Exploring affordances and hindrances when using Grade 8 Physical Science learners' home language to mediate learning of chemical bonding

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By

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Declaration of Originality

I, Shilongo Wilhelm Nghidiputate hereby declare that this thesis is my own original work and has not been previously submitted in any form for assessment or for a degree in any other higher education institution. All ideas, quotations and other materials used in this study derived from the work of other people have been acknowledged using complete references according to Rhodes University Education Department Guidelines.

7th December 2020

Signature

Date

Abstract

It seems code-switching from English to learners' home language is a regular practice in Namibian schools. That is, science teachers mediate specific challenging science topics such as chemical bonding through code-switching from English to learners' home languages. Based on anecdotal evidence and on Grade 10 Examiners' Reports for previous years, chemical bonding is one of the challenging key concepts in Physical Science, and yet it is an important concept in the study of chemistry. Therefore, the purpose of this interventionist study was to investigate how the use of learners' home language enables and/or constrains Grade 8 Physical Science learners' sense making of the topic, chemical bonding. The study is a convergent parallel mixed method case study and was underpinned by an interpretive paradigm. It was conducted with 17 Grade 8 learners in a rural school, where I teach, in the Oshana region. I used a diagnostic test to elicit learners' prior knowledge on this topic, a post-intervention test, observation, reflections, focus group interview and stimulated recall interviews as my data collection methods. I used Vygotsky's (1978) Socio-Cultural Theory as my theoretical framework to help explain how learners make sense of the concept of chemical bonding when learners' home language is used in a Physical Science class. To analyse the quantitative data obtained, I used a descriptive statistics and inferential statistics method. In the descriptive statistics, data were compiled into graphs, tables, and other visual representations, while for the inferential statistics, a t-test was used to establish the significant difference of the data collected. On the other hand, a thematic approach to analyse the qualitative data was employed to come up with sub-themes and themes.

The findings of the study revealed that learners' home language stimulates learners' interest to learn new concepts, and enhances learners' understanding and participation during the science lessons. Another finding of the study revealed that learners' prior knowledge in chemical bonding contained some misconceptions. Furthermore, the findings of the study also revealed that learners learn best when their prior knowledge are elicited before they are introduced to new concepts in their science classrooms. The study recommends that learners' home language should be incorporated into Physical Science lessons, especially when the teachers are teaching challenging concepts such as chemical bonding.

Key words: physical science, chemical bonding, code-switching, home language, sense making, socio-cultural theory

Dedication

This thesis is dedicated to my only daughter Betty Namutenya Shilongo and my mom Selma Tutala Shikalepo who always tells me that "*lihongeni manga mushona fyee otwahala eedokotola kepata"* (study while you are still young we want doctors in our family), and she always encourages me to work harder in everything that I do.

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List of Abbreviations and/or Acronyms

ACE:	Advanced Certificate in Education
BEd:	Bachelor of Education
BETD:	Basic Education Teacher Diploma
LCE:	Learner Centred Education
LoLT:	Language of Learning and Teaching
MBESC:	Ministry of Basic Education, Sports and Culture
MEC:	Ministry of Education
MKO:	More Knowledgeable Other
NCBE:	National Curriculum for Basic Education
NERA:	Namibian Education Research Association
NSHE:	Natural Science and Health Education
PhD:	Doctor of Philosophy
SCT:	Socio-Cultural Theory
TIMSS:	Trends in International Mathematics and Science Study
UNESCO:	United Nations Educational Scientific and Cultural Organisation
UNICEF:	United Nations International Children's Emergency Fund
ZPD:	Zone of Proximal Development

CHAPTER ONE: SITUATING THE STUDY

1.1 Introduction

The main aim of the study was to explore affordances and hindrances when using learners' home language of Oshikwanyama to mediate learning of the concept of chemical bonding to Grade 8 Physical Science learners. In this chapter, I describe the context of the study in relation to the international and national context. I also describe the context of the study based on the Namibian National Curriculum for Basic Education, the Language Policy for schools in Namibia, as well as what Grade 8 learners are expected to achieve in terms of chemical bonding as it is stipulated by the Grade 8-9 Physical Sciences syllabus. The statement of the problem and the purpose and significance of this study, the research goal, questions, and theoretical framework of the study are highlighted. Finally, the key concepts used in the study are defined and the outline of the thesis is provided. The chapter ends with a chapter summary.

1.2 Context of the Study

Under context of the study, I present the background to the study in relation to the international and national contexts.

1.2.1 International context

The role of language as a medium of instruction in the academic arena has been a concern for a number of academics across the world for many years. In his socio-cultural theory (SCT), Vygotsky (1978) posits that language is a vital mediation tