multicultural and multilingual structures.

Ogunniyi (2007: 970) states that, “Interactive classroom arguments and dialogues have tended to encourage teachers and students to alternative viewpoints on the subject matter”.

Ogunniyi further adds “from social–cultural and psychological perspectives, interactive classroom arguments and dialogue can help teachers and students to clear their doubts, upgrade current knowledge, acquire new attitudes and reasoning skill, gain new insights, make informed decisions and even change their perceptions” ( ibid).

These authorities agree that it is important for teachers to include indigenous knowledge (IK) in their teaching of science in order to make learning relevant to their learners’ everyday lives. Therefore, school curricula should connect science to learners’ everyday life experiences and focus on everyday life application of science in schools (Oloruntegbe & Ikpe, 2011). It is important to note that IK and western knowledge are not at different poles but rather they complement one another. For example, traditionally, people use friction of stones and wood to produce fire, which is the same principle used to light a matchstick.

Learners’ enthusiasm and motivation can be developed by using their indigenous knowledge. They might feel proud that their knowledge and culture are being acknowledged in their learning process. Their values are also recognized in the sense that they build on what they already know. In fact, they construct their own knowledge embedded in and directed by their values, beliefs and social environment. This could form the basis of teaching and learning. In other words, they build from known to unknown (Roschelle, 1995).

Kibirige and Van Rooyen (2006:8) support the above idea by stating that “using indigenous knowledge as a starting point for the exploration of scientific concepts and inquiry procedures helps learners to learn more with understanding”. Furthermore, research has shown that historically most countries in the past ignored IK in science curricula and many cultural knowledge and value system have not been considered (Namibian Curriculum 2010; Agea, Lugangwa, Obua & Kambugu, 2008). As a result, students do not see the importance of their environment as a valuable resource for their study. In the context of the Namibian Ministry of Education (2010) Curriculum, the principle is further articulated in the science syllabus:

teaching and learning should be characterized by critical thinking, investigating phenomena, interpreting data, and applying knowledge to practical skills and abilities which are essential to understanding the value and limitations of natural scientific knowledge and methods, and their application to daily life (Namibia, Ministry of Education, 2010, p. 2).

Thus, teachers are advised to employ various teaching strategies and identify the indigenous knowledge that learners bring to class. In other words, teachers should present learners with thought-provoking questions gathered from their society, so that learners could value their local knowledge.

For example, what is the importance of cleaning our teeth? This is a good example that learners may use to improve their subject content knowledge while at the same time improving their health and that of the community. This was the focus of my study.

As another example, in *Owambo* culture food such as beans, fish, mopane worms, and meat are sun dried to preserve them. This technique could be compared to the western ways of canned meat and smoking food for the same purposes. Recognition of IK could inspire learners to be responsible citizens and that could bring about knowledge in terms of food production and storage. It should be recognized, however, that consideration of IK does not necessarily guarantee meaningful learning. Rather, some IK can be a source of misconceptions in the science classrooms.

In their study in Uganda on IK for food security, Agea, et al. (2008) found out that the use of local knowledge in enhancing food security could improve agricultural productivity which has become an important issue in sub-Saharan countries. The methods used to preserve food are basically same. This helps learners to relate what they are learning to what they do or have seen done in the community.

It is through such arguments that IK is said to compliment learners' understanding of the world around them. For example, in Caprivi there is a cultural belief that girls should eat the soil to make their wombs strong. This seems to be acceptable in this community irrespective of the level of individuals' education. This could afford teachers an opportunity to ask some questions on how IK enriches students' understanding of natural phenomena from multiple perspectives as long as they know which perspective is appropriate for a given context.

## **2.6 Practical activities in the teaching and learning of science**

With change, development, individualization and globalisation, the science curriculum should strive to address the needs of the society. In this sphere the curriculum was revised, syllabus and policies were created to meet the change (Namibia Vision 2030 sees Namibia as

developing from a literate society to a knowledge based society where knowledge is constantly being acquired and received) (National Curriculum, 2010). The science curriculum emphasized the role of practical work in improving the quality of teaching and learning activity which at some point involved the student to observe and manipulate the materials (Millar, 2004: 2). Pea (1993: 273) defined practical work as a “philosophical investigation by which meanings is communicated and concepts developed”.

### **2.6.1 The benefits of practical activities in the teaching and learning of science**

Practical work is regarded as beneficial, not only to science teaching but to most subjects within the scope of Education. It arouses learners’ interest and eagerness to learn. Hodson (1990: 33) states that practical activities “allow development from concrete situation to abstract ideas and can be the vehicle for arousal of curiosity and appreciation of aesthetic aspects of the subject”.

By doing practical work, learners become motivated and enjoy lessons as they learn. This provides a conducive and lively environment for learning science concepts and subject matter. Learners become free to participate since they become actively involved in the construction and reconstruction of science knowledge.

Millar (2004:7) states that, “learning science should involve seeing, handling and manipulating real objects and materials and that teaching science will involve acts of showing as well as telling”. Millar (2004: 14) and Maselwa and Ngcoza, (2003) argue that learners can be more effectively involved through minds-on as well as hands-on when they feel they understand how the equipment they are using works. Millar (2004: 18) further explains, “practical work is essential for giving students a feel for the problematic of the ever presence of uncertainly”. He further argues that practical work is an important tool for teaching about experimental designs in the science classroom.

Vygotsky (1978) believes that when children take part in hands-on activities; they always perform above their average age and above their everyday behavior. He further states that what children can do today with the help of others, they are able to do alone tomorrow and he referred to this as the zone of proximal development (ZPD). Goos (2004) describe the ZPD as the distance between a child’s problem solving capability when working alone and with the assistance of a more advanced partner. Notably, when learning of science is through practical

activities, learners get used to handling the equipment and materials as a form of scaffolding for learning.

Berk and Winsler (1995: 30) define scaffolding as a “warm pleasant collaboration between a teacher and learners while the two are engaged in joint problem solving activity”. The teacher as a coach supports the learners’ autonomy by providing well planned practical activities which facilitate their representational and strategic thinking in developing scientific knowledge. Thus, a conflict develops between the teacher and learners and between learners themselves during practical.

Piaget highlighted the role of conflicts, especially between peers. “Through argument and disagreement with age-mates children are repeatedly jarred into noticing that others hold viewpoints different from their own” (Berk & Winsler, 1995: 18). They further argue that contact with age mate is more valuable than with adults for stimulating cognitive change, since learners might superficially accept adults’ perspectives without examining them.

Teachers should model appropriate language use in the activities and tasks given to learners. Berk and Winsler explain this by stating:

*Once teachers began to design classroom activities that took into account children’s home language experiences, the formerly passive, reticent children become lively, eager participants (1995: 11).*

Group practical activities also empower learners by sharing the responsibility within their groups. A good example is when the teacher asks a group of learners to set up an electric circuit, some will be connecting bulbs and cells and some will connect the ammeter and voltmeter.

Hodson and Hodson (1998: 23) add, “Group work not only makes more likely the expression of alternative views about phenomena and events, it creates a forum for challenge, debate and the construction of meanings”. Furthermore, “Group works are in themselves teaching communities that can replicate essential features of scientific community” (ibid).

Arguments during practical work help learners to identify and correct misconceptions on a particular subject matter. Therefore, learners develop self-esteem, personal motivation and ability to solve problems in their social environment.

The role played by practical work is multifaceted. It is essential in developing learners' scientific knowledge. This is because learners have to play around with the materials, study them in terms of the observable characteristics. Piaget views the goal of education as to "create people with the ability to be creative, inventive and discoverers rather than those who constantly reflect on others ideas" (Mwamwenda, 2004: 95). He added;

*So we need pupils who are active, who learn early to find out by themselves, partly by their own spontaneous activity and partly through materials we set up to them; who learn early to tell what is variable and what is simply the first idea to come to them (Piaget, 1964: 5)*

Practical work helps learners to link the domains of knowledge and that of ideas (Millar, 2004, Maselwa & Ngcoza, 2003). This stimulates their thinking and eagerness to learn. Maselwa and Ngcoza (2003: 654) add that "practical activities get learners to become exposed to manipulating apparatus and thus acquire manipulative and observational skills". Hodson (1990), further claims that practical work improves learners' understanding since it allows development from concrete situations to abstract ideas and arouses curiosity. This is what the current Namibian curriculum advocates (learner centred education).

The other most important attribute of practical activities in the science classroom is motivation. According to Mwamwenda (2004: 231), motivation is referred to "external stimuli, either positive or aversive used to make individuals engage in certain behaviours". It is the energiser for learners to do their best. In this regard, practical work brings enjoyment since the participation of all learners promotes equal opportunities for all to partake in the learning.

This is what Gott and Duggan (1996) refer to as relevant communication and the ability to work with others. Practical work promotes environments of interaction. Interactive classroom arguments and dialogues have tended to encourage teachers and learners to externalize their viewpoints on any subject matter (Ogunniyi, 2007: 968).

Gott and Duggan (1996) further emphasise that motivation promotes social skills as well as development of experimental skills. Through practical work learners make use of their senses to become scientifically literate (Millar, 2004; Gott & Duggan, 1996). Through practical activities, learners pursue their own ways, explore their ideas and develop their self-reliance. This might help with some, but could be unrealistic to other learners. This is because not all learners can be motivated by the same thing; one size does not fit all.

Although learners should be encouraged to discover and explore learning for themselves, this is not always followed in practice. For example, learners in our school are not allowed to use test tubes to prevent breakage of these scarce resources. Instead, they merely observe the teacher demonstrating the practical activities. In my view, this denies learners opportunities to learn. They would become scared to even touch materials.

Millar (2004), continues; “practical work is important tool for teaching about experimental designs”. In essence, learners extend this to a sense of questioning their own practices (at home). For example, learners may ask questions such as: Why does my granny add sugar when preparing “*otombo*”? Why are we prevented from sleeping on our backs when it is thundering, and what is the use of old car tyres on top of traditional sleeping huts? These questions might stimulate arguments and discussions in science classrooms.

“Discovery learning is both an interesting and effective way of learning science and a powerful way of learning about methods and procedures of science” (Hodson, 1990: 36). Mwamwenda (2004: 193) adds, “discovery learning involves learners discovering what they are capable of doing and thinking for themselves. Wilmot (2002) adds that as children grow older; they appear to discover the need for imposing some sort of structure and organisation on what they are trying to learn. Through discovery, learners understand that there is no absolute ‘truth’ but multiple realities.

Moreover, Hodson and Hodson (1998: 23) explain that practical work helps learners to identify and correct misconceptions. This could also improve their communication skills (Gott & Duggan, 1996; Pea, 1993; Maselwa & Ngcoza, 2003). Learners can identify what is wrong and right in a particular experimental topic. This helps them to develop positive self-esteem and teaches them about social changes and how to adapt themselves in their situation.

This can only be achieved when science teachers are actively involving learners in the co-construction of their knowledge through well planned practical activities.

Practical work makes science easy, thus eliminating the myth that science is difficult. Learners can easily recall and remember what they did in class and refer it to real life situation, be it in problem solving or experimenting. Hodson (1990: 34) adds that “teachers have been subject to a powerful myth making rhetoric of profession that sees hands on practical work as universal panacea”. Indeed, practical work is one of the well-known strategies used in the learning of science but does not guarantee that learning will necessarily take place. It all depends on how well the lesson is prepared.

In addition, practical work stimulates and develops learners’ minds and prepares them for adulthood. Mwamwenda (2004: 84) argues in favour of the unique work of Piaget since that is based on intensive clinical and empirical investigations. This emphasises the usefulness of practical work to promote construction of new ideas by manipulating objects around in their environment. Piaget’s main area of focus is on **accommodation** (learning new structures to handle new information and experience) and **assimilation** (new experiences and information understood in terms of their similarities to previous experience and information gained). Whatever the knowledge that learners acquire through practical work causes conflicts in their minds and that brings about understanding. This results in scientific reasoning, discussion and explanations of scientific concepts.

Although it is not the focus of my study, language is an important aspect of learning and teaching. Vygotsky is one of the psychologists that highlight the role of language in the acquisition of new knowledge. As I have noted earlier, when learners are doing practical work they discuss, exchange ideas and debate using scientific language. Hodson and Hodson, (1998: 36) remark that “It is through social interactions – initially with parents or other care givers, family members and peers, later via teachers and other knowledgeable adults – that children learn the cognitive and communicative tool and skills of their culture”. This implies that language is the vehicle through which ideas are exchanged and concepts developed. As a tool, language creates the possibility of thoughts, organizes the thinking processes and both reflects and shapes the human society in which it is used.

In the same vein, language plays a major role in the scaffolding of learning. Teachers communicate to learners and vice versa, through asking of questions and debating. As Hodson and Hodson (1998: 36) remark “teachers present ideas in advance of development and create opportunities for students to use and take control of them”. Hodson and Hodson add “Responsibility is gradually transferred from expert to the novice until such time as the student is intellectually independent and no longer needs the teacher”. Hodson and Hodson (1998: 37) state that “teaching comprises of the activities associated with enabling the learners to participate effectively in the activities of the more expert and learning is seen as enculturation via guided and modeled participation”.

By engaging learners in practical activities, you are promoting the use of the enquiry method. It is through the enquiry method that scientific knowledge is propagated. This makes knowledge both valid and reliable. “The most effective form of learning is likely to be enquiry-oriented, personalized and collaborative and conducted in accordance with the norms and values of the scientific community under the guidance of a skilled practitioner” (Hodson & Hodson, 1998: 38).

### **2.6.2 Some weaknesses of practical activities in the teaching and learning of science**

Despite the universal consensus that practical work in science education has a legitimate role in the teaching and learning of science, it has many critics. The first point that I would like to make is that practical activities consume a lot of time. It takes time for the teacher to prepare practical work and also learners need time to work it out. Therefore, teachers tend to set up simple tasks to save time in order to finish the syllabus of the subject as prescribed by the Ministry of Education.

In addition, practical work is associated with a lot of misconceptions if not treated carefully. According to Millar (2004: 11), “If the teacher did not handle well the circumstances, under which practical work is done, it may lead to confusion and misunderstanding of the intended aim of the subject matter”. This might be one reason why most teachers do not prefer practical activities in their science teaching. Another reason might be that “external examination would not adequately reward such investment of time and energy since it requires time and thorough planning” (Hodson, 1990: 33). According to the science syllabus, grade 8-10, practical work covers 10% of the year assessment marks.

In the previous section, I pointed out that in using practical activities, learners become motivated and interested in the lessons. However, research has shown that it is unrealistic to expect all children to be motivated by the same thing (Hodson, 1990). This is to remind us (teachers) that there are other techniques that we can use in science lessons that might also stimulate learning, and to remind us that motivation is not guaranteed by simply doing practical work unless we provide exciting experiments (Hodson & Hodson, 1998: 35).

It is also not always easy to make observations, to collect data and to draw conclusion during practical activities. The teacher already knows the procedure and steps to be followed and their outcome, but these do not necessarily appear as natural for the learner. The exercise could be more valid if learners are allowed to pursue their own investigation using their own procedures and methods. According to Hodson (1990: 34), “It would have more validity if experiments in class had a visual stimulus, a positive outcome and if they worked successfully”.

However, both conceptual and practical work is required to bring about understanding. Therefore, learners need to discover fully by receiving proper guidance from the teacher. “Not only does discovery learning fail to ensure that children have the appropriate conceptual framework, it ignores totally the likelihood that they may have alternative conceptions” (Hodson, 1990: 35). In essence, teachers should be well prepared as well as organized to avoid misleading results that differ from the intended outcome of the practical work.

## **2.7 Digestion and chemical reactions**

Digestion is the process whereby larger and complex particles of food are broken down to small and simple soluble particles of food which can be absorbed in the small intestine (Chikarango & Chauke, 2011: 57). Digestion of food starts in the mouth and ends in the small intestine, by the help of teeth, bile juice from the liver and enzymes. This can be either physical or chemical digestion. The former, refers to the digestion of food without any change in chemical composition. The activity is carried by teeth as they chew and grind to make food easy to swallow (physical change). The latter refers to the chemical break down of complex insoluble food particles into simple soluble food particles. It is helped by enzymes which are biological catalysts which speed up the reaction (chemical change)

- **Tooth decay**

Tooth decay is the damage of tooth enamel and dentine by decomposition reaction. It causes the development of a hole that becomes bigger and deeper, until it reaches a pulp cavity. It is caused by acids which react with enamel and decompose it. The acids are produced by bacteria in the mouth when they feed on sugar that remains in the mouth between teeth after a meal. The hole forms a trap for more food particles and continues to be fermented by bacteria and to form more acids (Chikarango & Chauke, 2011)

- **Chemical reactions**

All chemical reactions involve a change in a substance and a change in energy. Neither matter nor energy is created or destroyed in a chemical reaction. Chemical reactions are accompanied by one or more of the following changes (Matthews, 1995: 72)

- A substance disappears;
- A new substance is formed;
- The colour changes permanently; and
- The temperature changes.

## **2.8 Theoretical Framework**

This study is informed by constructivism, in particular, the socio-cultural perspective and social constructivism.

*In a constructivist perspective learning is seen as an active process involving the learners constructing meaning for themselves. The process requires the application of knowledge, skills and values. It is a problem solving approach, which leads to new knowledge for individuals. The basis for the approach is discovery learning: new knowledge comes from reconstruction by discovery (Vygotsky, 1987: 241).*

In accordance with this perspective, the Namibian curriculum policy advocates constructivist ways in teaching, whereby learners construct their own knowledge. In the constructivist approach, “learning is an active process involving learners making meaning on what they are learning, which requires the application of knowledge, skills and values” (Moll, 2002: 9).

The theoretical framework of constructivism is well explained and supported by many educational psychologists, such as Jean Peaget, Levy Vygotsky and the Gestalt psychologists, Bartlett, Bruner and John Dewey to mention a few. “The constructivist perspective emphasizes the active role of the learner in building, understanding and making sense of information” (Woolfolk, 1998: 277). Piaget’s theory focuses on constructivism based on children’s cognitive development. According to this philosopher, knowledge does not exist outside a person; it can only be constructed within the mind of an individual being (Mwamwenda, 2004). Cognitive learning views the learners a source of plans, intentions, goals, ideas, memories, and emotions actively used to attend, select and construct meaning from stimuli and knowledge from experience (Woolfolk, 1998: 245).

Also, Piaget’s main area of focus is on accommodation (learning new structures to handle new information and experiences) and assimilation (new experiences and information understood in terms of their similarity to previous experiences and information already gained). With regard to this case study I believe the community is rich of social and scientific knowledge of tooth decay and learners can build on this experience to accommodate and assimilate new information as they learn science.

Vygotsky (1978) talks of the zone of proximal development (ZDP). In this context, teachers have to take into consideration that learners are not of the same level. They have to create a situation so that learners can learn for themselves in a process of enquiry. In addition to this, Hodson and Hodson (1998: 33) explain that in a constructivist environment, students learn science best by making sense of their own world. Learners take advantage of what they know outside science classroom to help them understand school science. They further suggest that teachers should organise and plan activities which enable learners to participate effectively.

Brown (2009: 8) argues that constructivism should not be seen as transmission of knowledge but rather as a facilitating process in the construction of meanings. Nonetheless, it should not be seen as a teaching method *per se*. It is recognized, however, that this depends on the form of instructions provided. The basic approach for learning new knowledge is through discovery methods. I now discuss the two perspectives informing my study.

### 2.8.1 Socio-cultural perspective

Since this study has as a major, if not the defining feature, the inclusion of community experiences in the school science classroom, I see socio-cultural perspective as a very relevant theory. It provides a foundation on which I built to help learners better engage with and understand the science,

The socio-cultural perspective concentrates on the individuals' culture or society which helps to bring understanding in the classroom (Boran, 2008; Mark, 2009). These authors argue that socio-cultural theory views human cognitive development as transformational in nature and mediated by the use of tools.

Boran (2008:368) argues that the "Socio-cultural perspective foregrounds the environment in which an individual lives". It is crucial to start with what learners know from home or community since that is informed by their initial social structure. Hence, science teaching has to consider socio-cultural aspects of the learners.

In the course of my study, I needed to keep in mind the learning conditions and the interaction of individual learners with me as teacher and with their peers as well as the individual cultural backgrounds that might affect the success of acquisition of science knowledge (Boran, 2008). This was necessary to enable learners and myself to share ideas and to value our individual potential in the learning process. In particular, I had hoped that there would be many student-student as well as student-teacher interactions around different viewpoints on the causes of tooth decay in *Onangalo* Village

Lemke (2001) argues that the socio-cultural perspective attempts to situate science education in the broader material and cultural condition. We must see the role of social interaction in teaching and learning of science. In giving substantial theoretical weight to the role of social interaction we make it a central and starting point for learning.

Unlike before, during our time of schooling science was perceived as an abstract subject and has been the most disliked school subject. For this reason most learners opted rather to do agriculture and home science.

### **2.8.2 Social constructivism**

In this study, I used as guiding principles those advocated in social constructivism, viz., learning as an active and social process. Social constructivism recognizes learning as an active process of involving learners in tasks associated with making connection between their experiences and class extant knowledge (McRobbie & Tobin, 1997; Moll, 2002; Woolfolk, 1998). In addition, Vygotsky (1978) addresses the concept of social constructivism as:

Individual learning can be more or less socially-mediated learning, individual can participate in the learning of a collective sometimes with what is learned distributed throughout the collective more than in the mind of any one individual, individuals and social aspects of learning in both of these senses, can interact over time to strengthen one another in a reciprocal spiral relationship (Vygotsky, 1978: 123).

The social world surrounding learners refers to all people and things that directly affect them. This includes parents, teachers, friends, other learners, environments and all forms of activities in and outside the classroom. McRobbie and Tobin (1997: 205) argue that for learning to take place, the interaction between the learners and learning environment should be active. The learning environment in the class is considered as the experiential reality to be optimized for most effective learning.

In addition to this, learners should be involved in the creation of their own knowledge through social interaction (Moll, 2002). Moreover, Woolfolk, (1998: 279) is in support of social constructivism and sees knowledge as being constructed through social interactions and experiences. He continues that knowledge reflects the outside world as filtered through and influenced by culture, language, beliefs, interaction with others, teaching and modeling.

Also, social constructivism proposes that learners should be encouraged to be involved in putting language to ideas, testing their understanding with peers and listening to and making sense of the ideas of other students collectively (McRobbie & Tobin, 1997: 197). Piaget argues that through arguments and disagreements, learners are repeatedly jarred into noticing that other learners hold different viewpoints from theirs. It might indeed be more valuable for children to be in contact with other learners than with adults. It should be borne in mind that teaching science is not only for fun and pleasure, but above all for understanding. Learners should be enabled to apply what they learnt in class in real life situations experienced out of class.

Splitter (1991:101) argues that in a community of inquiry, “students and teachers become aware of themselves as thinkers but not merely as learners of other people’s thoughts”. In becoming aware, learners gain an opportunity to exercise autonomy if they make use of their local knowledge. In my case study, I wanted learners to intermingle their experiences and classroom science in order to make meanings through discovering things about tooth decay for themselves.

McRobbie and Tobin (1997: 197) argue that social constructivism has the role of active involvement by learners in tasks associated with making connections between experience and extant knowledge. They further argue, “learners’ use of everyday language, their learning to use the technical register of science in discussing and engaging in arguments over meanings they are giving to experience and the evidence relating to their knowledge claims are important components in making connectors and testify the viability of their knowledge” (ibid).

These are all forms of scaffolding which refer to interactions using tasks which the teacher has structured to allow learners to participate in joint activities that would otherwise be beyond their reach (Goos, 2004). The pivotal task of the teacher is therefore to structure learning activities and social interactions in order to increase participation and thereby promote scientific understanding. Peer interactions can create collaborative ZPD (the process of coming to *be* as well as coming to *know*) by interweaving spontaneous and theoretical concepts (ibid). These challenge the learners to integrate their existing language and experiences with the more abstract concepts and scientific terminology (Goos, 2004: 282). This makes a link between everyday knowledge and scientific concepts. Thus, social constructivism is said to be the act of acquiring knowledge in the course of social relationship.

Drawing from Vygotsky’s general genetic laws of cultural development, the new capacities in children are firstly developed during collaboration with adults or with more competent peers and then internalized to become part of a child’s psychological world. With this social setting, learning might take place. The role of education is to provide children with experiences that are in their ZPDs, and activities that challenge them but are accomplished

with sensitive adult guidance (Berk & Winsler, 1995). In this sense, science teachers carry much responsibility for making sure that learners' learning is maximized and actively leading them along the path of development.

## **2.9 Concluding remarks**

This chapter provided the theoretical support for my study. That assisted me to keep focused and make arguments based on my research topic. It also gave me a broad insight of thought on what other researchers say about the inclusion of IK in the classroom curricula. These insights improved my lesson planning. The studies that investigated the integration of prior every-day knowledge into the learning of science illustrated how this could be done practically without, however, anticipating all possible challenges that might emerge. I further explored how teachers, in general, negotiate or are expected to negotiate meaning of science. This was contextualized within the Namibian Education Curriculum.

Critical issues that emerged include the need for learners to be properly socialized on how to learn and do science, appropriate subject representation as well as the need for teachers to be able to understand how learners acquire scientific knowledge. This work was explained in the context of socio-cultural theory as well as social constructivism. The next chapter presents the research design and methodology in this study.

## CHAPTER THREE

### RESEARCH DESIGN AND METHODOLOGY

#### 3.1. Introduction

Methodology refers to the range of approaches used in educational research to gather data which are to be used as basis for inference and interpretation for explanation and prediction (Cohen, Manion & Morison, 2010: 47). The content of this chapter constitutes planning the research journey. The notion of planning a research journey is shaped by its purpose.

The chapter begins with a discussion of the philosophy underlying the research design. Then I focus on the research goals, research site and participants. Data gathering techniques used in this study are then discussed as well as ethical considerations.

#### 3.2. Research design and methodology

##### 3.2.1. Paradigm

The concept paradigm refers to the way we observe, think and understand the world and draw conclusions about the phenomena. My research case study is located within the interpretive paradigm.

##### **The philosophy underpinning the research methodology**

This research study is positioned in an interpretive paradigm. Interpretivists “provide the meanings and purposes attached to human actors to their activities” (McRobbie & Tobin, 1997: 194). Cohen, Manion and Morrison (2010: 182) describe the interpretive paradigm as having the focus on practice, intervention and interpretation with the aim of improving the situation. The goal of this interpretive research is for me to attain an understanding of how to teach chemical reactions from learners’ everyday knowledge. The classroom in this context was the best natural environment which enhanced the understanding of chemical reactions. This entails that learners were given the opportunity to identify the problem in a guided manner so that they could explore, extrapolate and discover (Nyambe, 1993).

In my case, I wanted to improve meaning making and the conceptual understanding of chemical reactions through practical investigations. Practical investigations refer to activities where learners are required to plan and carry out investigations, and collect and analyze information and finally report it (MoE, 2010: 63). The practical investigation which I planned and carried out with my learners was based on chemical reactions relating to tooth decay which is a problem in our community. I had hoped that such an activity would create a good starting point; provide inquisitiveness and eagerness for learners to learn better.

### **3.2.2. Qualitative case study**

My research is a qualitative case study. According to Wilkinson (2000: 270), qualitative research attempts to “study human actions from the perspective of the social aspect with the goal of describing and understanding rather than explaining human behaviours”. Qualitative research helped me to capture actions as they occurred in the classroom. In addition, it was essential because it gave me opportunity to take into account factors of complexity, mutual causality, indeterminacy and perspectival view of the social reality. These factors are not always catered for in mainstream scientific study like those of quantitative paradigm (Stake, 1995).

Punch (2005) describes the case study as one that aims to:

Understand the case in depth and in its natural setting, recognizing its complexity and its context. It also has a holistic focus, aiming to preserve and understand the wholeness and unity of the case. Therefore the case study is more of a strategy than a method. We can define a case study as a phenomenon of some sort occurring in a bounded context. Thus the case may be an individual, or a role, or a small group, or an organization, or a community, or a nation. It can also be a decision, or a policy, or a process, or an incident, or even of some sort [.....]. (Punch, 2005: 144)

Through the qualitative case study method, I was able to generate “rich, vivid and thick descriptions of data from the data generation techniques” (Cohen, et al., 2010). The data acquired from this case study, provided descriptions of current conditions and revealed information that might help inform a new idea for further research.

### **3.3. Research goal and questions**

The main goal of this research study was to investigate how grade 9 learners make sense of prior everyday knowledge and practical learning through exploring tooth decay problems in *Onangalo Village*.

**To achieve this goal I tried to answer the following questions:**

- 1. What do learners think are the causes of tooth decay problems in *Onangalo village*?**

To answer this question, I made use of brainstorming lesson during the normal class lessons. A video tape was taken during this lesson and note writing was done by a critical friend. The data generated from this session was transcribed and interpreted by me and validated by the critical friend.

- 2. What do community members think are the causes of tooth decay problems in *Onangalo village*?**

To answer this research question, questionnaires were used and these were administered by learners to members of the community whom they are familiar with. The use of questionnaires was informed by the initial stage of brainstorming as they triangulate each other. An audio and video recording was used during this second session. The data generated was transcribed and interpreted as far as possible.

- 3. How does the selected intervention approach of using tooth decay problem (everyday experience of chemical reaction) mediate understanding of prior everyday knowledge and concepts in chemistry?**

This question was divided into two sub-questions;

- a. Does affording learners an opportunity to brainstorm and find out about the causes of tooth decay problems in *Onangalo Village* enhance/constrain learner engagement and meaning making of prior everyday knowledge?**

To answer this sub-question, a practical activity was planned based partially on the learners' findings from the community as well as from the brainstorming session. A video record was taken, which I watched and discussed with my critical friend and thereafter transcribed it.

**b. Does engaging learners in practical investigations associated with tooth decay enhance or constrain meaning making of concepts in chemistry?**

To answer this sub-question data were obtained from observation, focus group interview, and audio video as well as from a stimulated recall interview with the critical friend. Data were also obtained from the learners' worksheets.

### **3.4. Research site and participants**

My research participants comprised of my grade 9 class consisting of 20 learners in *J.K.* (pseudonym) Junior Secondary School, *Omusati* Region, Northern Namibia. The reason for choosing this class was because it was the only grade 9 class I was teaching at the school at the time of this study. Another reason of using my own class was that the research process would not deviate from my normal teaching programme and I therefore did not expect any resistance from my learners with whom I had established a good rapport. Also, all the learners in this class were from the same community.

A teaching and learning unit of work based on chemical reactions was developed to facilitate the learning process. I also worked with one critical friend who volunteered to be involved to see what I was doing. This critical friend gave me feedback throughout the process since it was not easy to assess my own practice.

#### **3.4.1. My role in the research study**

My role in this research process was to:

- ✓ Facilitate the whole research process throughout;
- ✓ Do the planning and the teaching throughout the case study session;
- ✓ Familiarize the critical friend with the materials to be used and discuss her role in this research;
- ✓ Be in touch with my supervisor, to update him of my research progress;
- ✓ Transcribe and interpret video and other data gathered in a useful way; and
- ✓ Write the report of my findings in an easy and accessible language.

### **3.4.2. A critical friend (a Life Science teacher)**

Since it was not easy to observe my own practice, I invited my colleague to observe my lessons and she helped to

- ✓ Write the reflections;
- ✓ Assists during research process where possible, for example assist learners during the lesson discussion, practical activities *etcetera*;
- ✓ Assist me in planning where possible;
- ✓ Watch the video with me and do the discussion;
- ✓ Validate data gathered; and
- ✓ Triangulate data (investigator triangulation).

### **3.4.3. Learners**

Learners were the crucial participants in this study. They did the various activities which were the unit of analysis. Their roles were:

- ✓ Participate in the lessons;
- ✓ Identify community member(s) who they know well and gather the data using the questionnaire provided;
- ✓ Report their finding in groups and to the rest of the class;
- ✓ Work out the practical activity; and
- ✓ Keep journals to record their experiences throughout the research process.

## **3.5. Data generating techniques**

Data gathering techniques refer to the range of approaches used in educational research to gather data which were used as a basis for inference and interpretation, for explanation and prediction (Cohen, Manion & Morrison, 2010: 47). The data gathering techniques that I used in this study included brainstorming and discussions; questionnaires; interviews (focus group and stimulated recall interviews); observation, practical activities and worksheets. A variety of data gathering techniques were used so as to complement one another (methodological triangulation). The following table summarizes the data gathering techniques that I used in this research.

<b>Stages</b>	<b>Methods used to generate data</b>	<b>Data generated</b>	<b>Purpose</b>
Stage 1	Brainstorming and discussion <i>(Lesson)</i>	Different learners' thoughts (prior everyday knowledge) on the causes of tooth decay.	Aroused group attention and to generate ideas on what they think causes tooth decay. This helped me to understand what related knowledge they bring in the science lesson to move from known to unfamiliar.
Stage 2	Questionnaire with closed and open-ended questions <i>(research project)</i>	Various community members' thoughts onto the causes of tooth decay etc.	Developed young citizens into researchers. Learners went into the community with questionnaires to gather topic related data thereby gathered quality data. Learners' engaged with the community- they only asked people whom they know well or are familiar with or even their family members since it is individual task.
Stage 3	Discussion <i>(classroom lesson 2)</i>	Learners sat in small groups, presented their findings to the entire class and information generated was documented on news prints.	For learners to present their group findings to the whole class on to what community members think causes tooth decay
Stage 4	Observation; Practical Activities and Worksheets <i>(classroom lesson 3)</i>	I presented a lesson on chemical reactions using common beverages to illustrate the process of chemical reactions on animal teeth. Followed a unit of work was given to the learners. This lesson took over a week because reactions need time to show results.	Drawing learners into science; evaluated my own practice; saw how practical activities enhanced/ or constrained the learning in science classroom.

		Learner engagement in the lesson; how they did observation and how they communicated the findings of experiment ( <i>Predict Explain Explore Observe Explain approach</i> ) (see Maselwa & Ngcoza, 2003)	
Stage 5	Focus group interview with learners	To complement the data generated previously; Hear their feelings about the whole process and how practical activities assisted them in the learning of sciences in particular to understand chemical reactions within their scope.	To get views on the best tool and approach in science classroom; triangulated the data gathered in the process as well as to validate data.
Stage 6	Informal discussion with a critical friend	Heard feelings and reflection on the research process, suggestions for future research, complements etc.	Triangulated and validated data gathered

**Table 3.1. Shows the different data gathering techniques**

### **3.5.1. Brain-storming and discussion**

Brainstorming refers to “a group creativity technique by which a group tries to find a solution for a specific problem by gathering a list of ideas spontaneously contributed by its members” (Furnham & Yazdanpanhi, 1995). This was the first part of the research process. It was done in the classroom during normal class lessons, with the whole class. The lesson was planned with the aim of eliciting learners’ prior-everyday knowledge and experiences (Roschelle, 1995) on the causes of tooth decay in *Onangalo* Village. This lesson allowed free discussion on the topic. During this lesson, the emerging ideas were written in the journal. This lesson was videotaped and the critical friend was present to discuss and write some reflections on the lesson. The brainstorming session led to the next step of questionnaire where learners asked people whom they know well in *Onangalo* Village about tooth decay problems.

### 3.5.2. Questionnaires

A questionnaire is a series of questions set out on paper and to be answered on paper rather than verbally (Cohen, Manion & Morison, 2010: 125). Questionnaires generally provide space for an answer or offer a number of fixed alternatives from which the respondent is requested to make a choice (Irwin, 2011: 1). The use of questionnaire (see Appendix C) in my study does not entail that this research was quantitative. However, it was intended to dig in depth into what community members think is the cause of tooth decay and so equip learners with research skills as young scientists.

Each learner in the class was developed into a researcher. Few questions, both closed and open-ended questions (about 10) were formulated based on my research goal. These were aimed to guide my learners during the process. In addition, open-ended questions enabled respondents to answer as much as they wished (Cohen, et al., 2010: 84).

The questionnaire questions were written in English (language of teaching and learning) and then translated into *Oshiwambo* (learners' mother tongue or vernacular). This helped to keep communicate the message that the researcher intended to share with them. Hendricks (2003) argues that it is best to communicate in the language that you understand better (home language). The rationale for using questionnaires with few questions was to avoid overloading them, so to go as deep as possible rather than broadly. It also helped to keep focused.

After the data gathering using questionnaires, learners gave feedback by sitting in groups and summarized their findings on newsprints and translated the data into English. Then one member from each group presented the group's findings to the rest of the class.

Initially, I thought the questionnaire based on tooth decay might be too sensitive, thus I gave it first to my colleagues to go through them and to make sure the questions were not ambiguous or intrusive.

### **3.5.3. Observation, practical activities and worksheets**

During the practical activities, learners used and organized techniques, apparatus and materials; observed, measured and recorded; handled process and evaluated experimental observations and data; planned investigation (Namibia: MoE Physical Science syllabus, 2010:63). In this study, the practical activities were based partly on the outcomes of the brainstorming lesson and answers on the questionnaires.

Before learners did the practical activities, they were asked to Predict-Explore-Explain-Observed-Explain (PEEOE) as advocated by Maselwa and Ngcoza (2003). During these practical activities I used pigs' teeth because they were readily available in the community. These were inserted in different alcoholic beverages and in water. I obviously used pigs' teeth for ethical reasons and also since pigs are omnivores as human beings.

### **3.5.4. Focus group interviews of sample of learners**

A focus group interview of five learners was conducted. This group was made by learners who volunteered to be part of this group. Gender discrepancy was not considered due to the overriding importance of their willingness (Chikunda, 2010). This aimed to give an opportunity to the sample of learners to say something about the research process.

The interview questions were not tightly structured; but rather semi-structured to allow for in-depth interviewing and data gathering:

Interview questions are not pre-planned and standardized, but instead there are general questions to get the interview going and to keep it moving. Specific questions will then emerge as the interview unfolds and the wording of those questions will depend upon the directions the interview takes. There are no pre-established categories for responding (Punch, 2005: 170)

This group also validated the data from the previous lesson sessions as well as expressing their feelings on the whole research process. It is through interaction of the group that other data emerged (Cohen, et al., 2010). This empowered the participants to speak out in their own words (Section 5.5). The 'organized discussions' triggered some thoughts and ideas among the participants which had not emerged during brainstorming, practical activities and

discussion. The focus group interviews also provided an opportunity for me to discuss deeper and to get more insights (Cohen, et al., 2010)

### **3.5.5 Stimulate recall discussion with critical friend**

Simulated recall (SR) interview is a family of introspective research procedures through which when prompted by a video sequence, subjects are invited to recall their concurrent thinking during the event (Lyle, 2012). I had a semi-structured interview with a critical friend on the whole research process. SR can provide an opportunity to maintain real life context of the phenomenon investigated. Since the goal was to elicit her views and to discuss her reflections, she therefore was part of the research process. By conducting SR with a colleague, this established interactive skills such as hypothesizing. This was also useful in validating the data gathered.

### **3.6. Data analysis**

Data analysis refers to the system used to identify themes, patterns and relationship in order to present robust evidence for claims made (Cohen, et al., 2010: 109). In my study, data was analyzed based on my research goal. For example, the practical activity was planned based partially on earlier findings. After transcribing the video recordings, I invited my critical friend to view such material with me to check its reliability.

In addition, as learners presented their group findings, data was analyzed based on how frequently the item was mentioned. For coding purposes I used different colours. For example, green for scientific, red for non-scientific and so on. The overall method used to analyze my data was pawing (Gery & Bernard, 2009). According to Gery and Bernard (2009), pawing is the method of analyzing data by marking them up with different coloured highlighters pens. I repeatedly re-read the data while highlighting key phrases (Appendices E-F and M).

### **3.7. Validity**

Osborne, et al. (2002) define validity as referring to the truthfulness of a measurement. They however warn that determining the validity of a measure is elusive. In order to keep the accuracy or trustworthiness of the data gathered, I gave back the transcripts to the participants (focus group and critical friend) to confirm that what I presented and translated (questionnaire from the mother tongue to English) was what they said and discussed. This is called member checking (Cohen, et al., 2010). Furthermore, the critical friend read through the transcripts (for learners) and gave me feedback. Triangulation of the different data sources was aimed at providing rich and in-depth data to ensure trustworthiness (ibid).

### **3.8. Ethical consideration**

Cohen, et al. (2010: 51) argue that, “ethical dilemma is that which requires researchers to strike a balance between the demands placed on them as professional scientists in pursuit of truth, and their subjects’ rights and values potentially threatened by the research”. Such threats are likely to occur with regard to the gathering of data and in the process of dissemination of findings. Burton, Brundret and Jones (2008) propose that taking ethical consideration seriously increases the chances of maintaining positive relationship between the researcher and participants.

In this study, I endeavoured to foreground dignity, respect, trust and welfare of the respondents involved as well as honesty with professional colleagues (Leedy & Ormrod, 2010: 101). First of all, before I started with the research, an official letter was written to the school principal, inspector of education for the circuit (Tsandi circuit) and the regional education director (Omusati educational region) requesting permission to conduct the research at the school, using learners and school resources, for example; classrooms, laboratory materials and so forth (see Appendix A).

Learners and their parents were also asked for authorization through formal letters (see Appendix B). Respect and confidentiality was upheld throughout the duration of the case study. The research participants were ensured that the video would be used strictly for educational purposes only, not for something else. During the research process, any participant who felt uncomfortable could withdraw at any time.

### **3.9. Concluding remarks**

In this chapter, I have provided and explained the research design decision which informed my research study, the methods used and the research tools for gathering data. Justifications for choosing those particular orientations, approaches and methods have been explained. Finally, I presented the validity, and ethics of this study.

The next chapter presents and analyses the data gathered from the brainstorming sessions, questionnaires and statistics from a local state dentist.

## CHAPTER FOUR

### DATA PRESENTATION AND ANALYSIS: PHASE ONE

#### 4.1 Introduction

The goal of this research was to investigate how grade 9 Physical Science learners make sense of prior everyday knowledge and practical learning through exploring tooth decay problems in *Onangalo* village. In this chapter, I present and analyse the findings from Phase One of data gathering, namely; the brainstorming session, questionnaires and statistics from a local state dentist. Below I present a summary of the three data sources.

#### 4.2 A summary of data sources

The findings from each data gathering tool are presented sequentially as shown in the table below:

Stage	Methods used to generate data	Data to generated	Purpose
Stage 1	Brainstorming and discussion ( <i>Lesson</i> )	Different learners' thoughts (prior-every day knowledge) on the causes of tooth decay.	Arouse group attention and generate ideas on what they think causes tooth decay. This helped me to understand what knowledge they bring to the science lesson to move from known to unfamiliar.
Stage 2	Questionnaire with closed and open-ended questions ( <i>research project</i> )	Various community members' thoughts onto the causes of tooth decay etc.	Develop young citizens into researchers. Learners went into the community with questionnaires to gather topic related data. Learners' engaged with the community- they only

			asked people whom they know well or were familiar with or even their family members since it were individual task. This strategy was adopted as an attempt to address ethical considerations as it was deemed sensitive to ask people about their tooth decay problems.
Stage 3	Discussion ( <i>classroom lesson 2</i> )	Learners sat in small groups, presented their findings to the entire class and the information gathered was documented on news prints.	For learners to present their group findings to the whole class on to what community members thought what caused tooth decay.
Stage 4	Statistics on tooth decay problems from a local state dentist	Statistics of patients who visited the dentist and were diagnosed with tooth decay problem	To compare the data generated from the research study with that of the dentist in the district

**Table 4. 1. Shows the different stages during data gathering in Phase One**

#### **4.2.1 Brainstorming session**

Since learner-centered education (LCE) is a pedagogy that is propagated in the current education in Namibia, it entails consideration of learners’ background knowledge and experiences from their homes and environment as a basis of teaching and learning. Rowell (1995: 7) argues that:

In learner centred pedagogy, the teacher’s role becomes that of mediator of learning experiences in which learners generate meaning rather than one of transmitter of knowledge to learners.

During this session, learners discussed in their groups (and discussion was done in English, but learners were allowed to code-switch to *Oshiwambo*, their mother tongue, where

necessary). Each group was given newsprint where learners had to write down their ideas. Thereafter, each group presented its findings to the entire class.

Furthermore, the session started by arousing learners' interest with a teaching aid of a donkey skull and I asked questions. I did this as a means of trying to elicit learners' prior knowledge (See Appendices D - F). The following shows part of the above said introduction:

T: Thank you, we are going to learn about teeth (*holding jaws*). Thus, you can see I brought these jaws for animals like you. Now give me the types of teeth that you know? *Kakopi*.

L: Canine...Canines (*wrong pronunciation*)

T: Crushing and gridding, hhmhhh (writing it on the chalkboard), why do we have to crush and grind food?

L: To make it easy for swallowing.

T: To make it easy for swallowing, is that all? Hhmhhh *Shamina!*

L: To smash food into small pieces.

T: Why do we have to smash food into smaller pieces? What if I put a piece of food into the mouth and swallow it without chewing?

L: Just to *pondwaring* (*when a piece of food get stuck in the esophagus because it cannot fit*)

T: What do you mean to *pondwa*? Anything else? Eeee!

L: Help in swallowing

T: Help in swallowing with easier, ok, but, but..... is that all

The findings of the entire class were then summarized as shown below;

Questions	Responses from groups	Explanation of facts
1. What is tooth decay?	<ul style="list-style-type: none"> <li>• Is a bacterial that stays in the food that we eat.</li> <li>• Is a process where teeth are destroyed by chemicals because of dirty.</li> <li>• Is a substance that attack somebody if did not clean teeth.</li> <li>• Are the bacteria that use to stay in our teeth.</li> </ul>	<ul style="list-style-type: none"> <li>• Is the damage of the tooth enamel and dentine by decomposition.</li> </ul>
2. Causes of tooth	<ul style="list-style-type: none"> <li>• Nature</li> </ul>	<ul style="list-style-type: none"> <li>• Tooth decay is caused by acids which react with</li> </ul>

decay	<ul style="list-style-type: none"> <li>• Food that contain sugar</li> <li>• Sharing tooth brush</li> <li>• If you did not brush your teeth after meal</li> <li>• Bacterial from food</li> <li>• Take long time without cleaning teeth</li> <li>• Witchcraft</li> <li>• By sharing tooth picks and tooth brush</li> </ul>	enamel and decompose it forming a hole.
3. Is it important to clean our teeth or not?	<ul style="list-style-type: none"> <li>• Cleaning teeth after meal help to avoid tooth decay</li> <li>• Yes, it helps to avoid bad smell in the mouth.</li> <li>• It is important not to have tooth decay and smell bad smell</li> </ul>	<ul style="list-style-type: none"> <li>• is very important to clean our teeth in order to remove food remnants thus minimize the bacterial action to teeth</li> </ul>
4. What do people do when their teeth have decayed in Onangalo village?	<ul style="list-style-type: none"> <li>• Visit the hospital for the teeth to be taken away</li> <li>• Visit the dentist regularly</li> <li>• Use different methods to remove the sick tooth</li> <li>• Use to put <i>omahini go shingumati</i></li> <li>• Use <i>onziku</i> to treat themselves</li> <li>• Eat food that have no sugar</li> </ul>	<ul style="list-style-type: none"> <li>• Visit the dentist for proper treatment</li> </ul>
5. How many people do you know that suffering or have suffered from tooth decay in Onangalo village?	<ul style="list-style-type: none"> <li>• Many people are suffering from this.</li> <li>• 100% people are suffers from tooth decay</li> </ul>	<ul style="list-style-type: none"> <li>• The number of people suffering from tooth decay depends on how many promotes the bacterial action in the mouth that causes it</li> </ul>

6. What do people use to clean their teeth in Onangalo village?	<ul style="list-style-type: none"> <li>• Mopane leaves</li> <li>• Ash from wood</li> <li>• Tooth paste</li> <li>• Small sticks</li> <li>• Skin for animals</li> </ul>	
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**Table 4.2. Shows the summary responses to questions during the group presentation**

Despite the active participation of learners in this lesson, the data emerged was mainly the indigenous home practices. For example, the use of *Oshingumati* tree and *onziku* grass to treat tooth decay. However, scientific (classroom science) ideas also emerged. Learners tried to respond to questions using knowledge from previous grades and from other subjects (integration of subjects)

#### 4.2.2. Questionnaire

Each of the 20 learners was given a questionnaire to take in the community/homes to ask people whom they were familiar with. This was done for ethical reasons (Section 3.7). Unfortunately, not all learners completed all the questions in the questionnaires and three of them did not return them. The questionnaires were written and completed in *Oshiwambo* and learners had to translate them to English under the watchful eyes of my critical friend and me. This in hindsight helped to reinforce my learners' language skills although this was not the focus of my study *per se*. I suggest this to be an area for future research. The findings from the questionnaires are summarized as follows:

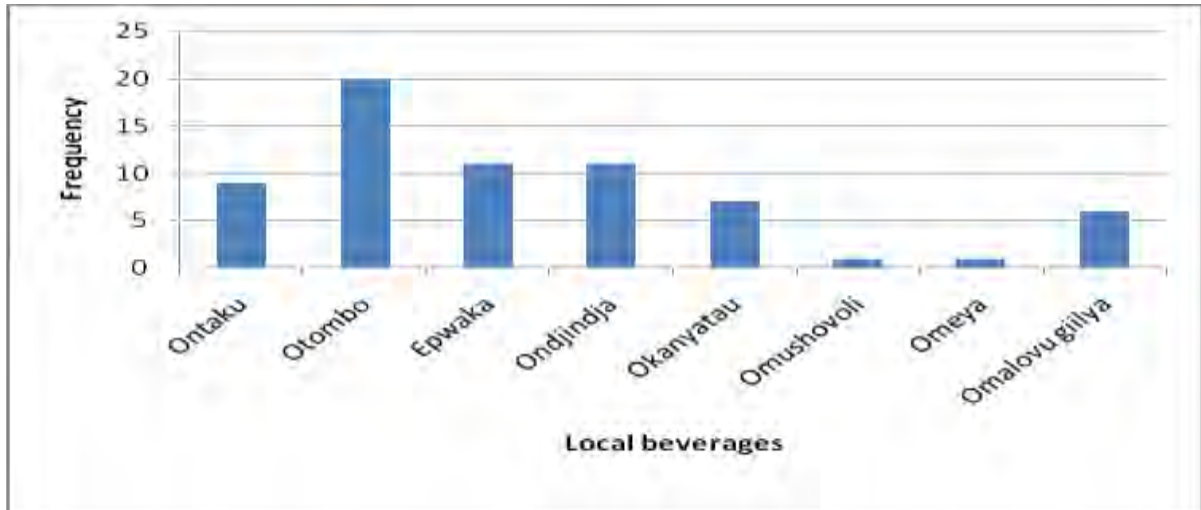
**The types of beverages that people in *Onangalo* commonly drink are:**

Beverages:	Tally	Frequency	Explanation of the beverages
Ontaku		9	Available in every house
Otombo	—	20	Common and liked beverage in the village though some are using it for commercial purposes but it is very cheap.

Epwaka	—	11	Common and liked beverage in the village though some are using it for commercial purpose but it is very cheap.
Ondjindja	—	11	Common and liked beverage in the village though some are using it for commercial purpose but it is very cheap.
Okanyatau		7	Commonly a drink for woman
Omushovoli		1	Is a seasonal drink for few man
Omeva		1	Few people liked water since it is tasteless
Omalovugiilya		6	Free in most houses though they use it for commercial purpose sometimes
		<b>Total: 66</b>	

**Table 4.3. Shows the different types of beverages that people in Onangalo Village drink**

According to the data generated from the questionnaires, *Otombo* (made from sorghum wheat, sugar and water) is the most liked beverage in *Onangalo* village, with the *Epwaka* (a local beverage made from mahangu peels, water and sugar) and *Ondjidja* (a local beverage made from *Ondjidja* tree roots, sugar and water) taking the second place and *Omeva* (water) and *Omushovoli* (made from boiled water melon added to mahangu flour) are the least liked beverages. The information above is summarized in the following graph:



**Graph 4.4. Shows the different local beverages that people in Onangalo Village drink**

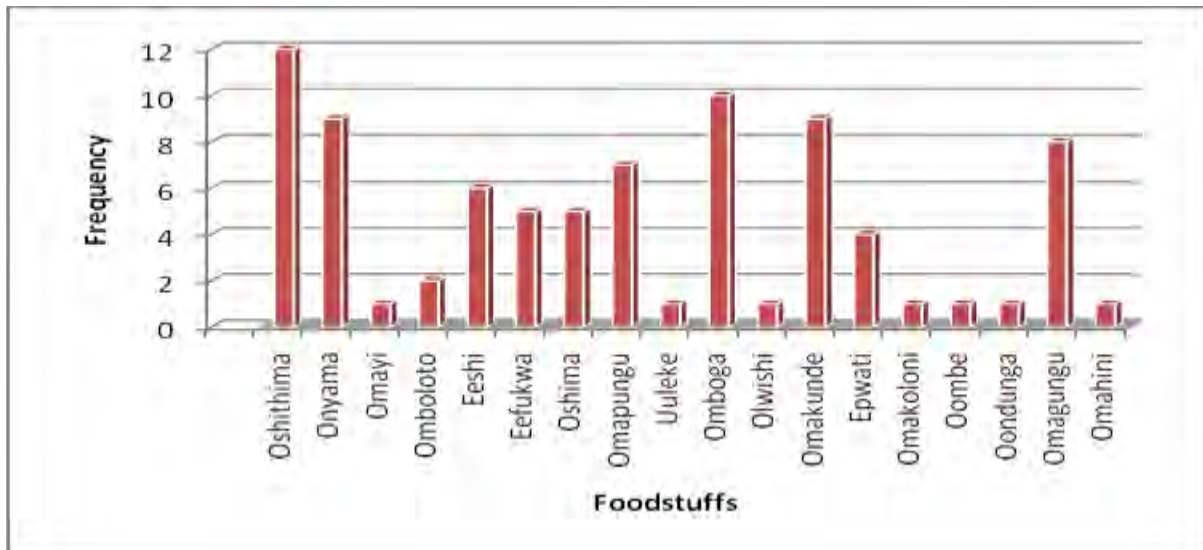
**1. The types of food that they eat?**

Food Stuff:		Tally:	Frequency:	An explanation of the different foods eaten in Onangalo
<i>Oshiwambo</i>	<i>English</i>			
Oshithima	Porridge	-	12	Available, produced in every house annually
Onyama	Meat		9	Most of people are keeping animals for meat only
Omayi	Eggs		1	Though there are chickens in every house, eggs are used for commercial purpose
Omboloto	Bread		2	Costly
Eeshi	Fish		6	Available free of charge during rainy season
Eefukwa	Groundnuts		5	Produced annually
Oshima	Local bread made from mahangu flour		5	Prepared as food for school children as their

				lunch
Omapungu	Maize	≡≡ ≡≡	7	Available
Uuleke	Sweets		1	Costs money
Omboga	Traditional cabbage	≡≡≡≡	10	Available every year in the veld
Olwishi	Rice		1	Very costly
Omakunde	Beans	≡≡ ≡≡≡	9	Produced in every house
Epwati	A soup made from water melons seeds		4	Normally eaten by children
Omakoloni	Macaroni		1	Expensive
Oombe	Berry		1	Rare and used for commercial purpose
Oondunga	Palm fruit		1	Most of them have sour taste and used as donkey food and for brewing of <i>Ombike</i>
Omagungu	Mopane worms	≡≡ ≡≡	8	Collected free from the forest
Omahini	Milk		1	Used for commercial purpose
			<b>84</b>	

**Table 4.5. Shows foods that people in Onangalo Village eat**

The above information reveals that porridge is the food mostly eaten in Onangalo Village probably because porridge is a staple food in the area. It is believed to have a lot of nutrients in it. It is then followed by traditional cabbage although it is only available during rainy seasons. Foods that are bought from shops are the least eaten most probably because not all people have income to buy these. The data that emerged from the table above is summarized in the following graph:



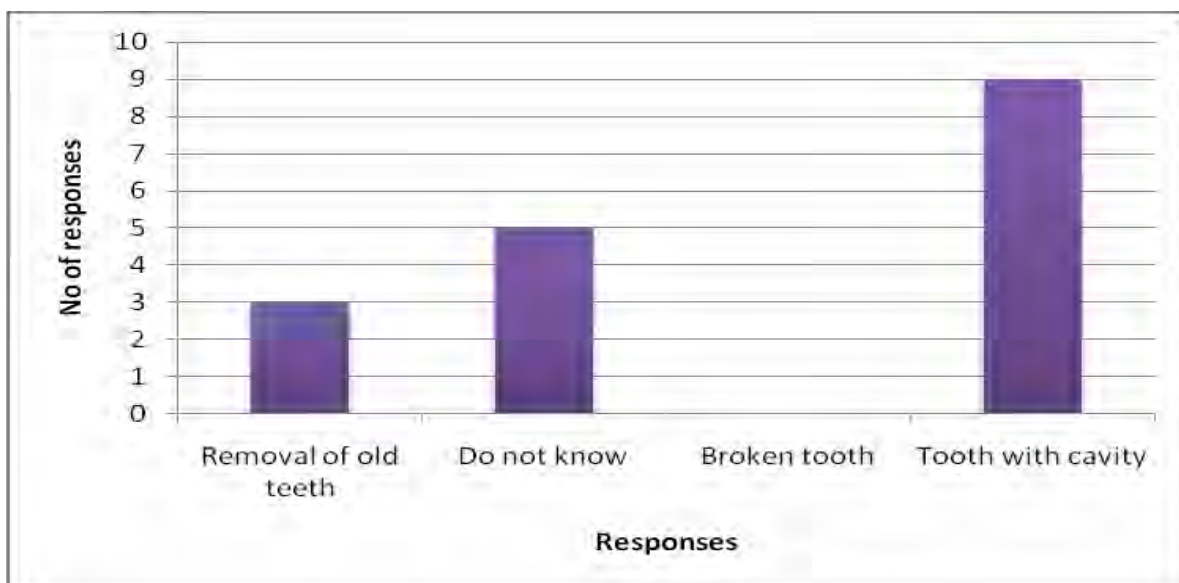
**Graph 4.6.** Shows the types of foods that people in Onangalo Village eat

## 2. What is Tooth Decay?

Response:	Tally	Frequency
Tooth with cavity		9
Removal of old tooth		3
Do not know		5
Broken tooth		0
<b>Total:</b>		<b>17</b>

**Table 4.7.** Shows the responses to what tooth decay is

According to the data, tooth decay is a tooth with cavity (hole). I believe this answer emerged because my learners had already covered this topic in the previous grade in the Life Science subject. However, about 30% did not know what caused tooth decay. A few (18%) believed that it is a removal of tooth and none of them responded in favour of broken teeth. I present the aforesaid information on the following graph:



**Graph 4.8. Bar graph representing the responses to the question on what tooth decay is**

**4. Is it important to clean our teeth or not? Explain.**

In response to this question, learners debated and argued for a long time. As a result, I had to stop them so that we could move to the next questions. Their responses to the question are summarized below:

- ✓ Yes, it prevents tooth decay and bad smell in the mouth.
- ✓ It is very important because it prevent bacteria from acting in our mouth.
- ✓ Yes, it prevents bad smell in the mouth and development of cavity.
- ✓ Yes, cleaning of our teeth helps remove dirty between teeth in the mouth.
- ✓ It is important because it prevents our teeth and mouth from infections.
- ✓ It helps remove food remains that cause cavity.
- ✓ Cleaning of teeth many times can make them very old
- ✓ Cleaning of our teeth help teeth not to get old soon.

From this data, it emerged from the respondents that it is important to clean our teeth. It is believed that tooth decay is caused by not cleaning teeth (as indicated by the data above). In contrast, it is also believed that cleaning teeth too frequently can make them look old.

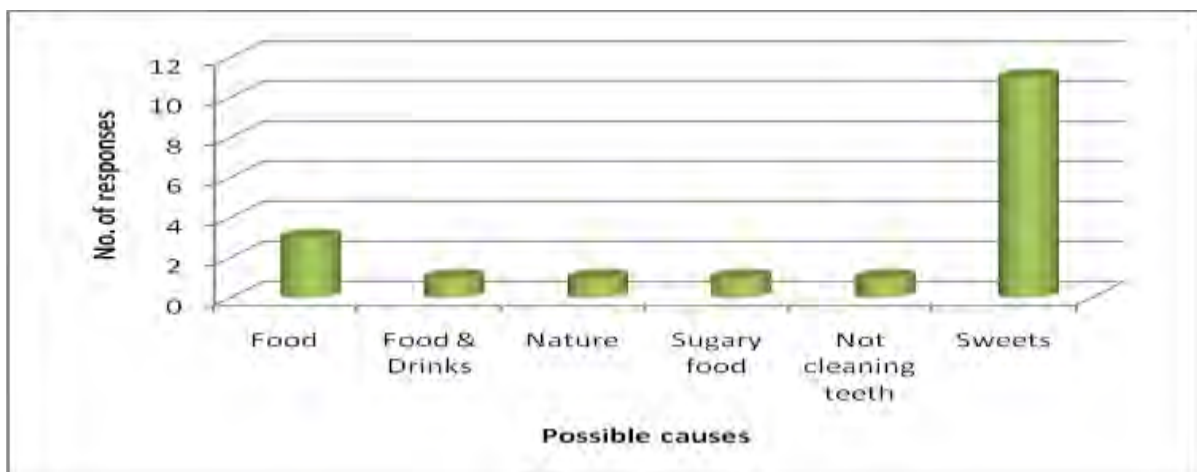
**5. What do you think causes tooth decay?**

Causes:	Tally:	Frequency:
Sweets		11
Food		3
Both Sweets and Food		1
Nature		1
Sugary Food e.g. <i>eembe</i>		1
Not cleaning teeth		1

**Total: 18**

**Table 4.9. Shows the responses to question on the causes of tooth decay**

The data revealed that most learners said that tooth decay is caused by sweets. This suggests that sugar plays a big role in the cause of tooth decay problems. Others stated that it is caused by food but did not specify the types of foods that cause it. Few of the responses described that it is caused by not cleaning teeth. The data also revealed that sugary food in which sweets form part of it contributed to tooth decay problems in the village. This is shown also by the following graph.



**Graph 4.10. Shows causes of tooth decay**

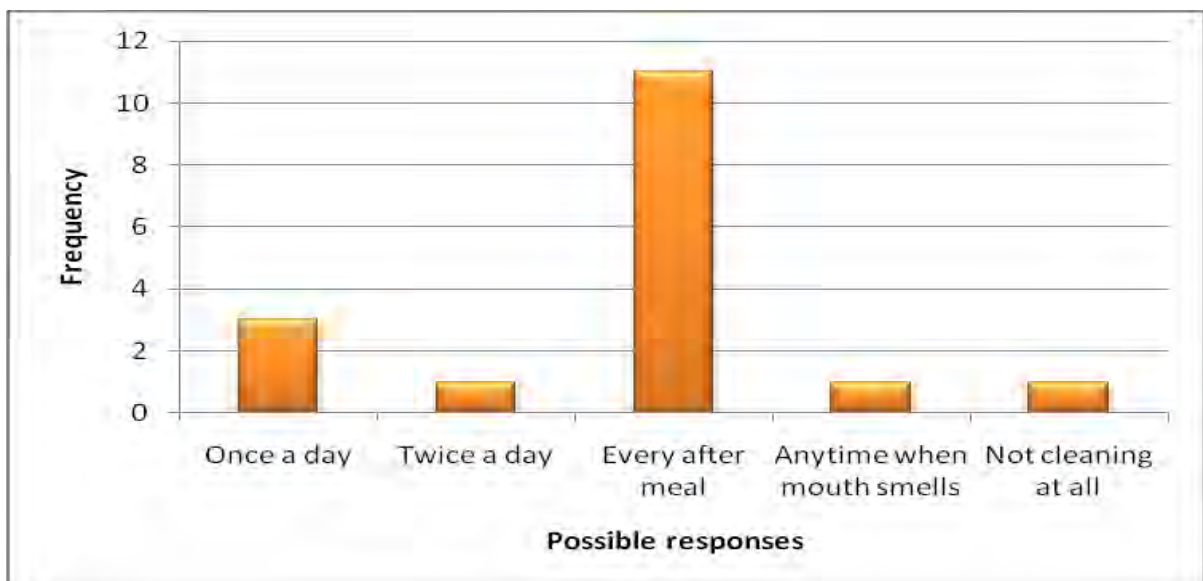
**6. How often do you clean your teeth?**

<b>Response:</b>	<b>Tally:</b>	<b>Frequency:</b>
Once a day		3
Twice a day		1
Every time after meal	-	11
Anytime when my mouth smell		1
I do not use to clean the teeth		1

**Total: 17**

**Table 4.11. Shows the responses to the question on how often people should clean their teeth**

The data shows that most of the learners (65%) clean their teeth after every meal. 18% of them indicated that they only clean theirs daily. Few of them do not clean their teeth at all. There is a need for awareness on the importance of cleaning our teeth. These results are shown in the following graph below:



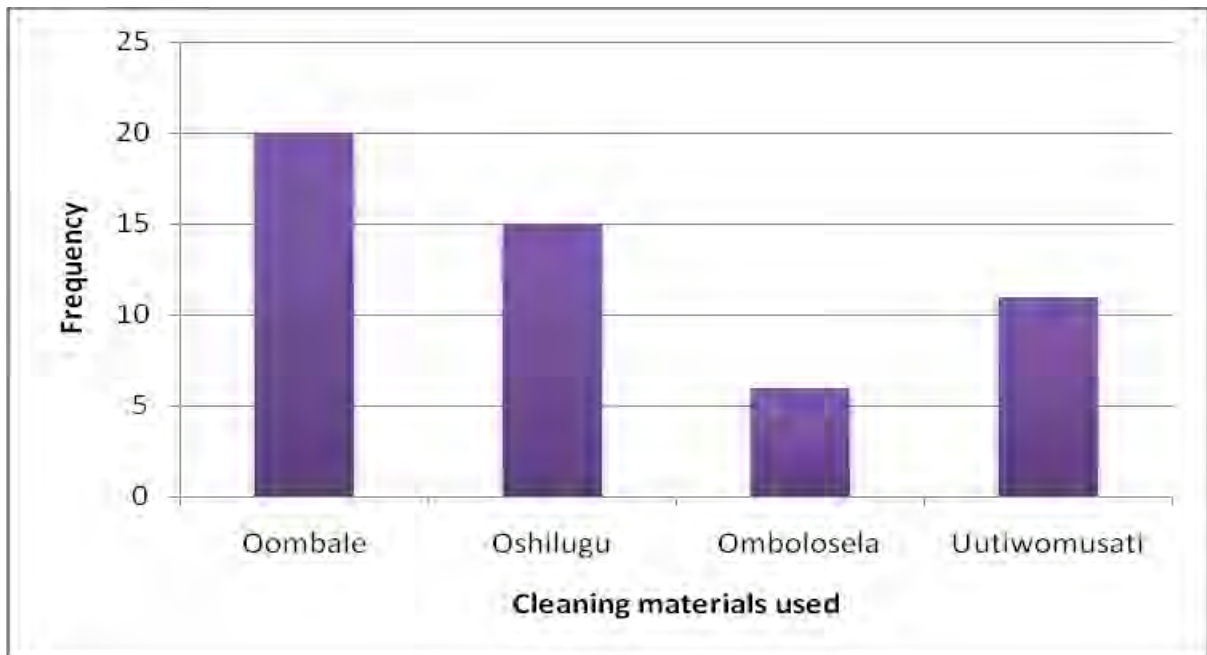
**Graph 4.12. Shows how often learners clean their teeth**

**7. What do people in Onangalo Village use to clean their teeth?**

Materials used		Tally	Frequency	Explanation
Oshiwambo	English			
Oombale	Palm leaves	———           ———	20	They are available in the village
Oshilugu	Roots of <i>Oshilugu</i> plant	      	15	Available, can remove dirty and beautify the inside of the mouth, although some dig them and sell them to local people
Ombolosela	Tooth paste		6	Costly in shop and not all people are familiar with on how to use it
Uutiwomusati	Small branches of Mopane tree	 	11	Available, but not in every house
			<b>Total =52</b>	

**Table 4.13. Shows what people in Onangalo Village use to clean their teeth**

The data above shows that about 30% of the people are using palm leaves, 28% use *oshilugu* roots (from a wild bush which grows closer to water points; a habitat to scorpions and snakes), 21% are using the Mopane tree’s small branches and 12% are using tooth paste. The reason why toothpaste is used the least might be that given in the explanation column in Table 4.8. The following graph presents these findings:



**Graph 4.14. Shows what people in Onangalo Village use to clean their teeth**

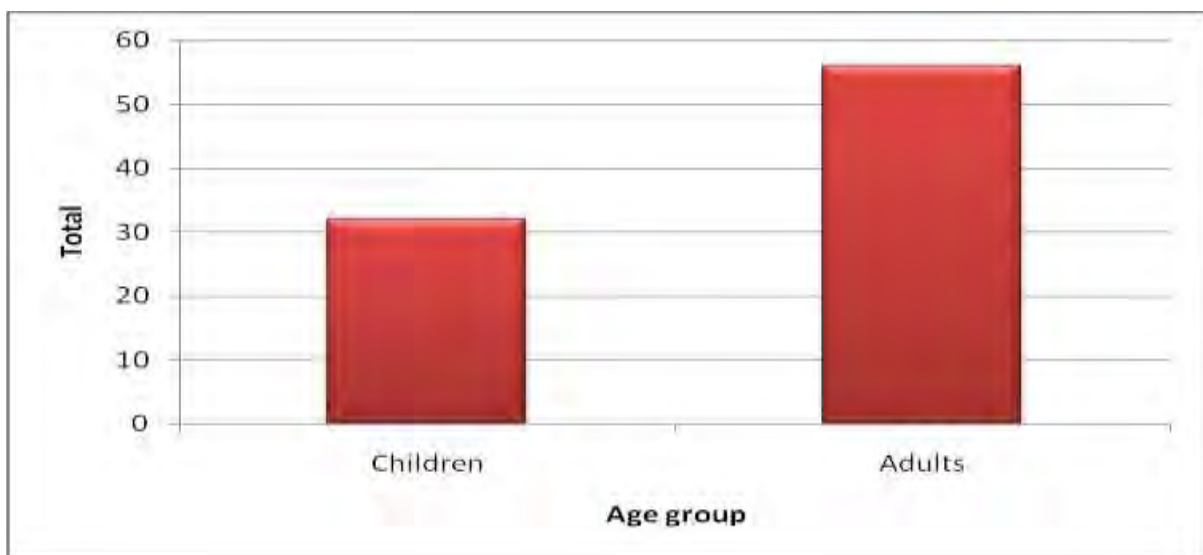
**8. How many people in your family are suffering from tooth decay?**

Learner	Children:	Adults:	Total:
A	1	5	6
B	4	2	6
C	4	1	5
D	1	3	4
E	1	3	4
F	2	5	7
J	4	3	7
H	0	6	6
I	2	6	8
J	3	2	5
K	1	2	3
L	1	5	6
M	2	1	3
N	1	6	7
O	5	4	9

P	-	2	2
<b>Total:</b>	32	56	<b>88</b>

**Table 4.15. Showing data on adults and children suffering from tooth decay**

The data revealed that most of the adults are the victims of tooth decay (64%) and 36% of children are also suffering from tooth decay. The data did not reveal the possible reasons for this difference. It also did not reflect the gender which is most affected. The following graph shows these results:



**Graph 4.16. Showing children and adults suffering from tooth decay**

**9. The possible reasons why most people in Onangalo Village are suffering from tooth decay are summarized as follows:**

- Most of them are illiterate and they have no idea of what causes tooth decay;
- The use of sugary foods and drinks;
- Sugar from local traditional beverages, for example, otombo;
- Too many sweets; and
- Not taking care of teeth by keeping them clean.

## 10. What do people in Onangalo Village do when their teeth have decayed?

- Chew tablets, for example, paracetamol;
- Chew leaves from a traditional plant called *Omwaangombe*
- Go to the clinic for treatment/repair of the cavity formed;
- They treat themselves with hot salt water;
- Apply liquid from *omungumati* tree;
- Go to traditional healers ; and
- Treated traditionally using a herb called *onziku*.

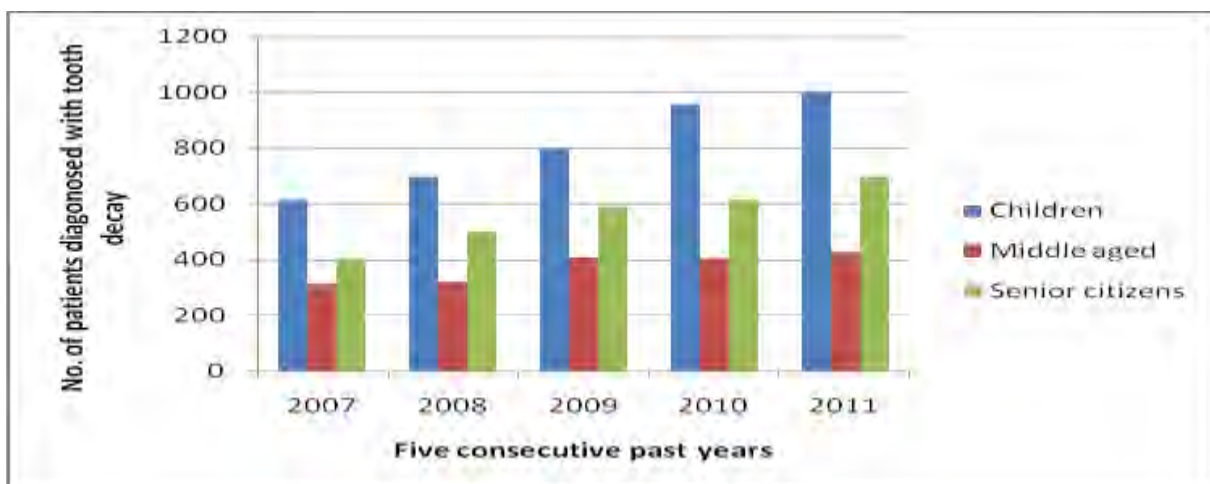
Most of the data that emerged are common practices that people in Onangalo Village use to cure themselves. Among these, some are scientific and others are not.

### 4.2.3. Some statistics from a local state dentist

According to information obtained from the state dentist at Tsandi clinic (which treats people from Onangalo Village), tooth decay problem is drastically increasing every year and it is a serious threat to people's health. The following table shows the statistics for patients who visited the dentist and were diagnosed with tooth decay problems from 2007 to 2011.

	2007	2008	2009	2010	2011	<b>TOTAL</b>
Children (4-17 years)	612	698	800	957	1002	4069
Middle aged (18-59 years)	311	319	406	405	425	1866
Senior citizens (60+ years)	404	500	590	615	699	2193
<b>Total</b>	<b>1 327</b>	<b>1 517</b>	<b>1 796</b>	<b>1 977</b>	<b>2 126</b>	<b>8128</b>

**Table 4.17.** Shows the number of patients who visited the Tsandi clinic for tooth decay problems



**Graph 4.18** Shows the age groups diagnosed with tooth decay from 2007- 2011 at Tsandi Clinic

The table reveals that children are the most victims of tooth decay in the area forming more than 50% of patients suffering from that malady. This information contradicts information obtained from the survey. The reason could be the differences between the scientific and traditional beliefs people have in Onangalo Village. Senior citizens formed a quarter of the patients, and middle aged came last. The data may not give a true reflection as most of the people do no longer prefer state hospitals. They rather go to private doctors (especially those with an income) and leave the state doctors to the low earning and pensioners.

#### 4.6. Concluding remarks

In this chapter, I presented data that was generated from Phase One techniques, namely, the brainstorming session, questionnaires and statistics from a local state dentist. I started with the brainstorming session, where it clearly emerged that learners have rich knowledge of the subject content and that is up to the teacher to tap into such knowledge. I then presented from questionnaires. It emerged from questionnaires that people from Onangalo Village have lots of information that could be used in science classrooms. Data from the local clinic has shown that the number of patients' diagnosed with tooth decay is speedily increasing every year. Children are the most victims as they form about 66% of the patients. The next chapter presents data and analyses generated from Phase Two of my research.

## CHAPTER FIVE

### DATA PRESENTATION AND ANALYSIS: PHASE TWO

#### 5.1. Introduction

In this chapter, I present and analyse data obtained from the practical activities, semi-structured interview with a focus group of learners and the stimulated recall interview with a critical friend. The design of the practical activity was based partially on the outcome of the brainstorming session and questionnaires. The following table shows the sequence of the data gathering process:

<b>Stage 1</b>	Observation; Practical Activities and Worksheets ( <i>classroom lesson 3</i> )	I presented a lesson on chemical reactions using common beverages to illustrate the process of chemical reactions on animal teeth. Following which a unit of work was given to the learners. This lesson took more than a week because reactions need time to show results. Learner engagement in the lesson; how they did observations and how they communicated their findings of experiment ( <i>Predict Explain Explore Observe Explain approach</i> ) (see Maselwa & Ngcoza, 2003)	Drawing learners into science; evaluate my own practice; see how practical activities enhance/ or constrain the learning in science classroom.
<b>Stage 2</b>	Focus group interview with learners	To complement the data already generated; hear learners' feelings about the whole process and how practical activities enabled or constrained them in the learning of scientific concepts, in particular, understanding of concepts associated with chemical reactions.	To get views on the best tool and approach in science classroom; triangulate the data gathered in the process as well as to validate data.
<b>Stage 3</b>	Informal discussion with a critical friend	To get his feelings and reflections on the research process, suggestions for future research, complement if any, and so on.	To triangulate and validate data gathered

**Table 5.1** Shows the sequence of data gathering in Phase Two

## 5.2. An introduction to the practical investigation

As I stated above, the data obtained from Phase One in this study was used to plan the session on practical activities. The session started with the recap of what was done in the previous session (Phase One) and elicitation of learners' prior everyday experiences on tooth decay. This helped learners to keep track, focus and make the links between the two sessions. However, I have to admit that not all variables were controlled as it was not the focus of the study.

The following section illustrates part of the class discussions during the session of practical activities:

T: (*Write all the possible causes as learners are presenting*) we are now going to use some of the drinks which are locally made; we use to brew them home, is it?

Ls: Yes (*chorus*)

T: (*Explain the procedures and step for experiment and write them on the chalk board*).  
.....why are we using pig teeth? Why not for a donkey or goat?

L: Because for the donkey is big and pig teeth are the same for a person.

T: Very good, a pig is omnivores, is it?

L: Yes like people

T & Ls: Assigning each other on who is to bring which beverage for the next day experiment. Some learners volunteer themselves to bring.

T: Okay fine, we are also going to use pure water or tap water. Why tap water?

Ls: Very quiet

T: Tap water is neutral, is it? It acts as a control for our experiment. Then hmmm, after done with our first phase of the experiment, you should keep a record by observing what is happening in each test tube every day. Thank you very much pupil. We shall meet the next day and don't forget to bring our material. I will provide test tubes and pig teeth.

During the class discussion, both teacher and learners found it difficult to use the proper language of learning and teaching (LoTL). For example, the teacher gave the following direction to learners; *we are now going to use some of the drinks which are locally made; we use to brew them home, is it?*

### **5.3. Practical investigation and worksheets**

According to the data obtained from the brainstorming session and questionnaires, many beverages such as *otombo*, *ontaku*, *epwaka*, *ondjidja etcetera* and foods such as *oshithima*, *eembe*, *omagungu etcetera* are commonly consumed by Onangalo village residents. Sweets and *otombo* were the most foods and drinks (see Section 4.2 above) that were suspected to cause tooth decay. We therefore decided to use and test these in our investigations. Learners suggested that it would be better to use a pig's tooth because it is from an omnivore instead of a human tooth. The other reason highlighted was that this had to do with ethics. The mistake I made at this stage, though, was that I did not ask learners to explain what was meant by an omnivore since they had hopefully covered it in grade 5.

For this investigation, we thus used locally brewed beverages and learners had to bring these from their homes. We did not use all the drinks though due to time constraints and availability of materials, for example, test-tubes. We then decided to use four local beverages. Their choice was determined by the availability of each. In addition to this, tap water was used as a control.

#### **5.3.1. The practical investigation process**

After the class discussions presented in Section 5.2 above, materials and guidance were provided. Learners were able to carry out the practical activities using the pig tooth in *lieu* of a human tooth. I observed that during the process, learners shared the responsibilities, for example, while some were measuring the level of the liquids others were inserting the tooth. They were also arguing using both languages (LoLT and the vernacular). This created a forum for debates among themselves. This process of debate and challenging each other helped them to clear some misconceptions though not all. The participation of learners during this process was strikingly high.

Before the practical investigation, I asked the learners to predict what would happen when pig teeth were inserted into the different local traditional beverages. This was done to elicit predictions which they would be able to refer back to later so as to know whether their predictions were wrong or right. Here are learners' responses and explanations:

<b>Learners predictions</b>	<b>Explanations</b>
1. Volume of liquids increases	<ul style="list-style-type: none"> <li>• The pig tooth will occupy a space.</li> </ul>
2. The tooth will not do anything	<ul style="list-style-type: none"> <li>• Pig tooth is very strong</li> </ul>
3. Bubbles will be seen	<ul style="list-style-type: none"> <li>• These beverages produce bubbles when sugar is during fermentation</li> </ul>
4. Test tubes will get hotter or colder	<ul style="list-style-type: none"> <li>• The reaction is either exothermic or endothermic</li> </ul>
5. Only in <i>otombo</i> that might boil the pig tooth	<ul style="list-style-type: none"> <li>• The <i>otombo</i> is very strong and can make red lips to those taking it</li> </ul>

**Table 5.2. Learners’ predictions and explanations before doing the practical activity**

From the learners’ predictions and discussions, they predicted that since matter occupies space, the volume of the beverage would increase. I also found out that learners were very active and happy to do this activity. They had to observe the reactions over a period of six consecutive days.

According to the information from the learners’ observation sheets, *otombo* was the most concentrated beverage that caused a quick reaction with the pig tooth.

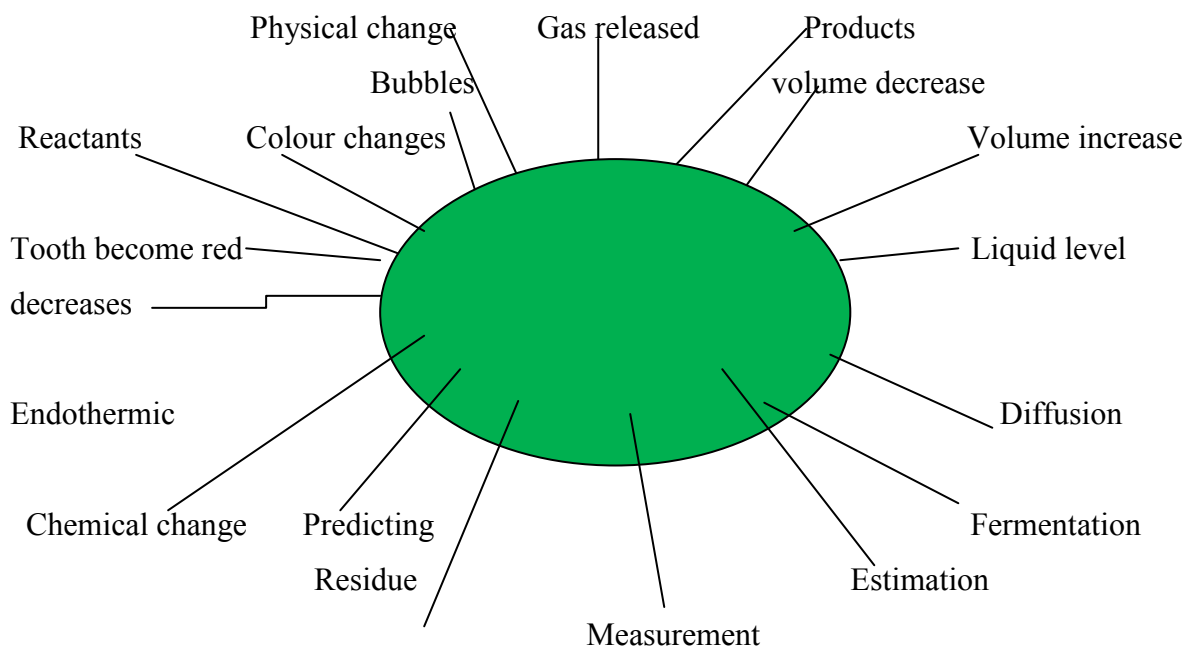
The following table summarizes the learners’ findings:

<b>Days</b>	<b>Epwaka</b>	<b>Mundele</b>	<b>Otombo</b>	<b>Ondjidja</b>	<b>Tap water</b>
<b>Day 1</b>	<i>Nothing is happening</i>	<i>Nothing is happening</i>	<i>Lots of bubbles and the liquid is seems like boiling</i>	<i>Nothing is happening</i>	<i>Nothing observed</i>

<b>Day 2</b>	<i>Colour of the beverage changed</i>	<i>Few bubbles are seen</i>	<i>Colour of the otombo changed. Many bubbles, but not as many as for the first day.</i>	<i>Few bubbles seen</i>	<i>Nothing observed</i>
<b>Day 3</b>	<i>Level of the liquid decreases and the colour of the liquid change to red</i>	<i>Residue is seen at the bottom of the test tube. The liquid become transparent. Tooth is seen reddish</i>	<i>Residue at the bottom. Bubbles decreases. Tooth coat in scales</i>	<i>Residue at the bottom. Brownish coat on tooth. Few bubbles</i>	<i>Nothing observed</i>
<b>Day 4</b>	<i>The colour of the beverage change to colourless</i>	<i>Bubbles disappear. The liquid looks milky</i>	<i>Few bubbles. Residue remains at the bottom and liquid colour is colourless.</i>	<i>Volume of the liquid decreases. No more bubbles seen</i>	<i>Colourless coat on tooth.</i>
<b>Day 5</b>	<i>Few bubbles observed from the bottom of test tube</i>	<i>Residue at the bottom. Few bubbles seen</i>	<i>No more bubbles seen. Tooth becomes reddish.</i>	<i>Very smelly</i>	<i>Water release bad smelling.</i>
<b>Day 6</b>	<i>Tooth with a creamy coat on it</i>	<i>Residue at the bottom. Very few bubbles</i>	<i>No more bubbles seen. Tooth becomes reddish and soft.</i>	<i>Too smelly. Parts of the tooth can be removed by scratching</i>	<i>Water release bad smelling</i>

**Table 5.3. Summary of data from learners' observation sheets**

**The following scientific concepts emerged during the practical investigation:**



**Figure 5.4 Mind-map**

### 5.5. Semi-structured interview with a focus group

For the focus group interview, I used five learners who volunteered to participate in the focus group interview (2 boys and 3 girls). Most surprisingly, these learners were not particularly active during practical activities sessions according to my own observation and that of my critical friend. These are also the same learners whose performance other subject teachers used to complain about.

Questions	Responses
1. Do you think science teachers should consider or not what learners know from home and what they learned from their environment when teaching science?	<ul style="list-style-type: none"> <li>• Yes because we want to talk a lot from our homes</li> <li>• Yes, because it help me to think a lot that.....things from home are important because we also learn them at school</li> <li>• Yes, because we cannot fail things we know very ..... (nawa) well.</li> <li>• It is important because it help me to know good examples and can remember everything during examination</li> </ul>
2. How do you feel that we started the lesson on chemical reactions by	<ul style="list-style-type: none"> <li>• I feel good because we talk and talk a lot even my friends Selma who is always quite was talking.</li> <li>• It was nice because we learned a lot of science things</li> </ul>

<p>exploring causes of tooth decay in Onangalo village?</p>	<ul style="list-style-type: none"> <li>• It was good. We all know tooth decay as we use to see people at home sick tooth. I enjoyed it</li> <li>• I was not known if the things from our homes can be used in the class, it was good.</li> <li>• Good because after finishing we watch ourselves in the video and learn again from watching</li> </ul>
<p>3. Do you think it is important to do practical investigations such as the one we did on tooth decay? Explain</p>	<ul style="list-style-type: none"> <li>• Yes, it was good because I see with my own eyes but not the teacher to tell me.</li> <li>• It is important because we learned and see which beverages caused the teeth to decay.</li> <li>• Yes, because we are going to tell our friends and parents not to drink the <i>otombo</i> that cause tooth decay.</li> <li>• Practical activity is good because we learn a lot of things of tooth decay and chemical reactions. Many scientific concepts emerged as a result of practical activities.</li> </ul>
<p>4. Which scientific concepts did you learn during the practical investigation?</p>	<ul style="list-style-type: none"> <li>• Measurement, endothermic, exothermic, recording, synthesis, decomposition, gas given off, observation</li> </ul>
<p>5. Do you think the lesson helped you to understand the topic on chemical reactions better?</p>	<ul style="list-style-type: none"> <li>• Yes, it helped me a lot, last year I was not understand it and I think is why I failed.</li> <li>• Yes, I understand well and if I m to write a test about what we learned I will pass it very well</li> <li>• Yes, but I do not understand, why <i>otombo</i> caused the tooth to decay more and is liked by many people.</li> <li>• This lesson was very good to me and to other learners. We learn a lot and will never forget this lesson.</li> </ul>
<p>6. What else do you think should be done by science teachers to facilitate the understanding of scientific concepts?</p>	<ul style="list-style-type: none"> <li>• We want other teachers to teach us like you</li> <li>• They must teach us nicely by asking us things from home that we know well. They need to give us time to talk a lot in the class and do a lot of practical activities.</li> <li>• Give us assignments to complete at home as you did.</li> </ul>

**Table 5.5. Shows the questions and responses from the focus group interview**

From Table 5.5, it is clear that most, if not all the learners, enjoyed the session especially the practical part of it. They indicated how important their experiences were in helping them to make meaning of scientific concepts discussed in class. Different scientific and non-scientific concepts emerged during the practical investigation. For all those six days, I also gave my learners summaries of the key scientific concepts developed.

During the focus group interview, I also noticed that learners were freer to express themselves than they used to be in class. The practical investigation was a revelation in that I realized the problem of labeling learners as I had done for all these years of my teaching.

### **5.6. Stimulated recall interview with a critical friend while watching the video**

My critical friend is a colleague in the same department in my school. She volunteered to be involved in my research as she wanted to see what I was doing. The interview took place at our school on the 5 June, 2012 while watching the video from 16h00. The watching of the video took about 3h30.

First, I watched the video alone and came up with three main questions (question 1 - 3, see Table 5.6 below). Other questions emerged when we watched together. Before I asked her these main questions and before we watched the video, I asked her what inspired her to become a teacher, her teaching experiences as well as the highs and lows in her professional experience. This was done for warm up purposes. Her responses were as follows:

“I am inspired by the way those olden teachers use to dress and behave. They were highly respected by each and every member of the community and were regarded as source of information [.....] The good thing to be a teacher is that I developed knowledge and attitude toward learning, I m always busy thinking how to better the understanding of life sciences and this exercise my brain as a reflective practitioner, thus why my subject is one of the better performed at the school, last year I got an award from education inspector for reaching the regional target of 70% pass in. The other thing a teacher gets paid every month as a form of motivation [...] these days school learners are too democratic that the behaviors are worse than before, there are no adequate resources and sometime it can cost me as a teacher to use my own resources, parents are not actively involving in their children’s education[...].”

After this warm up, I asked her the following questions which are given with her responses:

Questions	Responses
1. Do you think that considering learners' prior-everyday knowledge is important in the teaching and learning of science?	Yeah, It is very much important. This is because what they know from home and surrounding environment can form the basis of classroom science. The newly introduced curriculum (C-2010) also emphasized on teaching to be from known to unknown content. However, not all the topics can suit it.
2. How did you see the participation of learners during this lesson?	Uhhh, I can say, this lesson was very enjoyable. I could see that all the learners were participating and even happy. I have been teaching for more than 30 years but I did not experience a greater participation like this one. I was even expecting learners to fear the video camera, but my expectation failed. One cannot even say it is Onakayale class ( <i>Onakayale is a discourse given to this class. Onakayale is a centre for disabled people in Omusati region</i> ).
3. Do you think involving learners in active lessons like this; can enhance learning of scientific concepts?	Why not? Throughout the lesson, concepts emerged themselves. Learners were able to develop many concepts like; decomposition, estimation and so on. Some of the concepts developed are not only useful in physical science but also in other subjects like life science. This made it easier for other teacher too, I am happy for this.
4. How did the lesson benefit you as a science teacher?	As a science teacher, I call myself as lucky for getting this valuable opportunity to be part of this lesson. I learned a different approach to the teaching and learning of science. I also learned how to prepare and plan a practical activity as well as how to engage learners in an active lesson.
5. What do you think should have been done, which did not go well if we were to do the same practical investigation	Hmmmmmmm, not really. I just want to say, let's try to use a real human being tooth in order to have succinct results. A pig tooth which is

again?	used in the experiment may not give a clear reflection on the effects of the beverages to our teeth
6. What else can you say about this lesson?	I am suggesting the video to be watched by the whole school; teachers and learners to see how wonderful it was. Other teachers can use it to prepare their lessons particularly when teaching the topic of chemical reactions

**Table 5.6. Shows the responses from the critical friend during stimulated recall interview**

This teacher replied that the inclusion of learners' prior everyday knowledge and experience was vital. She also indicated that she was surprised to see how teeth and local beverages could be used for meaning making in the classroom. She further revealed that she could not believe the way the learners participated during these lessons since the class was made of failures and most of them were even repeating the grade for the third time.

The teacher further stated how useful the lesson was not only to Physical Science but also to other science related subjects, for example, in Agriculture and Life Science (subject integration). She further suggested that the video should be used by other teachers to prepare lessons especially practical activities.

### **5.7. Concluding remarks**

This chapter presents the data obtained from the second phase of my data gathering process. During this phase the data generation techniques used were practical investigations, focus group interview with learners and a stimulated recall interview with a critical friend.

From the practical investigation session, it was clear that learners had prior-every day knowledge and experiences about tooth decay. This helped me and my learners to communicate and understand the subject content clearly and with ease. Moreover, through this session learners were free to participate because they were using teaching resources they were familiar with. In the next chapter, themes and categories that emerged from Chapters 4 and 5 will be further discussed.

## CHAPTER SIX

### ANALYSIS, INTEPRETATIONAND DISCUSSION OF FINDINGS

#### 6.1. Introduction

In this chapter, I present the emerging themes and findings from my study. The evidence that emerged from Chapters 4 and 5 is discussed with reference to the relevant literature that was reviewed in Chapter Two.

The following table shows how themes were developed:

Themes and sub themes	Analytical statement	Data sources/evidence	Research question(s) that the theme corresponded to
<p><b>Learner engagement</b> <i>(blue)</i></p> <ul style="list-style-type: none"> <li>➤ Learner talk/argument</li> <li>➤ Co-construction of knowledge</li> <li>➤ Learners' questions</li> <li>➤ Laboratory work</li> <li>➤ Research project/Field work</li> </ul>	<p>Prior everyday knowledge and experiences on tooth decay prompted active learner engagement</p>	<p>Learners were active rather than sitting and listening. In the process of active participating, they asked questions and responded to questions. Therefore knowledge construction occurred throughout. (see <b>Chapter 4</b> and <b>data sources 4 and 5</b>)</p>	<p>Research questions 1, 2 &amp; 3.</p>
<p><b>Conceptual Development</b> <i>(green)</i></p>	<p>Contextualizing subject content knowledge enhancement</p>	<p>Throughout this research, learners developed many concepts. These concept fall in the following</p>	<p>Research question 3.</p>

	conceptual development: <i>Exploration of tooth decay leads to conceptual development</i>	categories: Scientific, non-scientific, myth, misconceptions and contradictions (See <b>Chapters 4 &amp; 5 and data sources 1-6)</b>	
➤ Scientific			
➤ Non-scientific			
➤ Myths			
➤ Misconceptions			
➤ Not clear/ contradictions			
<b>Mediation of learning</b> <i>(red)</i>	Teaching is influenced by the teacher's knowledge and experience in the mediation of learning	Teacher mediates the learning in many different ways. The research processes started with designing of the research activities, hypothesis and learners finding data from the community and reporting their findings. Teacher used simple language, code switching and motivated learners intrinsically and extrinsically through laboratory work (see <b>entire transcript, Chapter 5)</b>	Research questions 1, 2 & 3.
➤ Teacher's questions			
➤ Learners response			
➤ Laboratory practical			
➤ Field work			
➤ Role of language			

**Table 6.1. Shows show how I came up with my themes and analytical statements**

The following three analytical statements are discussed in more detail.

## **6.2. Analytical Statement 1:**

### **Prior everyday knowledge and experiences on tooth decay prompted active learners' engagement**

The newly introduced Curriculum 2010 emphasizes that learners' prior everyday experiences should be used as a stepping stone to understand subject content in schools (MoE, 2010). Nyambe (2008) argues that the principles and practices that are in accordance with the learner-centered education (LCE) are that learners need to be actively engaged, visible and take the central position during lessons (see Section 2.2).

The study too tried to close the gap between classroom science and learners' prior everyday knowledge as proposed by Rennie (2011). I thus started the lessons with the elicitation of learners' prior everyday knowledge in relation to chemical reactions (see Chapter 4). This helped me as a facilitator to understand the type of knowledge learners brought to my science classroom. Roschelle (1995) argues that significant learners' prior everyday knowledge is important in the learning process.

This study also helped me to observe how each learner participated. In the first activity, learners brainstormed on what causes tooth decay and how it could be avoided and treated. This activity was done in groups and guiding questions were written on the chalkboard. Thereafter, one member from each group had to present their results to the entire class. I observed that learners demonstrated an understanding of what tooth decay is and explained different methods on how it could be treated. In the process of group presentation, learners wanted to know why some substances were used to treat tooth decay for example *Oshingumati* tree but not other substances like *Enongonongo* shrub (a local shrub that is used as poison on arrows while its ash is used as a hair relaxer). This query arose because both plants contain a white liquid in its stems. This shows that learners were starting to think critically.

During their presentations, one could clearly observe that learners had a lot of knowledge about tooth decay from their homes and environment. I also found out that some of their

knowledge was related to chemical reactions although they could not give proper scientific explanations. They thus needed some scaffolding (Vygotsky, 1978; Goos, 2004) in this regard, which I failed to do (see Appendix F).

Nonetheless, I noticed that they were actively engaged without any fear of making mistakes including pronunciations of terms (see Section 4.2.1). For example, [Canine...Canines (*wrong spelling*)] or saying words in their vernacular. Some learners even used their home language to explain things so that others could understand their contributions. They had arguments within individual groups and these prompted further thinking.

Furthermore, it was truly fascinating that after the presentation of the individual groups, others were keen to complement or ask for clarifications. Although all learners participated, on average, boys participated less than girls. Given this experience, I do not concur with Chikunda (2010) and Isak (2008) who claim that boys are always more active than girls during science lessons. Isak (2008) argues that on average boys participate more than girls because they have a healthy conception of their own intellectual autonomy and have denied girls the opportunity to study science related subjects.

In Chapter 4, I presented the data generated from the questionnaires. These questionnaires were written in the Oshiwambo vernacular to make the communication easier (Section 3.5.2). This implies that the data generated were also written in the vernacular. Learners had to sit in their groups and translate their data into English. During the process of translating, I noticed how learners were struggling with the translations; and some changed meanings of words and sentences. I also realized that there are some words which I also found difficult to translate into English.

During this process, I noticed that this was enjoyable to the learners as they were trying to find proper words in English. Some ended up writing some words still in vernacular as they could not find proper English word(s) (Appendix O). In requiring this translation I tried to reinforce my learners' language skills as stipulated by the curriculum (MoE, 2010) as well as for validation purposes (see Section 3.7). I also realized that learners were using gestures to explain and even scratching their heads when they wanted to mention the word in *Oshiwambo* because they did not know it in English. This shows how English can act as a barrier to

learners for whom English is a second or third language and this could be an area for future research.

Despite the English language deficit, learners were able to explain other science related phenomena around tooth decay. They talked about how their parents treat this malady in a traditional way. During group discussions they went further to the extent of explaining how things are done traditionally in the community, for example, treatment of wounds, snake bites and scorpion stings; though they were not able give clarifications as to why these are treated the way they are. During their explanations, other learners (including myself) were inquisitive to learn and listen.

During the focus group interviews, learners indicated how important prior everyday knowledge is during the learning process. One learner said; *it is important because it helps me to know good examples and can remember everything during examination* (Table 5.3). So, the school curriculum should supplement what is there already. Henze-Rietveld (2006) adds that learning is integrally situated in the everyday world of human activities. O'Donoghue, Lotz-Sisitka, Asafo-Adjei, Kota and Hanisi (2007) too argue that human learning activities are social processes and learning is enhanced when related to the real life context.

Furthermore, the active participation and engagement of the learners in this study was brought about because they were positioned at the centre of the learning process. For example, they voluntarily brought other materials from their homes which were used to perform practical investigations in class.

### **6.3. Analytical Statement 2**

#### **Contextualizing subject content knowledge enhances conceptual development: Exploration of tooth decay leads to conceptual development**

In the exploration of tooth decay problems, many concepts emerged. Learners were able to come up with different concepts through their group discussions, class discussions, translation from vernacular into English and especially during practical activities (Section 5.4).

Before learners were engaged with the practical investigation on tooth decay, they were given an opportunity to make their predictions as advocated by Maselwa and Ngcoza (2003). For example, when I asked them to predict what would happen when we put pig teeth into the different beverages, they responded; *L1: Crack sound, L2: Bubbles, L3: Water goes up*. Some of the learners' predictions have been written in Table 5. 2. During their predictions, concepts also emerged, for example; *bubbles, volume etcetera*. In the process, I found that most of the learners knew the concepts but they could not explain them further as per curriculum guidelines.

Learners referred to *otombo* as diesel due its nature and being strong and its ability for making one to get drunk in a short period of time. One learner explained '*it is given that name because it is very strong, make people drunk quickly and turn lips to red colour*'. This emerged because the moment the tooth was inserted in *otombo*; the reaction was vigorous (see Table 5.3).

The practical activities helped learners to identify scientific concepts associated with chemical reactions. Learners were also given an opportunity to explore the phenomenon, by manipulating the locally made beverages. The reason that most of the learners were familiar with tooth decay and the processes around it, made it easier for me to give explanations. Thus, these practical activities clarified learners' perceptions about the world in which they live.

Likewise, some errors and some misconceptions emerged during the practical investigations. For example, *a learner said pretending instead of prediction, and bubbles suggest the presence of oxygen gas (Appendix F)*. Stears, Malcolm and Kowlas (2003) argue that misconceptions result because learners are not aware of the extent to which they bring their everyday experience into the classroom. Therefore, there was a need to clear out these misconceptions that learners were making.

Exciting experiments always stimulate the construction of scientific concepts especially when doing practical activities (Hodson & Hodson, 1998). I planned my learners' practical activity well in advance. This also implies that the teaching was at a reasonable pace in that I did not need to rush to finish the syllabus. I believe finishing off the syllabus is important but understanding should be the main goal of teaching and learning.

In this study, some scientific concepts emerged firstly from the brainstorming session (class discussions), and then from group work and later during the practical activity (see Section 5.4.). I also discovered that the practical activity on tooth decay reminded learners of the scientific concepts that they learnt in the previous grades. It also helped them to understand chemical reactions better (Appendix G).

Mwamwenda (2004) and Millar (2004) argue that practical activities promote construction of scientific concepts through the manipulation of materials. In the context of this study, such materials were familiar from the learners' everyday lives and facilitated meaning making of chemical reactions (Appendix F).

Although some teachers see practical work as not functional and time consuming, in this study learners were afforded an opportunity to interact and share knowledge (see Appendices E & F). Furthermore, learners learnt to write the correct scientific formulas which are currently problem facing science learners in most Namibian schools (MoE, 2011).

Appendix M (Green 3) shows different myths that emerged from the study. Myths are strong beliefs that if not handled properly may lead to confusion and misunderstanding of concepts. Some of these myths were:

- *Tooth decay is caused by witch craft;*
- *Traditional cabbage is eaten to have luck in life;*
- *Traditional healers help to treat tooth decay.*

I was supposed to take this opportunity to elicit more information on this as there seem to be a number of science concepts involved. Kibirige and Van Rooyen (2006) too argue how science is embedded in culture and so propose that science teachers need to identify the indigenous knowledge learners bring to class, scrutinize it and correct fallacies.

In analyzing my data in this research study, contradictions emerged. For example, the data obtained from the local clinic (Section 4.2.3) shows that children are the most vulnerable to tooth decay. This contradicts the findings of my own research which suggested that adults are

more vulnerable (Graph 4.16). Furthermore, the data from the local clinic revealed that the number of children, diagnosed with tooth decay is increasing very rapidly.

In the context of my study, I also noticed that some learners' answers did not make sense. Hence, I had to probe in their Oshiwambo vernacular (Appendix O). For example, a learner answered '*It is important not to have tooth decay and smell bad smell*'. That sentence has no meaning but when I asked him to say it in vernacular he responded "*onda hala okutya otashi keelele omayego gahole nokukeelela ezimba ewinayi mokanya*" (Freely translated: I want to say cleaning of teeth is important because it prevents tooth decay and eradicates bad smell in the mouth). Probyn (2009) argues that teachers and learners divert from the language policy in order to achieve social and pedagogical common goals.

#### **6.4 Analytical Statement 3**

##### **Teaching is influenced by the teacher's knowledge and experience in the mediation of learning**

It could be argued that the whole research process was designed as a tool to mediate the teaching and learning process of chemical reactions in grade 9. It started with the elicitation of learners' prior everyday knowledge (Appendix D). I also designed a questionnaire for community members to record their perspectives on what they thought the causes of tooth decay in Onangalo Village were. I was inspired by Prawat's (1996) recommendation to do this describing the nature of a human being to be a creature that uses non-biological heredity to transmit knowledge, experiences and symbolic tools from generation to generation (Kibirige & Van Rooyen, 2006).

Essentially, the main aim for recording community views was to complement what learners came up with in class on the same topic. I also wanted my learners to realize how important everyday knowledge is, which could be relevant to both indigenous knowledge (IK) as well bearing on the nature of science (NOS) (see Sections 2.4 & 2.5). I believe that the strategy of taking these knowledge systems into consideration during teaching and learning could be a useful strategy to mediate learning of science.

Therefore, my research produced some evidence of shifts in the learners' ZPD (Vygotsky, 1978) in which mediation of learning is critical. Firstly, this was done through scaffolding either with tools, environment or language. Secondly, learners were able to collaborate in groups (peer collaboration) and came up with findings which they presented to the entire class. Lastly, theoretical concepts emerged that highlighted the teacher's central position in assisting learners to appropriate science as cultural knowledge (Goos, 2004). As a teacher, I structured my lessons to allow students to participate in joint activities that would have been beyond their reach on their own – for example the use of the PEOEE approach (Maselwa & Ngcoza, 2003).

Moreover, I designed the questionnaire as a guide to help them, but not necessarily to limit the length of their responses. Questions were written in Oshiwambo, their vernacular, which was another strategy to foster mediation and scaffolding of learning (Vygotsky, 1978).

Leading support, Mwamwenda (2004) notes that language is the vehicle through which information is shared and ideas exchanged. In addition, Lemke (2001) shows how significant are the role of social interactions in teaching and learning of science. I believe if this questionnaire was not written in the vernacular, we could have obtained some incomprehensible data since English is a foreign language to most community members.

In organizing the community questionnaire I involved learners in the field of research as young researchers as recommended by the Curriculum (2010). One of the basic competencies in the Namibian curriculum is that learners should be equipped with research skills. This means that learners should be able to observe, do hypothesis, prove their hypothesis, record, report draw conclusion *etcetera* (see Table 5.5). For instance, when I engaged learners during the practical investigations, they were keen to work cooperatively as a class. Firstly, they manipulated the materials which they used as a catalyst of their scientific thoughts. Daniels (2008) argues that mediational tools are not really important but rather the significant aspect is the meaning encoded in them.

In using this mediational tool, I noticed that learners were using their experiences and practical activities to reason scientifically. Millar (2004) argues that learners use practical activities to bridge between on the one hand what they see and do with their hands to on the other hand, making sense of scientific ideas.

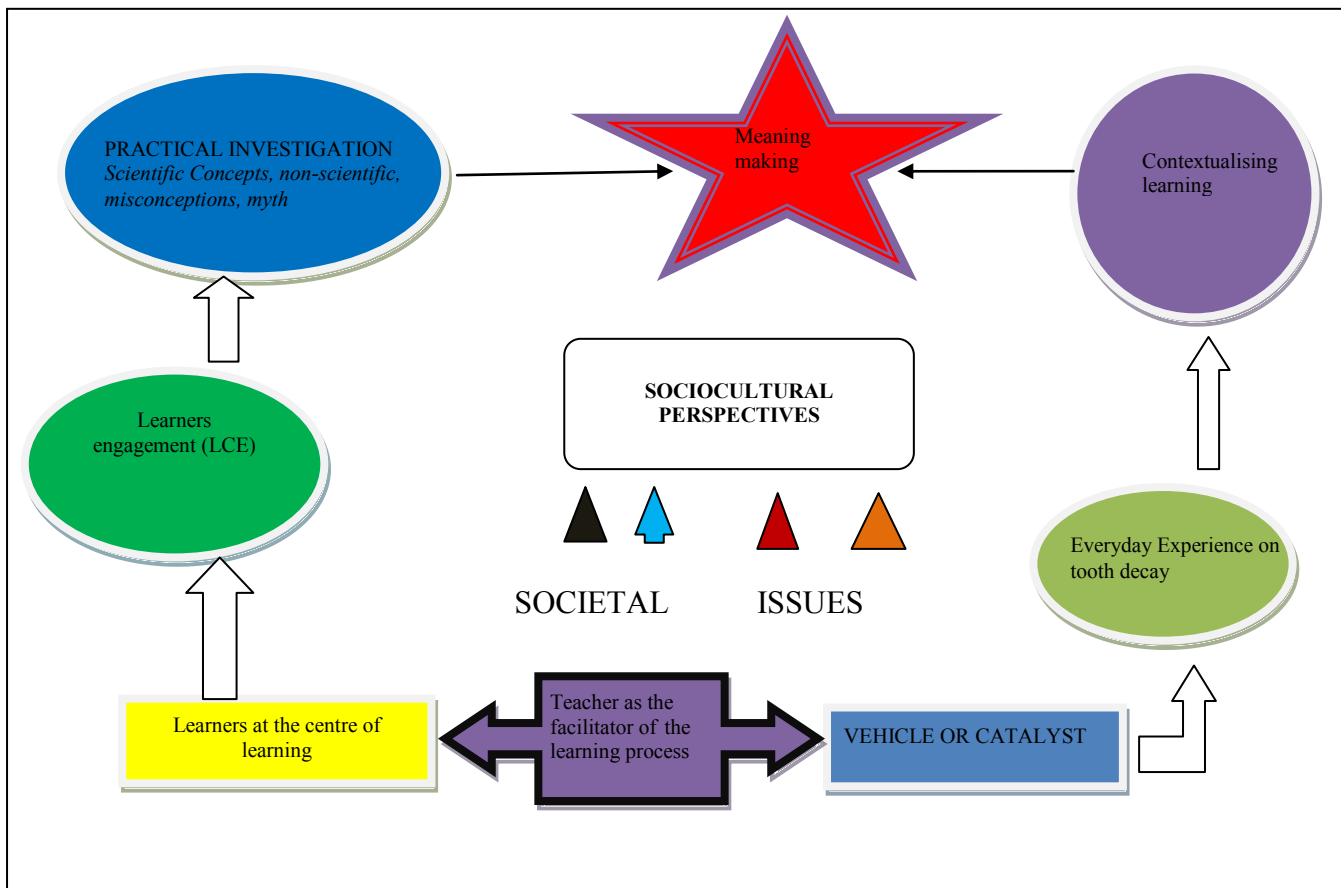
Worksheets were used to record observations. Learners were actively involved with these and did not miss any day without recording. They even came to me during their free lessons requesting another practical investigation. What was also striking was that one of the learners asked me to do an investigation on which local food contains lots of nutrients as part of the class lesson. Though this was not the focus of my study I wanted to do it for their enrichment, but time did not permit.

As part of assessment, I designed a test at the end of research study in order to check my learners' conceptual development and understanding. According to the MoE Curriculum (2010), assessment refers to the test for understanding and skills that a learner demonstrates as a result of teaching and learning. In this study, learners' performance showed that there was some understanding of the concepts developed (see Section 5.4).

## **6.5 Summary diagram of the research process**

Learners were actively engaged during the brainstorming sessions and through researching information on tooth decay in the community using questionnaires. Also, during the practical investigations I used materials from the society that learners brought to class. These activities were culturally embedded in the society (socio-cultural) (see Section 2.8.1). In other words, they were influenced by culture.

The following is an illustration of the process on how meanings emerged from different parts of society.



**Figure 6.2** Shows how the prior every day knowledge and practical work influenced by the society informs the Learner centered pedagogy

The diagram unpacks the influence of the social context in which interaction takes place. It demonstrates that learning depends on to a large extent on socially constituted collaboration between learner and others as well as the social environment (Vygotsky’s sociocultural theory). Vygotsky (1978) views human cognitive development as transformational in nature and mediated by the use of tools such as practical activities in the context of this study. The approach itself created a social space. In this supportive, learner centered environment, I took the responsibility of developing the teacher-learner interaction. Working together, this teacher and my learners created a collaborative interaction, a discourse community based on shared norms and goals.

## 6.6 Concluding remarks

In this chapter, I analyzed, interpreted and discussed the data presented in Chapters 4 and 5. Furthermore, I integrated the literature reviewed in Chapter 2. These were done in accordance with the analytical statements that I constructed. The findings showed that scientific concepts

can be extracted through the exploration of tooth decay. Local beverages and pig teeth proved to be useful mediational tools in the teaching and learning of classroom science particularly in chemical reactions.

There is evidence that learning has taken place (see Appendices), though some learners were struggling with the writing of the correct chemical formula and balancing. With that I planned additional classes in the afternoon to help them acquiring such basic competencies. The participation and active engagement of learners throughout the research process demonstrated that consideration of learners' prior everyday knowledge can enable this and hence promote meaning making in classroom science.

In the following chapter, I summarize the findings, provide recommendations, areas for future research, limitations and conclusion.

## CHAPTER SEVEN

### SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

#### 7.1 Introduction

In this chapter, I present a summary of my findings and the significance of my study with reference to my research goals. I further offer possible suggestions for the implementation of the findings in education. I also make some recommendations in the context of teaching and learning of science as a school subject.

#### 7.2 Summary of findings

The findings in Phase One of this study suggested the possible causes of tooth decay in Onangalo Village. Different traditional beverages and pig teeth were used during the practical investigations. The beverage *Otombo* was found to react most quickly with the pig tooth. These findings answered my research questions 1 and 2 which are:

**What do learners think are the causes of tooth decay in *Onangalo* village?**

**What do community members think are the causes of tooth decay in *Onangalo* village?**

Learners further gained insights on the gathering and presentation of data. Learners were at the centre of learning in every stage of the study. Learners also acquired some research skills during this process (MoE 2010). Furthermore, the research revealed that our community is rich in scientific knowledge as learners were able to gather many scientific concepts from their homes and community (Oloruntegbe & Ikpe, 2011). Furthermore, the research revealed that learners demonstrated the scientific processes of prediction, inferring and explaining scientific knowledge and skills.

Using the learners' vernacular rather than English during the gathering of data in the community proved to be a worthwhile strategy. According to Probyn (2009), code-switching is against the language policy but is a common strategy to achieve social and pedagogical goals if administered appropriately. Even though language was the main barrier discovered during the research process, I did not focus strongly on it because that was not the intention for this study.

The research also revealed that practical investigations are essential in the development of learners' scientific knowledge and concepts. Scientific concepts emerged during the practical investigations and learners' participation increased. Hodson (1990) discusses how practical activities can be used as mediational tools to arouse learners' interest during the teaching and learning process. Wilmot (2002) concludes that practical activities cause learners to discover for themselves and this could potentially result in meaning making.

Certain psychologists have supported constructivism and social constructivism in line with practical work. Jean Piaget focuses on constructivism based on cognitive development. He argues that learners should be given concrete materials to help them think (Mwamwenda, 2004). In addition, a conducive social environment should be created for proper learning to occur. He added that "the goal of education is to create people with the ability to be creative, inventive and discoverers rather than people who constantly reflect the ideas of others" (Mwamwenda, 2004: 95). On the other hand, Levy Vygotsky singles out the role of language in the mediating and scaffolding of learning. Practical work creates an environment for oral presentation, whereby learners themselves and with the teacher share and communicate ideas and thoughts thereby constructing new knowledge.

In addition to practical activities, prior everyday knowledge and experiences encourage constructive discussion and argument in the classroom. In this study, I started with the exploration of learners' prior everyday knowledge and experiences on tooth decay, which helped them to understand concepts associated with chemical reactions. As we might be aware, classrooms and schools are societal structures which accommodate students from different cultural beliefs and values. Therefore, learners' prior everyday knowledge and experiences can promote and encourage the understanding and development of scientific concepts.

### **7.3. The importance of the study**

My research goal was to investigate **how grade 9 learners make sense of prior everyday knowledge and practical learning through exploring tooth decay problems in Onangalo Village**. This was done in order to improve the performance of science at my school since science is a poorly performed subject and learners tend to dislike it. In addition to this, the research study was undertaken to respond to the Curriculum 2010 (C2010) which emphasizes

that learners should be empowered by the central authority of their own learning. Furthermore, C2010 points out that the role of the teacher in the teaching and learning process is to provide a setting in which the learners play an active inquiry role in their own learning.

My intention was to find a new way other than the one I usually use to bring changes in my classroom science teaching (Kasambira, 1993). The results indicated that many scientific concepts were embedded in the prior everyday knowledge, implanted in the community (society) and entrenched in the practical activities. It was further established that the use of prior everyday knowledge promotes active participation and learners' engagement in the science lesson. This was clearly seen on how learners constructed knowledge in their group settings, in individual discussions and class discussion.

Teachers have to be well informed with reasonable understanding that for effective learning to take place, they need to be involved in this type of teaching. The research also highlighted the role of the teacher in a Learner Centered Education (LCE) environment with coaching, and mentoring to build a bridge between the individual's interests and the learner understanding of the common skills and knowledge that society expects them to acquire (Nyambe, 2008).

The significance of this research to other teachers is to encourage them to formulate general plans about what they teach. It further reinforces the need to learn along with their learners. Also, it might help science teachers to understand the diverse nature of the society and how that influences the acquisition of new knowledge in schools.

One of the reasons why science teachers do not implement the curriculum fully could be that there is a scarcity of teaching and learning materials, for example, hydrochloric acids, sodium hydrogen carbonate and so on. This study can help them to use local materials as mediational tools toward the understanding of the Nature of Science (NOS). In the context of this study, presenting the topic of chemical reactions through exploring tooth decay did not cost any money. The lesson has been socioculturally-centered and its outcome was highly inspiring.

Current literatures (Rennie, 2011; Oloruntegbe & Ikpe, 2011; Stears, Malcolm & Kowlas, 2003; Kibirige & Van Rooyen, 2006) to mention a few, report similar findings. However, this

study has specifically demonstrated the usefulness of exploring tooth decay (prior everyday knowledge) as a stepping stone to understand chemical reactions. Other researchers investigated other indigenous practices.

#### **7.4. Possible implementation of the research study in the Namibian education system**

Due to the nature of my research project and its positive outcomes for the teaching and learning process, it qualifies for a position in the current system that requires learner centered pedagogy which repositions the learner as the main pedagogic actor, who should occupy the centre stage in the teaching and learning process (Namibia, MEC, 1993). Below I discuss how this could be implemented in (i) other science lessons and (ii) other subjects across the school curriculum.

##### **7.4.1. Possible implementation of the research study in other science lessons**

The first theme in every science subject is scientific process. This research has covered the entire learning objectives associated with its theme (understand the importance of recording, and communicating results and conclusion from the experimental investigation to other people both scientists and non-scientists). This study did not only focus on the chemical reactions but other topics were also covered during the process.

##### **7.4.2. Possible implementation of the research study in other subjects across the curriculum**

As reference, this research study can be used in other subjects than science. A section of it (brainstorming session) can be used in subjects like English in teaching vocabulary (e.g. elicitation) or common mistakes in pronunciations to improve learners' English skills. In addition this research can be modified to suit the teaching and learning of other subjects, for example, in Entrepreneurship. In such a subject learners are required to create a business plan. They are sent in the community to interview local business people and present their findings for assessment. I am confident that the processes followed in this research study can help in Entrepreneurship.

However, activities can also mislead learners if the teacher does not plan them well. Planning requires a lot of time. Most teachers may think this activity is too time-consuming; but, understanding is the main goal of teaching and learning.

### **7.5. Limitations of my study**

This study has only used one junior secondary school and one grade 9 in Omusati education region. Thus, the data obtained from it cannot be generalized.

The findings for this research study could have been different if learners from other environments such as urban or boarding schools were used. The environment (societal issues) as a mediational tool in its own right, naturally affects the outcome of the entire research process.

The sensitivity of my research in terms of questionnaires could have had an effect on data. Although for ethical reasons I instructed learners to interview people they are familiar with, I am not convinced that the responses given were honest enough (Section 3.7).

Time to carry out my research process was insufficient. In most cases, I had to do it after working hours, late in the evenings and during weekends. At the same time I had to do my ordinary school work.

Two of the most active learners fell pregnant and dropped out from school during the research. This might also have affected the outcome of my research study.

English is the third language for all of us (teacher and learners). Learners are struggling with language even as I do as teacher. If learners could have been better in their use of English, their translations of data would have made the research easier for me.

### **7.6. Recommendations**

It could be more impressive and important to use real human tooth in the practical investigation with my learners. Then the experiment would model the problem of human tooth decay more closely.

Future researches should involve a larger number of community members. That could enrich the data. Traditional healers should be involved to give their voice to the findings and to confirm whether the community members' points of views and beliefs have any sound basis in their experiences. This is advisable because some people visit traditional healers for the treatment of tooth decay.

The time allocations implicit in science syllabus and curriculum should be revised to cater for those activities (Section 2.6.2). This will leave no room for science teachers whose philosophy is to finish the syllabus without considering the goal of teaching and learning.

Based on the findings of this research, teachers need to be better acquainted with IK and be trained to deal with it in their classrooms. Workshops for science teachers should be organized to promote the use of indigenous knowledge and practical activities in schools. By encouraging discussion in class, learners will improve their language proficiency.

Lastly, I recommend this piece of work as a guideline for teachers in the recognition of prior everyday knowledge and experiences in science classes. In my view, it can help teachers to improve the understanding and development of concepts, thus improving learners' performance. Teachers should not underestimate the value and usefulness of knowledge possessed by our community members as well as by learners. They should use this knowledge to complement teaching and learning. This is not only applicable to science, but can be used in learning and teaching other subjects.

### **7.7. Personal reflection**

To start with, my journey toward M.Ed was not easy. This research study has opened my eyes into the world of academics. For example, reading has never been my hobby from secondary school up to college. Though I was one of the best learners in school, I only read with the purpose of passing from one grade to the next. By now I hardly recognize myself. I read with understanding, critique and analyze the ideas presented even when reading daily newspapers.

My understanding of learner centered education has changed throughout the research process. Before, I had shallow ideas on LCE as a pedagogy that requires learners to sit and discuss in groups only. However, I now understand that it is pedagogy that requires a variety of

teaching and learning strategies so that learners could be active participants in the learning process.

As a result of engaging my learners in this research project, their engagement and performance in science has improved. They were actively involved throughout this research project. This made me think critically about what contributions I can make to address the challenges in our school circuit seeing that it was successful at my school level.

Lastly, my academic attitude has influenced colleagues at my school. Firstly, it has influenced the principal and a critical friend who joined me during the research process in the classroom. Secondly, other teaching staff, since learners' engagement in lessons is better than before. They are all keen to join Rhodes University hence; they all applied for admission in 2013.

## **7.8. Conclusion**

The thesis discussed ways to explore and discover scientific concepts associated with prior knowledge and practical learning. It is built on the theory of social and socio-cultural constructivism. A constructivist describes knowledge as constructed by learners themselves through their social interaction with each other, the teacher (who facilitates the learning process) and the environment. Based on this, there is no single 'truth', but there are multiple realities.

In particular, the study investigated the exploration of tooth decay with the view to understand concepts in chemical reactions. Findings showed that this research study was productive despite some limitations. It became evident that the gap could be closed between school science and relevant phenomenon of learners' home experience, provided clear guidance is provided. Home activities can provide a source of meaningful, experiential based teaching and learning and in-depth understanding of scientific concepts.

In conclusion, the study further recognizes the use of prior everyday knowledge and experiences in the teaching and learning of science as important. Thus, prior-everyday knowledge that learners bring from home as well as knowledge from the community should always be considered as these form the basis of everyday teaching and learning. This also helps learners to understand and develop scientific concepts. In the same breath, teachers can

use practical activities to enhance understanding. Learners learn best when they are doing hands on manipulating activities. Local materials can be used for this since they are cheap, familiar and available.

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# Appendices

- A. Letter to school Principal
- B. Letter to learners' parents in English and vernacular
- C. Questionnaire in English and vernacular
- D. Transcribe session 1
- E. Transcribe session 2
- F. Transcribe session 2
- G. Semi-structure interview with focus group
- H. Stimulated recall interview with a critical friend
- I. Learners work sheet
- J. Test administered to learners
  - Learners reflections
- M. Colour coding and themes identifications
- N. Unit of work
- O. Learners translation from Oshiwambo to English

## Appendix A

Onambala J.S

P.O. Box 112

Tsandi

The Principal

Onambala JSS

Dear Sir

### **Re: Request for permission to carry out a research project**

I am Asino T, a science teacher at the above mentioned school currently doing Med (Science) with Rhodes University, South Africa. One of the tasks to complete the course is to do a research thesis

It is within this background that I m humbly requesting your good office to permit me to do my research at the school as well as to use school materials were possible. My proposed topic is: **An investigation of using prior- everyday knowledge and experiences on tooth decay in Onangalo village with a view to understand chemical reactions concepts in grade 9: A case study**

I trust your good office will consider my request as important and keen waiting for a positive response

Yours truly,

Asino Tomas

(Science teacher)

J.K. Shaalukeni (Principal)

Signature if permission is given

---

**Appendix B (In Oshiwambo)**

Onambala J.S

Oshako 112

Tsandi

Omukuluntu gwa: Samuele Naho

Oto indilwa nisimaneko opo upitike omunasikola gwedhina lya tumbulwa pombanda tulonge nayo iilongadhalwa yuungomba konima yootundi. Otashika pula ethimo ele, onkene mupitika eye a tokelwa kashona

Ngele owemupitika, tula esaino kaha lyoye pokamusinda pevi.

Gweni

Asino Tomas

(omulongiskola: (0812931099))

\_\_\_\_\_

eshainokaha lyomuvali uuna eshi pitita

**Appendix B (In English)**

J.S

Onambala

P.O.Box 112

Tsandi

Respected parent (s) for Samuel Naho

You are kindly requested with honour to permit the above mentioned learner to partake in my research project. Sometimes she might come home late in the evening as there will be times to do this project after normal classes

In case the permission is granted on this kind request, sign on the space provided.

Yours truly,

Asino Tomas

(Science teacher: 0812931099)

-----

Parent signature, if permission granted.

## Appendix C

### Omapulapulo (Moshiwambo)

Kwathandje u pule aantu mboka wu shi nawa momudhingoloko gweni omapulo taga landula:

Hogolola eyamukulo lyomondjila. Sindolola owala ondanda mpono tashi vulika.

**Edhina lyomulongwa:**.....

1. Tumbula omaludhi giikunuwa mbyoka yiholike kaantuyomoshitopolwa sheni.

.....  
.....  
.....  
.....  
.....

2. Gandja omaludhi giikulya mbyoka hayi liwa momudhingoloko nguka

.....  
.....  
.....  
.....  
.....

3. Pomadhiladhilo goye oombolo dhomayego ohadhi etwa koshike?

A. Ekuthomo lyomayego omakulu (okukulwa)

B. Omayego ga hola

C. Omayego ga teka

D. Yilwe,

ngaashi:.....

4. Pamadhiladhilo goye oshike hashi eta oombolo momayego?

A. Iikunuwa mbyoka hayi dhangwa

B. Onkalo yombepo

C. Oomvula

D. Yilwe,

ngaashi:.....

5. Lungapi ho opaleke omayego goye?

A. Lumwe mesiku

B. Lu yali mesiku

C. Kehe ethimbo konima yokulya

D. Yilwe,

ngaashi:.....

6. Osha simana tuu oku opaleka omayego? Gandja omantopelo.

.....  
.....  
.....  
.....  
.....

7. Ngele nee osha simana oku opaleka omayego, ohamu longitha shike? (Ohamu ga opaleke nashike)

.....  
.....  
.....  
.....  
.....

8. Lungapi hamu li uuleke?

- A. Esiku kehe
- B. Oshiwike kehe
- C. Omwedhi kehe
- D. Yilwe,

ngaashi:.....

9. Aantu yangapi maanjeni/mezimo ya kwatwa koombolo?

Children	Adults		
	Male	Female	Total

10. Omolwashike ngiika aantu oyendji moshitopolwa sheni yakwatwa / ye na uupyakadhi woombolo momudhingoloko gwaNangalo?

.....  
.....  
.....  
.....  
.....

11. Oshike hashiningwapo uuna aantu yakwatwa koombolo?

.....  
.....

**Appendix C**

**Questionnaire (In English)**

To be completed by learners as they asking community members.

\*Where optional is given circle the letter

**Learner' Name** .....

1. List down the types of beverages that people commonly drink in this area?

.....  
.....  
.....  
.....

2. List down food-staff commonly eaten by people in this area?

.....  
.....  
.....  
.....

3. What do you think tooth decay is?

- A. removal of old teeth
- B. rotten teeth
- C. breaking of teeth
- D. others, specify .....

4. What do you think causes tooth decay

- A. beverages
- B. food-staff
- C. weather
- D. ages
- E. others, specify.....

5. How often do you clean your teeth?

- A. once a day
- B. twice a day
- C. every after meal
- D. others, specify.....

6. Is it important to clean our teeth? Explain your answer.

.....

.....

.....

7. If so, what do you use to clean your teeth with?

.....

.....

.....

.....

8. How often do you eat sweets?

- A. Daily
- B. Weekly
- C. Every month
- D. Others, specify:.....

9. How many people in your family are affected by tooth decay?

Children	Adults		
	Males	Females	Total

10. What do you think why so many people have tooth decay problem in your community (Onangalo)?

.....

.....

.....

.....

11. What do people do when their teeth have decayed?

.....

.....

.....  
.....  
.....  
.....

Thank you

## Appendix D

### Brainstorming session: Transcribing of Video

Key: T= teacher, L= learner, Ls= Learners

T: Good morning, how are you?

Ls: Good and how are you sir? (*Standing*)

T: I am doing fine. Take you sit and close all your books.

Ls: (*Take their seat and close all the books on their tables*)

T: Fine, today we are blessed to have some of the materials around us. So what is this?  
(*Holding two different jaws*)

L: Bones and teeth for donkey, *aye* for a goat.

T: can anyone guess our topic for today? *Shamina!*

L: Teeth decay

T: Any body else? *Kwacha!*

L: Natural science

T: Any body else?

L: tooth decay

T: Thank you, we are going to learn about teeth (*holding jaws*). Thus you can see I brought these jaws for animals like you. Now give me the types of teeth that you know? *Kakopi*.

L: Canine...Canines (*wrong spelling*)

T: Eeeee, Canine. Ok (*writing on the chalk board*). *Hilma!*

L: Moral,

T: Moral, eehhh, *Hilma!*

L: Premolar

T: Eeeeeee! Premolar, Inker,

L: Incisors

T: (*Writing it on the chalk board and misspelled it*). How do you spell it?

L: (*spell it correctly*)

T: Is that all?

Ls: Yes

T: Ok, good. Can you give me the function of your teeth? *Shingwedha!* Why do you have teeth

in your mouth?

L: To chew food

T: to chew food...

L: Incisor is to cut food

T: Eeeeeee, you are saying number one is to chew, no. two for cutting, what are you cutting?

Ls: food (*chorus*)

T: To cut food okay, what else, ya.....

L: premolar used to.....(*voice not clear*).

T: Can you stand up straight? Are you sick or what?

L: Yes she is not feeling good (*another learner responded*)

L: Used for crushing and gridding food.

T: Crushing and gridding, hhmhhh (writing it on the chalkboard), why do we have to crush and

grid food?

L: To make it easy for swallowing.

T: To make it easy for swallowing, is that all? Hmhhh Shamina!

L: To smash food into small pieces.

T: Why do we have to smash food into smaller pieces? What if I put a piece of food into the mouth and swallow without chewing?

L: **Just to pondwaring (in oshiwambo).R5**

T: What do you mean to *pondwa*? Anything else? Eeee!

L: Help in swallowing

T: Help in swallowing with easier, ok, but, but..... is that all?

Ls: No,

T: What is the reason of chewing apart from ..... make it easy to pass your.....

Ls: Oesophagus

T: Or gullet, and what else? Ok what happen in your stomach when swallowing food, do they

just go there and sit **G4**?

Ls: No, they move to all parts of the body.

T: They just move!

Ls: Yes (the whole class)

T: What do they do inside the stomach?

L: They move out when you are going to..... to.....drop wastes materials.

T: To drop waste products, ok, and what else? Tell me what is happening in your stomach

(*touching his stomach*). John.

L: They are broken down by intestine.

T: What is inside that help to break down food?

L: Stomach, **acids GI**.....hmmmm

T: Acids! What else?

L: water also.

T: Ok, if we have **acids GI** in the stomach, do we have any reaction taking place in the stomach?

L: Yes,.....hmmmmmmm.....no

T: Ok, now if you eat porridge, what is the colour for porridge?

L: **Colourless GI**, hmmmmm, somehow.

T: Somehow? Ok what will be the colour for stools?

L: Hahaaaaa, hmmmmm, black

T: Ok, is that **physical or chemical change? GI**

Ls: chemical change (*chorus*)

T: Why chemical reaction?

L: Because there is a change, hmmmm because new substance is formed.

T: New substance formed, the colour changed completely and even bad smell. Good that also formed part of our lesson. Our lesson is tooth decay, so in your groups (*since they already sit in groups*) discuss. And discuss and discuss about tooth decay. What causes it according to your own experience. What you heard from your grand father, what you read from books and whatever. Therefore, I am going to give each group a paper where to do the writing for your discussion (*give each group a big paper and marker pens*)

Follows are the learners' findings in their groups.

Questions	Responses from groups	
1. What is tooth decay?	<ul style="list-style-type: none"> <li>• Is a bacterial that stays in the teeth that we eat. <i>G1</i></li> <li>• Is a process where teeth are destroyed by chemicals because of dirty. <i>G1</i></li> <li>• Is a substance that attack somebody if did not clean teeth. <i>G3</i></li> <li>• Are the bacteria that use to stay in our teeth. <i>G1</i></li> </ul>	
2. Causes of tooth decay	<ul style="list-style-type: none"> <li>• Nature <i>G4</i></li> <li>• Food that contain sugar <i>G4</i></li> <li>• Sharing tooth brush <i>G1</i></li> <li>• If you did not brush your teeth after meal <i>G1</i></li> <li>• Bacteria from food <i>G1</i></li> <li>• Take long time without cleaning teeth <i>G4</i></li> </ul>	

	<ul style="list-style-type: none"> <li>• Witchcraft <b>G4</b></li> <li>• By sharing tooth picks and tooth brush <b>G4</b></li> </ul>	
3. Is it important to clean our teeth or not?	<ul style="list-style-type: none"> <li>• Cleaning teeth after meal help to avoid tooth decay <b>G1</b></li> <li>• Yes, it helps to avoid bad smell in the mouth. <b>G1</b></li> <li>• It is important not to have tooth decay and smell bad smell <b>G5</b></li> </ul>	•
4. What do people do when their teeth have decayed in Onangalo village?	<ul style="list-style-type: none"> <li>• Visit the hospital for the teeth to be taken away</li> <li>• Visit the dentist regularly</li> <li>• Use different methods to remove the sick tooth <b>G5</b></li> <li>• Use to put omahini goshingumati <b>G1/G6</b></li> <li>• Use onziku to treat themselves <b>G1/G6</b></li> <li>• Eat food that have no sugar <b>G1</b></li> </ul>	
5. How many people do you know that suffering or have suffered from tooth decay in Onangalo village?	<ul style="list-style-type: none"> <li>• Many people are suffering from this.</li> <li>• 100% people are sufferers from tooth decay <b>G5</b></li> </ul>	
6. What do people use	<ul style="list-style-type: none"> <li>• Mopane leaves <b>G1/G6</b></li> </ul>	

<p>to clean their teeth in Onangalo village?</p>	<ul style="list-style-type: none"> <li>• Ash from wood <b>G1/G6</b></li> <li>• Tooth paste <b>G1</b></li> <li>• Small branches <b>G1/G6</b></li> <li>• Skin for animals <b>G6</b></li> </ul>	
--	--	--

After the presentation by the learners the teacher continues:

T: Fine, this was our findings ne, is it?

Ls: Yes.

T: Now. Our next task is for you to go ask our **meme, tatekulu, your brothers, your sisters or anyone you know best in oshiwambo. Write anything what they are saying. Do not make judgments. Don't say aye that one is wrong. Topola kutya meme, shono hashi etitha omayego gahole oshike nande atya uulodhi, just write because is what she said R5/R6.** (Give each learner a **questionnaire R7** written on oshiwambo). But please I do not want you to cook, ask them ask people who you know best. Thank you, I think its break time and have a blessed weekend.

## Appendix E

### Session 2

#### Transcribing of Video

Key: T= teacher, L= learner, Ls= Learners

T: Good morning pupil, how are you?

Ls: Fine and how are you sir?

T: I am doing fine. Well come to our second session. I know by seeing this beautiful bones (*holding the skull and jaw*) you can still remember our topic.

Ls: Yes (*chorus*)

T: Which is.....Naambo?

L: Tooth decay

T: Is this **skull R7** for a chicken?

L: No, for donkey, for people

T: Ok. Last time I gave you **questionnaires R7**. Do you have them?

L: Yes (*chorus*)

T: Good, I said go and ask who?

Ls: Our parents (everyone was talking)

T: No, no, one person a time. This is not a church were we sing together, *Naango*

L: **All people in the community G4**

T: **All people? G4**

L: **Elder people G4**

T: Did I say elder people? I said **mukapula aantu mboka mushi nawa R5**. Now .....our **questionnaires R7** are in oshiwambo, is it?

Ls: Yes

T: **Now, we are going to translate questions and their answers into R5/R6.....**

Ls: **English R5**

T: Now, each group is going to compile its findings on one paper. Do you understand? (*Give papers to groups*). Later, you have to present your findings to the rest of the class.

Meanwhile the teacher move around, visiting each group each group to make sure at least all learners are engaged. He also assists where possible. Code switch also played a very big role here. In addition, a critical friend also moved assisting learners **R6**.

Each of the 20 learners was given a questionnaire in order to go in the community/home to ask people whom they are familiar with. This was done for ethical reasons. Unfortunately not all learners completed the questionnaire. Three of them did not return back. The following is a summary of data emanated from the questionnaire:

### 1. The types of beverages that people in *Onangalo* commonly drink are:

Beverages:	Tally	Frequency	Explanation of the beverages
Ontaku		9	Available in every house
Otombo	-	13	Common and liked beverage in the village though some are using it for commercial purposes but it is very cheap.
Epwaka		11	Common and liked beverage in the village though some are using it for commercial purpose but very cheap.
Ondjindja		11	Common and liked beverage in the village though some are using it for commercial purpose but very cheap.
Okanyatau		7	Commonly a drink for woman
Omushovoli		1	Is a seasonal drink for few man
Omeva		1	Few people liked water since tasteless <b>GI</b>
Omalovu giilya		6	Free in most houses though they use it for commercial purpose sometimes
		<b>Total: 59</b>	

### 2. The types of food that they eat?

Food Stuff:		Tally:	Frequency:	An explanation of the different foods eaten in <i>Onangalo</i>
<i>Oshiwambo</i>	<i>English</i>			
Oshithima	Porridge		12	Available, produced in every house annually
Onyama	Meat		9	Most of people are

				keeping animals for meat only
Omayi	Eggs		1	Though there are chicken in every house, eggs are used for commercial purpose
Omboloto	Bread		2	Costly
Eeshi	Fish	###	6	Available free of charge during rainy season
Eefukwa	Groundnuts	###	5	Produced annually
Uukuki	Cakes		3	Costly
Omapungu	Maize	###	7	Available
Uuleke	Sweets		1	Cost money
Omboga	Traditional cabbage	### ##	10	Available every year in the veld
Olwishi	Rice		1	Very costly
Omakunde	Beans	###	9	Produced in every house
Ihenda	Water melon (very young)		1	Normally eaten by children
Omakoloni	Macaroni		1	Expensive
Oombe	Berry		1	Rare and used for commercial purpose
Oondunga	Palm fruit		1	Most of them have sour taste GI and used as donkey food and for brewing of Ombike GI/G6
Omagungu	Mopane worms		8	Collected free from the forest
Omahini	Milk		1	Used for commercial purpose
			<b>79</b>	

### 3. What is Tooth Decay?

Response:	Tally	Frequency
Tooth with cavity	###	9
Removal of old tooth		3
Do not know	###	5
Broken teeth		0
<b>Total:</b>		<b>17</b>

**4. Is it important to clean our teeth or not? Explain.**

- Yes, this helps to prevent tooth decay and also keep our teeth clean and health.

- Yes, it prevents tooth decay and bad smell in the mouth.

- It is very important because it prevent bacteria from acting in our mouth. **G4**

- Yes, it prevents bad smell in the mouth and development of cavity. **G4**

- Yes, cleaning of our teeth helps remove dirty between teeth in the mouth. **G4**

- It is important because it prevents our teeth and mouth from infections. **G4**

- It helps remove food remains that cause cavity. **G4**

- cleaning of our teeth help teeth not to get old soon. **G3**

**5. What do you think causes tooth decay?**

<b>Causes:</b>	<b>Tally:</b>	<b>Frequency:</b>
Sweets		11
Food		3
Both Sweets and Food		1
Nature		1
Sugary Food		1
Not cleaning teeth		1

**Total: 18**

**6. How often do you clean your teeth?**

<b>Response:</b>	<b>Tally:</b>	<b>Frequency:</b>
Once a day		3
Twice a day		1
Every time after meal		11
Anytime when my mouth smell		1
I do not use to clean the teeth		1

**Total: 17**

**7. How many people in your family have suffered or are suffering from tooth decay?**

<b>Learner</b>	<b>Children:</b>	<b>Adults:</b>	<b>Total:</b>
A	1	5	6
B	4	2	6
C	4	1	5

D	1	3	4
E	1	3	4
F	2	5	7
J	4	3	7
H	0	6	6
I	2	6	8
J	3	2	5
K	1	2	3
L	1	5	6
M	2	1	3
N	1	6	7
O	5	4	9
P	-	2	2
	Total: <b>32</b>	<b>56</b>	<b>88</b>

**8. The reason why most people in Onangalo village are suffering from tooth decay is:**

- Most of them are illiterate and they have no idea of what cause tooth decay. **G2/G4**
- The use of sugary food and drinks. **G1**
- Sugar from local beverages e.g. otombo **G1/G6**
- Too many sweets **G3**
- Not taking care of teeth by keeping them clean.

**9. What do people in Onangalo village do when their teeth have decayed?**

- Bite tablets e.g. paracetamol.
- Use to chew leaves of one traditional plant.
- Go to the clinic for treatments/repair of the cavity formed.
- They treat themselves with hot salt water.

➤ Apply liquid from omungumati tree.

➤ Go to traditional healers. **G3**

➤ Treat traditional using a herb called onziku. **G1/G6**

T: (*Write all the possible causes as learners are presenting*) We are know going to use some of the drinks which are locally made; we use to brew them home, is it?

Ls: Yes (*chorus*)

T: (*Explain the procedures and step for experiment and write them on the chalk board*).  
.....why are we using pig teeth? Why not for a donkey or goat?

L: Because for the donkey is big and pig teeth are the same for a person. **B1**

T: Very good, a pig is omnivores, is it?

L: Yes like people **B1**

T & Ls: Assigning each other on who is to bring which beverage for the next day experiment.  
Some learners volunteer themselves to bring

T: Okay fine, we are also going to use pure water or tap water. Why tap water?

Ls: Very quite

T: Tap water is neutral, is it? It acts as a control for our experiment. Then hmmm, after done with our first phase of the experiment, you should keep a record by observing what is happening in each test tube everyday. Thank you very much pupil. We shall meet the next day and don't forget to bring our material. I will provide test tubes and pig teeth.

**S3**

## **Appendix F**

### **Session 3**

#### **Transcribing of Video**

*Key: T= teacher, L= learner, Ls= Learners*

**T: (*Getting into the class holding teaching aids*) Yes, good afternoon?**

Ls: Afternoon sir

T: How are you?

Ls: Fine and how are you sir?

T: Fine too

Ls & T: Collecting the materials or beverages R7 that learners brought

T: Right, out topic is.....

L: Tooth decay

T: And we proposed to carry out our experiment using what and what and what?

L: Alcohol, hmmmmmm.....different types of alcohol G4

Ls: No, No

L: We discussed about.....about different types of drinks

T: And what is the experiment all about? What are the materials that we are going to use?

L: We use different types of drinks and the teeth of the pig, we.....we....., put the drink in a test tube, we put a teeth, then we.....we.....we.....we.....

T: Anyone to help?

L: We....we observe what happen

T: How many beverages are we having here? They are.....

L: Four

T: And there is something missing. What is missing here?

L: Water

T: Water, is it? Why do we need water in our experiment? What is the main use? Is it a local drink like otombo?

L: No

T: Why do we have to include it in our experiment? Tell me, is water an acid or alkali or neutral?

L: Alkali, aye.....mmmmmm neutral

T: Neutral, tell me the reason why we use it in our experiment?

L: No sugar in water

T: Ok. In other words water acts as a.....? Naango

L: Neu.....tralize....

T: As a what?

L: Neutralizeee

T: Yaa, but we use water as.....?

L: Citric acid

T: In order for our experiment to be fair we need a control

Ls: Yeah.....mani

T: Now we managed to get some nice materials here (holding the pig jaws) heeeyee what is this?

L: It is a mouth

T: Shamina!

L: Teeth of a pig

T: Ok, mouth of a pig, .....why do we use the pig teeth? Why not for donkey or for elephant or lion?

L: Because the teeth of the pig are the same like a person

T: Are they the same?

Ls: No

L: Because the pig eat the food, the same .....because the pig is a mammal

T: Ok, the pig is a mammal, what else?

L: The pig use to eat what is eaten by people.

T: It use to eat what is eaten by you, me is it? It is an omnivore. It use to eat meat and.....

L: Plants.....

T: Now we are going to use pig teeth which acts like eeyeyee a person's teeth. Who brought this one? (*Holding a container of beverage*)

Ls: Embishi

T: Hilma, what is in here?

L: Epwaka

T: Eheeee, epyaka, we are then going to use one test tube contain epwaka (draw and write it on a chalkboard). Ook, this one (*holding another container*)?

L: It is me sir, Kasuanki.

T: What is in here?

L: omutjovoli (standing)

T: Omutjovoli, omundele?

L: Yes

T: Okay, we have to add another another one (drawing another test tube on the chalkboard).  
How do we spell it?

L: Omundele

T: This one is for whom?

L: For Junias

T: Eheeee, Shigwedha, what is in here?

L: Otombo

T: Otombo, another test tube which contain otombo (Still drawing on the chalkboard)

L: (without given a chance) Otombo is diesel

T: Diesel, why is it called diesel, why not paraffin?

L: No, no, it is very strong

T: Very, strong....and this one?

L: For suppa

T: For Kashupi, what is in here?

L: Ondjindja

T: Ondindja, ok there is another test tube contains.....how do we spell ondjindja, like this  
or there is n here?

L: No, Yes.....there is n there

T: Ok, then we has the last one for.....

Ls: Water!

T: And we said water is act as, water as a.....

L: **Control GI**

T: Now, do we have to put in epwaka here, mudele there, otombo here (showing different  
**volumes GI** of beverages)?

L: **No we have to put..... we have to put.....they have to be equal BI**

T: We have to make sure that they are of the same level. Why not like some are more and some are few (gestures)?

L: Hmmmmm, some drinks are not see, are not see... they are just.....see some.....

T: Ohooooo, any other ideas, why putting them of the same level, same capacity, same...volume?

L: Quite.....

T: Then, its fine for them to stay like this.....ok?

L: No.....no

T: Why do we have to balance everything in terms of .....capacity or volume? Eeeeeee, Monika!

L: help to observe

T: To observe, but you can still observe like this.

L: To manage them

T: Yaaaa..... What is the scientific term that we can use?

Ls: To make equal

T: What are we trying to do here? What do we call the whole process?

L: To observe GI

T: To observe GI, but we said is experiment, is it?

Ls: Yees

T: And we said we use water as what.....?

Ls: Control!

T: Control, is it? Why do we want yo make sure things are of the same volume or capacity?

L: Hmmmmm.....hmmmmmmmm

T: We want a fair experiment, is it? How do we compare Joan and Shikongo if Joan is a girl and the other one is a boy? You see there.....there is no fair test, experiment. You suppose to take all girls of the same.....

Ls: Level

T: Now the next step we have.....I mean.... How do we call this (holding the container for test tubes)?

L: Laboratory, hmmm...test tube holder

T: Is a test tube holder. What does it mean?

L: It is used to hold the test tube

T: It is used to hold test tubes, is it?

Ls: Yes

T: And.....how do we call this one?

L: Cotton

T: Are they cottons?

L: Noooo, they are covers

T: Yes, they are covers, but they have..... a proper name. they are called.....(Kalunga kandje)! **RS**

L: Cover tube

T: Uh, cover tubes.....they are called.....**stoppers GI**. Stoppers means.....?

L: To stop the **air GI**.....stop the air not enter

T: Very good, stop the air from entering the test tube.....remember when we learn about **rusting GI** .....we also covered them with stoppers to prevent air getting.....

Ls: Innnnn!

T: In order to have what... a fair experiment. Can somebody come forth to get for us teeth from the **skull R7** using this (*holding the pliers*) instrument?

L: (*Come in front of the class to extract teeth from the skull*)

T: Just break.....break it. Ok... we have this one.....

L: They are very strong

T: Look at the size (*holding the tooth*), they are very strong

L: And.....beautiful

T: Now, we have to make sure the capacity is of the same level.....we have epwaka...mudele.....we have otombo, ondjindja and now.....I need one, two, three, four five pupil here.

Ls: (*Five learners come forth*)

T: Why only girls? We are now going to give each one a test tube.....do not break it (*giving the test tube*) We have meme epwaka, this is your name for now (*giving names that correspond to the type of beverage to be poured in the test tube that they are holding*). We need some one to come and pour, epwaka here.....mundele.....otombo.....ondjidja.....and tap water there....

L: It is me sir.....it's me sir...me.....me..... (*Learners volunteer themselves to pour different beverage in their corresponding test tubes*)

T: Why only girls ano? Ayeee.....not full.....remember.....

L: No problem.....(*measure manually by putting test tubes with contents closer together, to make sure the volumes are more or less the same*)

T: Make sure the whole teeth is covered by the beverage.....do not hold like .....this.....make suere they are of the same level. What are you doing when you are doing like this in science?

L: Observation

T: Observation.....but what are you doing?

L: Measuring.....measuring

T: Ahhh, no.....what are you doing?

L: You are levelling the.....

T: Not levelling

L: Pretending

T: Predicting..... you are.....

L: Check if they are equal.....

T: Different scientific proccess, what are they.....?

L: Inference, observation, communication, classification, drawing.....

T: You forget some thing.....

L: Estimation!

T: Estimating, you are not sure if they are exactly equal or not (holding two test tubes). Are they of the same level?

Ls: Noooo

T: You have more here.....pour out some.....ok....bring them together. Are they fine?

L: Yes

T: The first thing that we have to understand here is we have

P.....E.....O.....E.....E, approach. Before you do any experiment, you have to predict...then.....you must explain your prediction.....then you do what? You observe...then you.....( Maselwa and Ngcoza, 2003)

Ls: Estimate

T: Explain your observation and explore (*repeating again and again and give examples*). Now we have these teeth six of them (*holding the teeth*)

L: (*the five learners each pick a tooth but not put them in the test tubes*)

T: Let us now predict what could happen when we put the tooth in these beverages

L1: Crack sound

L2: Bubbles

L3: Water go up

T: What else? Why are you saying water will rise?

L: Because volume changes

T: Yes, because the tooth will occupy the.....

L: Volume

T: Ookay. Start to put in.....

L: The otombo is start to boil, and *oshanyenya noho*

T: Did you see any changes there?

L: Yes....in diesel..... otombo (discourse given by learners because its strong)

T: There are .....?

L: Bubbles

T: What are those bubbles suggests?

Ls: There is oxygen.....acid (misconception)

T: There is a reaction takes place.....there is a reaction. Now tell me what are those bubbles suggests?

L: They are like.....

T: What do you think when you see bubbles in water?

L: There is .....air (Limitations on the name of the gas released as Carbon dioxide)

T: There is air which is released, air is given.....

Ls: Given out (*chorus*)

T: Which energy is associated with energy given out? Naango!

L: Endothermic reaction

T: Endo.....thermic reaction?

L: No, is exothermic

T: Exothermic. Can some one explain what exothermic is? Inker!

L: Is a reaction that energy is taken out

T: Ok, is a reaction that gives off energy, ok fine now, I hope we are almost done. What we have to do .....we are know going to cover our test tubes with stoppers, then from there, put them back to test tube holder and we put them up the cup board, ok.....and everyone have to do the observation. Remember, observation is.....

L: Seeing

T: See and then you go?

L: No, observation using five senses

T: Good! But there is one sense which is very dangerous. Which one is dangerous?

L: Taste

T: Taste, you don't taste.....aaaaaa, who did not participate today?

Ls: Aron Selma

T: Yaaaa, Selma you are just here like a Zobbie, stand up go and cover the test tubes

L: (stand and cover the test tubes)

T: Thank you, Hendrina write down some papers and paste them on test tubes. Everyone have to come and do the observation every morning. Meme Amukoto is having an activity for us that we have to do or answer questions. Write neat and I need them on Friday (*A critical friend distribute the question papers to the learners*)

Ls (*all*): (*Enjoy the over left beverages*)

## FGI

### Appendix G

#### Semi-structured interview with a focus group

Questions	Responses
1. Do you think science teachers should consider or not what learners know from home and what they learned from environment when teaching science?	<ul style="list-style-type: none"><li>• Yes because we want to talk a lot from our homes</li><li>• Yes, because it help me to think a lot that.....things from home are important because we also learn them at school</li><li>• Yes, because we can not fail things we know very .....(<i>nawa</i>) well.</li><li>• It is important because it help me to know good examples and can remember everything during examination</li></ul>
2. How do you feel that we start the lesson on chemical reactions by exploring about tooth decay?	<ul style="list-style-type: none"><li>• I feel good because we talk and talk a lot even my friends Selma who is always quite was talking.</li><li>• It was nice because we learned a lot of science things</li><li>• It was good. We all know tooth decay as we use to see people at home sick tooth. I enjoyed it</li><li>• I was not known if the things from our homes can be used in the class, it was good.</li><li>• Good because after finishing we watch ourselves in the video and learn again from watching</li></ul>
3. Do you think it is important to do practical activities like the one we did on tooth decay? Explain	<ul style="list-style-type: none"><li>• Yes, it was good because I see with my own eyes but not the teacher to tell me.</li><li>• It is important because we learned and see which beverages caused the teeth to decay.</li><li>• Yes, because we are going to tell our friends and parents not to drink the <i>otombo</i> that cause tooth decay.</li></ul>

	<ul style="list-style-type: none"> <li>• Practical activity is good because we learn a lot of things of tooth decay and chemical reactions.</li> </ul>
4. Which scientific concepts did you learn during the practical activities?	<ul style="list-style-type: none"> <li>• Measurement, endothermic, exothermic, recording, synthesis, decomposition, gas given off, observation</li> </ul>
5. Do you think the lesson helped you to understand chemical reaction better?	<ul style="list-style-type: none"> <li>• Yes, it helped me a lot, last year I was not understand it and I think is why I failed.</li> <li>• Yes, I understand well and if I m to write a test about what we learned I will pass it very well</li> <li>• Yes, but I do not understand, why <i>otombo</i> caused the tooth to decay more and is liked by many people.</li> <li>• This lesson was very good to me and to other learners. We learn a lot and will never forget this lesson.</li> </ul>
6. What else do you think should be done by science teachers to facilitate the understanding of scientific concepts?	<ul style="list-style-type: none"> <li>• We want other teachers to teach us like you</li> <li>• They must teach us nicely by asking us things from home that we know well</li> <li>• They need to give us time to talk a lot in the class and do a lot of practical activities.</li> <li>• Give us assignments to complete at home as you did.</li> </ul>

**CF**

**Appendix H**

**Semi-structured interview with a Critical Friend while watching the video.**

<b>Questions</b>	<b>Responses</b>
1. Do you think that considering learner learners prior-everyday knowledge is important in the teaching and learning of science?	Yeah, It is very much important. This is because what they know from home and surrounding environment can form the basis of classroom science. The newly introduced curriculum (C-2010) also emphasized on teaching to be from known to unknown content. However, not all the topics can suit it.
2. How do you see the participation of learners during this lesson?	Uhhh, I can say, this lesson was very enjoyable. I can see all the learners were participating and even happy. I have been teaching for more than 20 years but I did not experience a greater participation like this one. I was even expecting learners to fear the video camera, but my expectation failed. One can not even say it is Onakayale class <i>(Onakayale is a discourse given to this class. Onakayale is a centre for disable people in our mighty Omusati region).</i>
3. Do you think involving learners in active lessons like this; can enhance learning of scientific concepts?	Why not? Throughout the lesson, concepts emerged themselves. Learners were able to develop many concepts like; decomposition, estimation and soon. Some of the concepts developed is not only useful in physical science but also in other subjects like life science. This made it easier for other teachers

	too, I m happy for this.
4. How did the lesson benefit you as a science teacher?	As a science teacher, I call myself as luck for getting this valuable opportunity to be part of this lesson. I learned a different approach to the teaching and learning of science. I also learned how to prepare and plan a practical activity as well as how to engage learners in an active lesson.
5. What do you think should be done, which did not went well if we are to do the same practical activity once more again	Hmmmmmmmm, not really. I just want to say, lets try to use a real human being tooth in order to have a succinct results. A pig tooth which is used in the experiment may not give a clear reflection on the effects of the beverages to our teeth
6. What else can you say about this lesson?	I am suggesting the video to be watched by the whole school; teachers and learners to see how wonderful it was. Other teachers can use it to prepare their lessons particularly when teaching the topic of chemical reactions

**WS**

**Appendix I**

Work sheets



*Republic of Namibia*

**Ministry of Education**

Onambala Junior Secondary School

Tsandi Circuit

**Omusati Region**

**Physical Science Activity 1**

**Marks  
obtained.....**

Name of the learner:.....



Chemical (Mechanical) digestion is the breaking down of the large particles of food into small particles of food without any change in the chemical composition. It involves the process called mastication which is the chewing and gridding of food by teeth.

1.

a) List down four types of teeth.

.....  
.....  
.....  
...../4

b) Discuss two main functions of your teeth.

.....  
.....  
...../2

c) Mention two local tools used to clean teeth with in your community.

.....  
.....  
...../2

d) Describe four importance of proper care of teeth.

.....  
.....  
.....  
.....  
...../4

2. The bacteria in your mouth acts on food remaining to produce acids. These acids react with calcium to destroy the enamel and start a cavity.

a) What do we call a process of developing hole (cavity) on the enamel?

.....  
.../1

b) Explain the process you have mentioned in a.

.....  
...../2

c) State with a reason whether the process you mentioned in a above is:

i) Physical or chemical change.

.....  
.. /2

ii) Decomposition or synthesis.

.....  
.../2

iii) Exothermic or endothermic.

.....  
.../2

\*\*\*\*\*I love Physical  
Sciences\*\*\*\*\*

## Appendix J

### Test

**Instruction:**

Choose the correct letter, which correspond to the correct answer. Circle your choice.

1. In conclusion to the following reaction, which reaction does it represent best?  
Substance A + Substance B  $\rightarrow$  Substance AB

- A. Combustion reaction
- B. Neutralization reaction
- C. Respiration reaction
- D. Synthesis reaction

2. Which test would you use to determine if a substance was acidic?

- A cobalt chloride paper test
- B litmus paper test
- C conductivity apparatus test
- D lime water test

- 
3. Which test would you use to determine the presence of carbon dioxide?

- A cobalt chloride paper test
- B litmus paper test
- C conductivity apparatus test
- D lime water test

4. Which test would you use to determine the presence of hydrogen gas?

- A glowing splint test
- B burning splint test
- C conductivity apparatus test
- D lime water test

5. Which test would you use to determine the presence of oxygen gas?

- A glowing splint test
- B burning splint test
- C conductivity apparatus test
- D lime water test

6. When completing the conductivity test what additional test is required?

- A test for the presence of oxygen gas
- B test for the presence of hydrogen gas
- C test the pH to ensure that the solution is neutral
- D test for the presence of carbon dioxide gas

7. Which safety rules should you follow when doing tests for different substances?

- A wear safety glasses
- B do not work alone
- C know where safety equipment is located
- D All safety rules must be followed any time you are in the lab

8. Why is there an additional test as part of the test for the presence of salt?

- A both acids and bases can also conduct electrical current
- B salt is the only material that can conduct electrical current
- C acid is the only material that can conduct electrical current
- D base is the only material that can conduct electrical current

## **Appendix K**

### **Learners' reflections (sample)**

**Note: I copied them as they appears in their reflection books**

#### **Learner 1**

On a Monday we learned about tooth decay. We sat in our groups and discussed very well with class mates we were all happy because we were talking about things which we know. The teacher gives us some papers to write our discussion on and present to the whole class. It was a good lesson. The teacher then gave us questions to go ask people we know best.

#### **Learner 2**

It was Tuesday morning when our physical science teacher came to class and asked us about the homework. I was happy because I did mine. We were sitting in groups and writing our responses in English as they were in Oshiwambo. It was so funny that we could not write all the words in English because we do not know them. We laughed at each other during the presentation. Some of the learners who used to keep quiet were also talking. Anyhow it was good. Thank you teacher.

#### **Learner 3**

We came with some traditional drinks made from home. I brought otombo as I promised to do so yesterday. When we were in the class the physical science teacher came with some other two teachers. One was taking a video and we were so happy. We had a practical activity to see which traditional drink causes tooth decay. We did this in groups using test tubes and pig tooth. We learnt a lot of things e.g. endothermic, bubble etc.

# CC & TI

## Appendix M

Colour Coding and the Identification of Themes/ categories

Scientific G1	Non-scientific G2	Myth G3	Misconceptions G4	Inchoate (not clear) G5	Contradictions G5
<ul style="list-style-type: none"> <li>• Is a bacterial that stays in the food that we eat.</li> <li>• Is a process where teeth are destroyed by chemicals because of dirty.</li> <li>• Are the bacteria that use to stay in our teeth.</li> <li>• Bacterial from food</li> <li>• Food that contain sugar</li> <li>• Visit the hospital for the teeth to be taken</li> </ul>	<ul style="list-style-type: none"> <li>• Is a substance that attack somebody if did not clean teeth.</li> <li>➢ Too many sweets</li> <li>➢ Not taking care of teeth by keeping them clean</li> <li>➢ They treat themselves with hot salt water.</li> <li>• Pig tooth is very strong</li> </ul>	<ul style="list-style-type: none"> <li>• Nature</li> <li>• Witchcraft</li> <li>• Mahangu has a lot of nutrients.</li> <li>• Traditional cabbage is often eaten to have luck in life</li> <li>- Yes, it prevents tooth decay and bad smell in the mouth.</li> <li>- cleaning of our teeth help teeth not to get old</li> </ul>	<ul style="list-style-type: none"> <li>• Sharing tooth brush</li> <li>• If you did not brush your teeth after meal</li> <li>• Take long time without cleaning teeth</li> <li>• Witchcraft</li> <li>• By sharing tooth picks and tooth brush</li> <li>• Cleaning teeth</li> </ul>	<ul style="list-style-type: none"> <li>• It is important not to have tooth decay and smell bad smell</li> </ul>	<p>Sweets are eaten by few people yet they are responsible for causing tooth decay</p>

<p>away</p> <ul style="list-style-type: none"> <li>• Visit the dentist regularly</li> <li>• Use different methods to remove the sick tooth</li> <li>• Use to put <i>omahini goshingumati</i></li> <li>• Use <i>onziku</i> to treat themselves</li> <li>• Eat food that have no sugar</li> <li>• Sour taste</li> <li>• Tooth with cavity</li> </ul> <p>- It is very important because it prevent bacteria from acting in our mouth</p> <p>- Yes, it prevents bad smell in the mouth and development of cavity.</p> <p>- Yes, cleaning of our teeth helps remove dirty between teeth in the mouth.</p> <p>- It is important because it prevents our teeth and mouth from infections.</p>		<p>soon.</p> <ul style="list-style-type: none"> <li>➤ Most of them are illiterate and they have no idea of what cause tooth decay.</li> <li>➤ Go to witchdoctor</li> </ul>	<p>after meal help to avoid tooth decay</p> <p>L: Because for the donkey is big and pig teeth are the same for a person.</p> <p>L: To stop the air.....stop the air not enter</p> <p>Ls: There is oxygen.....acid</p> <p>T: There is air which is released, air is given.....</p> <p>Ls: Given out (<i>chorus</i>)</p> <p>T: Which energy is associated with energy given out? <i>Naango!</i></p> <p>L: Endothermic reaction</p> <p>T: Endo.....thermic reaction?</p> <p>L: No, is exothermic</p> <p>The otombo is very strong and can make red lips to those who take it</p>		
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- It helps remove food remains that cause cavity.

➤ Available, can remove dirty and beautify the inside of the mouth, although some dig them and sell them to local people

➤ The use of sugary food and drinks.

➤ Sugar from local beverages e.g. otombo

➤ Bite tablets e.g. paracetamol.

➤ Use to chew leaves of one traditional plant.

➤ Go to the clinic for treatments/repair of the cavity formed.

➤ Apply liquid from omungumati tree.

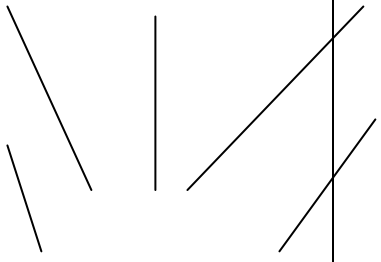
➤ Observation

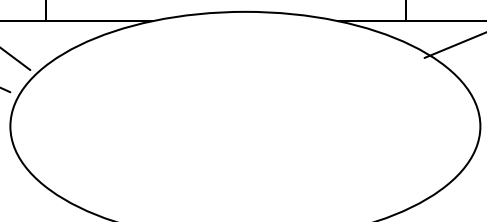
➤ Estimation

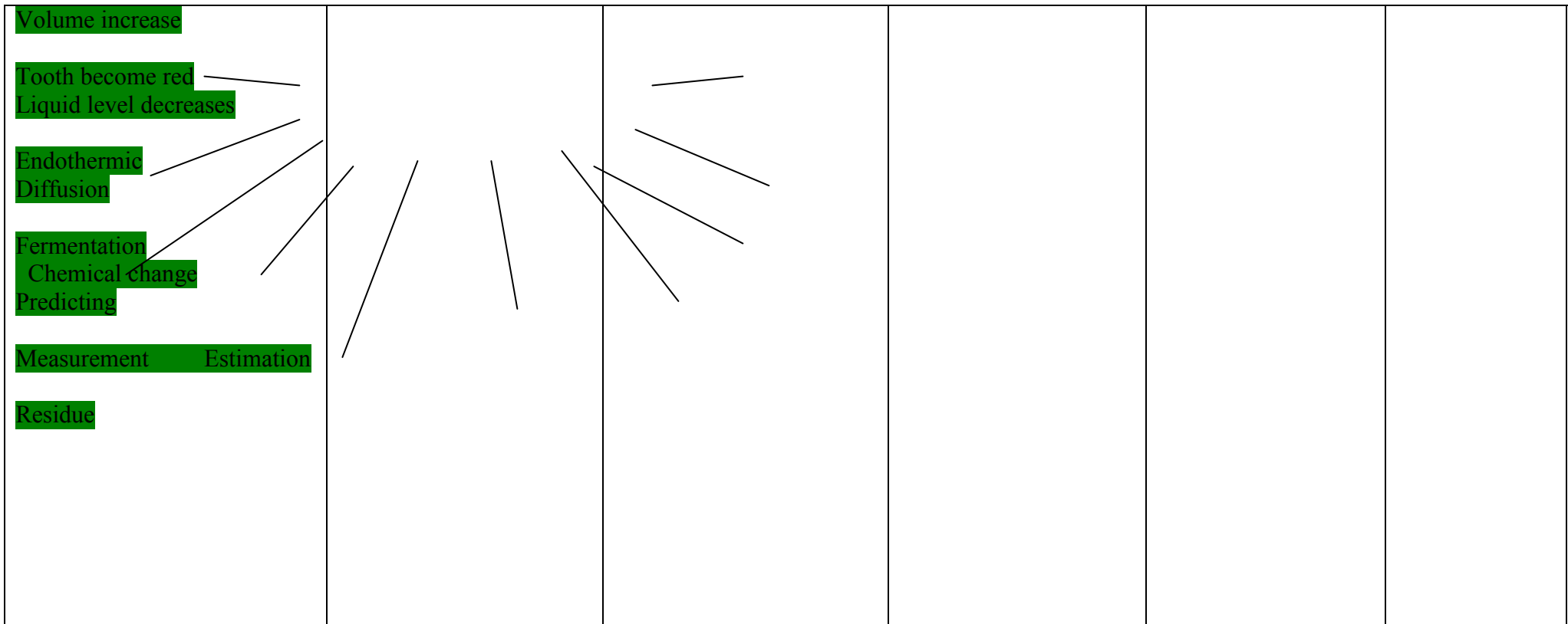
➤ Water goes up

➤ Volume changes

➤ The otombo is boiling

<p>➤ Oshanyenya (hot)</p> <p>Bubbles L: No, observation using five senses Residue is seen at the bottom of the test tube.</p> <p><i>The liquid become transparent.</i></p> <p><i>Water release bad smelling.</i></p> <ul style="list-style-type: none"> <li>• The pig tooth will occupy a space.</li> <li>• These beverages produce bubbles when sugar is during fermentation</li> <li>• The reaction is either exothermic or endothermic</li> </ul> <p>Physical change Gas released Products</p> <p>Bubbles volume decrease Reactants Colour changes</p>					
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Themes/ Categories, Analytical statements and data sources

Themes	Analytical statement	Data sources/evidence
<b>Learner engagement <i>B</i></b>	Prior everyday knowledge and experiences on tooth decay prompted active learner engagement	
<b>➤ Learner talk/argument <i>B1</i></b>		
<b>➤ Co-construction of knowledge <i>B2</i></b>		

➤ Learners' questions <b>B3</b>		
➤ Laboratory work <b>B4</b>		
➤ Research project/Field work <b>B5</b>		
<b>Conceptual Development G</b>	Contextualizing subject content knowledge to enhance conceptual development: <i>Exploration of tooth decay leads to conceptual development</i>	
➤ Scientific <b>G1</b>		
➤ Non-scientific <b>G2</b>		
➤ Myths <b>G3</b>		
➤ Misconceptions <b>G4</b>		
➤ Not clear/ contradictions <b>G5</b>		
<b>Mediation of learning R</b>	Teaching is influenced by the teacher's knowledge and experience in the mediation of learning	
➤ Teacher's questions <b>R1</b>		
➤ Learners response <b>R2</b>		

➤ Laboratory practical <b>R3</b>		
➤ Field work <b>R4</b>		
➤ Role of language <b>R5</b>		

## Appendix N

# UW

### Unit of work

#### Lesson

Chemical reactions occur all around us. Some reactions result in the formation of gas which will appear as bubbles, other reactions may form acids or bases, and some reactions form salts. How can you determine what is produced by a chemical reaction?

This lesson is a review of topics covered in grade 9 science. In this lesson you will carry out a lab activity in which you use simple tests to determine the identity of a few common chemicals.

Here is a short list of some common chemicals and a simple test that may be used for its detection:

In many chemical reactions, one of the products is a gas. The next three tests are standard tests for the detection of oxygen gas, hydrogen gas, and carbon dioxide gas.

#### 1. Oxygen gas (*glowing splint test*)

To test for the presence of oxygen gas, collect a sample of the gas in a small container such as a test tube. Light a wooden splint. Blow out the flame, but make sure that the tip of the splint has a reddish, glowing tip. Insert the glowing splint into the mouth of the test tube.

If the glowing splint bursts into flame, the gas is oxygen.

This test works because oxygen supports burning (combustion) of fuel. Since the wooden splint is a form of fuel and the tip is red hot, it will begin to burn in the presence of the oxygen.

## **2. Hydrogen gas (*burning splint test*)**

To test for the presence of hydrogen gas, collect a sample of the gas in a small container such as a test tube. Light a wooden splint, but do not blow out the flame. Insert the burning splint into the mouth of the test tube.

If the gas is hydrogen, you will hear a slight explosive "pop" sound.

This test works because hydrogen will tend to mix slightly with the oxygen in the air. Since this creates an explosive mixture, the burning splint will ignite the hydrogen gas and you will hear a slight "pop" sound from the tiny explosion.

## **3. Carbon dioxide (*lime water test*)**

To test for the presence of carbon dioxide gas, collect a sample of the gas in a small container such as a test tube. Add a small amount (2 to 3 ml) of lime water to the test tube and shake the test tube to mix the gas and the lime water.

If the lime water solution turns a milky white, the gas is carbon dioxide.

This test works because lime water and carbon dioxide gas react to form a white precipitate.

A second test is to light a wooden splint. Place the burning splint into the mouth of the test tube.

If the flame is extinguished, the gas **may** be carbon dioxide.

Since carbon dioxide is neither explosive nor does it support combustion, placing a burning splint into the mouth of the test tube containing carbon dioxide extinguishes the flame. This second test is not a positive test for carbon dioxide however since other gases may also extinguish a flame since they too do not support burning. Therefore, the first test is better!

#### **4. Water or moisture (*cobalt chloride paper test*)**

To test any sample for the presence of water (moisture), touch the sample with a piece of cobalt chloride paper.

If the cobalt chloride paper turns colour from blue to pink, water (moisture) is present.

Cobalt chloride is a chemical (salt) that turns blue when dried, but turns pink when even a slight amount of moisture is present.

To make cobalt chloride paper, dissolve a small sample of cobalt chloride in 5 ml of water. Take a piece of filter paper, or chromatography paper and soak the paper in the cobalt chloride solution. When the paper is wet, remove the paper, allow it to dry completely (it will turn blue when dry), and then cut the paper into small strips (4 mm x 15 mm).

#### **5. Acid (*litmus paper test*)**

An acid turns **Blue** litmus paper turns **Red**.

#### **6. Base (*litmus paper test*)**

A base turns **Red** litmus paper **blue**.

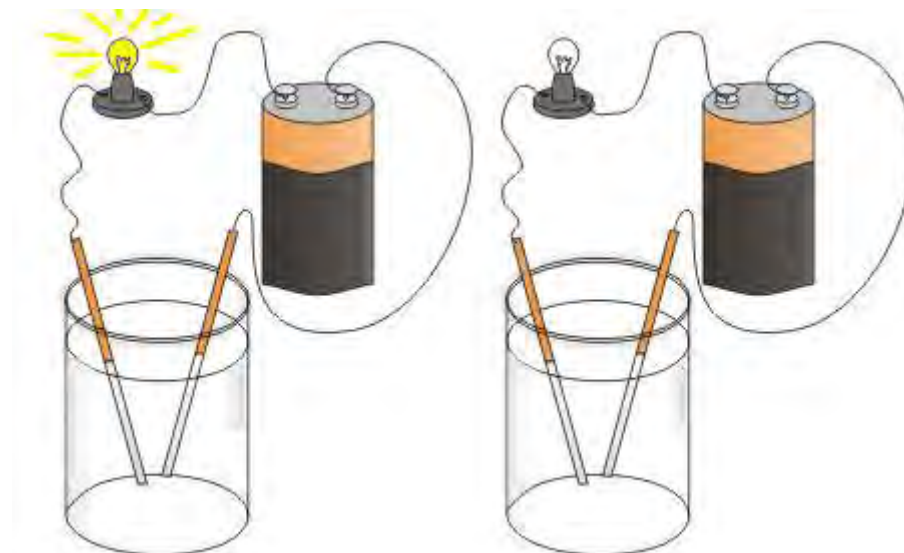
#### **7. Aqueous solution of salt (*conductivity apparatus test*)**

Salts are ionic compounds that dissociate in water to form ions. As a result of the formation of ions, an electrically conductive solution is formed.

Set up a conductivity apparatus like the ones shown below. Place the two electrical probes into the solution to be tested. Make sure that the two probes are close to one another, but do not touch one another.

If the light bulb comes on, the solution contains ions.

Since an acid or base can also form ions in an aqueous solution, test the solution using both red litmus paper, and blue litmus paper. If neither red litmus paper, nor blue litmus paper change colour in the solution, then the solution contains a salt. Can you identify which of the two beakers below contains a salt?



## Activity

### Activity 1:

1. Which test would you use to determine if a substance was acidic?

- a. cobalt chloride paper test
- b. litmus paper test
- c. conductivity apparatus test
- d. lime water test

2. Which test would you use to determine the presence of carbon dioxide?

- a. cobalt chloride paper test
- b. litmus paper test
- c. conductivity apparatus test
- d. lime water test

3. Which test would you use to determine the presence of hydrogen gas?

- a. glowing splint test
- b. burning splint test
- c. conductivity apparatus test
- d. lime water test

4. Which test would you use to determine the presence of oxygen gas?

- a. glowing splint test
- b. burning splint test
- c. conductivity apparatus test
- d. lime water test

5. When completing the conductivity test what additional test is required?

- a. test for the presence of oxygen gas
- b. test for the presence of hydrogen gas
- c. test the pH to ensure that the solution is neutral
- d. test for the presence of carbon dioxide gas

6. Which safety rules should you follow when doing tests for different substances?

- a. wear safety glasses
- b. do not work alone
- c. know where safety equipment is located
- d. All safety rules must be followed any time you are in the lab

7. Why is there an additional test as part of the test for the presence of salt?

- a. both acids and bases can also conduct electrical current
- b. salt is the only material that can conduct electrical current
- c. acid is the only material that can conduct electrical current
- d. base is the only material that can conduct electrical current

## Activity 2



### **Terrible Tooth Decay: Chemical or Physical**

#### **Introduction:**

Purpose: The students will set up and observe a science experiment where an egg is placed in vinegar for a three days. The students will observe changes in the egg (and vinegar) and then conclude whether the changes represent a physical or chemical change. This change also simulates a tooth that is being affected by tooth decay.

In a physical change, some properties (like shape, or phase) of the material change but the material itself is the same before and after the change. The change can also be "undone". In a chemical change the materials (substances) that are present at the beginning of the

change are not present at the end; new substances are formed and the change cannot be "undone". While you can't always tell for sure whether a change is physical or chemical, there are some signs that normally indicate that a chemical change has occurred.

<b>Signs of a Chemical Change</b>
Bubbles of gas appear
A color change
A temperature change
Light is given off
Some solid particles appear
A change in smell

Materials needed: One egg (or egg shell) per group, vinegar, plastic cups

Small plate    Paper Towels            bread            aluminum foil

**Exploration:**



1. Each group of students should obtain a plastic cup (or jar) and an egg from their teacher.

2. As a group, discuss what you think will happen when the egg is placed into the vinegar. Write down your prediction of what you think will happen. Recognize that the changes will occur slowly over the course of several days.
3. Place the egg gently into the vinegar and make careful observations of any changes that you can see. Record your observations.



1. Place plastic wrap over the cup and store it in a safe place.
2. Observe the eggshell everyday for 3 days. Record you observations and discuss your ideas about what you think.
3. On the third day, gently take your egg out of the vinegar, and clean it off with a little water and a paper towel. Discuss what you think happened to the shell. Be very careful with your egg because it will break easily.
4. Return your egg to your teacher and pour the remaining vinegar down the sink.
5. Wash your hands.

**Egg Observations:**

Prediction:	
Initial Observations	



3. What part(s) of your body do you think an eggshell is like?

4. What do you think would happen if you did not brush your teeth?

5. What do you think the food in your mouth does to your teeth when you are sleeping?

## Neutralization reaction

This is a reaction between acids and bases. The process is very common in our daily life, for example, drinking sodium hydrogen carbonate (Eno) to relieve the pain in the stomach. Now concentrate to the following reactions and think about what is happening in your environment.

### Activity 2

Problem: What happens when an acid is added to an alkali?

Apparatus: Dilute hydrochloric acid or Vinegar or strong Marula juice, Baking soda, spoon, Test tube

What to do:

1. Put some acid into the bottom of the the test tube
2. Add a half spoon of baking soda
3. Watch what happens
4. Add suitable indicator to the solution

Answer the following questions:

- a) Complete the following equation;

Sodium hydrogen carbonate + Hydrochloric acid → ..... + ..... + Carbon dioxide

b) What do we call this type of reactions

.....

c) Describe in simple terms what happens in this type of reaction

.....  
.....  
.....

d) Give the colour change of the indicator.

.....(1)

e) Predict what that colour suggests.

.....(1)

f) Give three everyday examples example of the reactions you mentioned in b.

.....  
.....  
.....

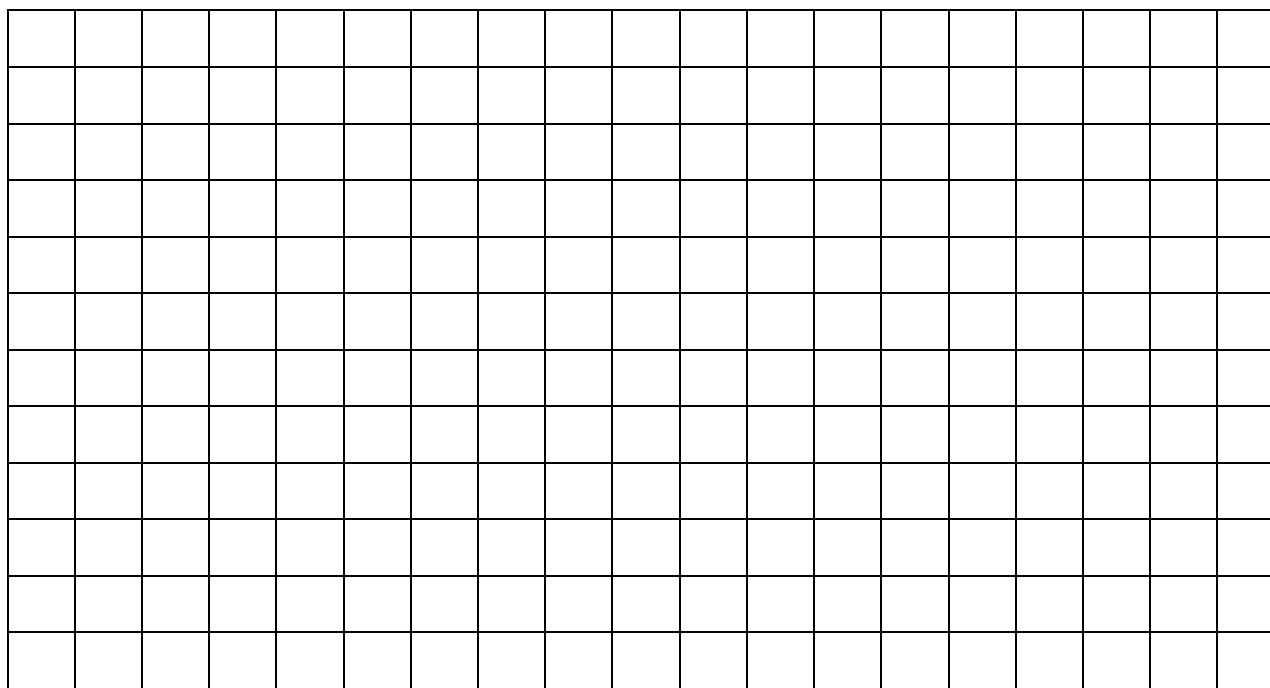
g) Describe how you will know that the result is satisfactory.

.....  
.....(2)

h) The following is a table of the results obtained from the experiment.

Ph	3	3,5	4	5	7	9	10	11
Spoon of baking soda	1	2	3	4	5	6	7	8

i) Plot the points on the grid and draw a graph with the relevant results.



ii) Write down how much of the baking soda made the solution neutral.

.....(1)

iii) Explain what was the condition of the solution after the reaction was completed, basic or acidic.

.....  
.....

.....(2)

## Appendix O

### Learners' translation their findings from vernacular into English.

Questions	Learners translation of the questions	Responses translation
1. List down the types of beverages that people commonly drink in this area?	Give the different drinks in your area	Water, ontanku, epwaka, otombo, omalovu, omutjovoli, ondjidja.
2. List down food-staff commonly eaten by people in this area?	Mention foods that people in your area are eating	Cabigge, porriedge, meat omahuku, eembe, oodunga, fish, oshima, bread.
3. What do you think tooth decay is? E. removal of old teeth F. rotten teeth G. breaking of teeth H. others, specify	What is tooth decay? A. Old teeth taken B. Rot teeth C. Broken teeth D. Other things, mention them	Teeth which is rotten, smelling, painful and swollen
4. What do you think causes tooth decay F. beverages G. food-staff H. weather I. ages J. others, specify	What is the cause of tooth decay do you think? A, Drinks B. food C. weather condition D. age E. others, mention	The drinks which are very strong like Otombo
5. How often do you clean your teeth?	How many times do you brush your teeth? A. one in a day	Many times, afer eating, in the morning

E. once a day F. twice a day G. every after meal H. others, specify	B. two times in a day C. after eating D. others, mention	
6. Is it important to clean our teeth? Explain your answer.	Is it very important to brush you teeth or not?	Yes it is important to avoid bad smell in the mouth and tooth decay
7. If so, what do you use to clean your teeth with?	If it is very important, what do you use to brush teeh?	We use oombale, Mopane stick, grass, water, tooth brush and animal skin
8. How often do you eat sweets E. Daily F. Weekly G. Every month H. others, specify	How many times do you eat sweets?	Weekly, three times in a month
9. How many people in your family are affected by tooth decay?	Mention the people having tooth decay in your family.	16 childrens and 10 adults
10. What do you think why so many people have tooth decay problem in your community (Onangalo)?	Why do people have tooth decay in Onangalo village?	Because they do not clean their teeth, some people they do not know what causes tooth to decay, they drink too much alcohol every day, some people are <b>whicked</b>

11. What do people do when their teeth have decayed?	When people have tooth decay what do they do?	They go to hospital for the teeth to be removed, they put a panado pill, go to the whichdoctor to be treated and told who eat them
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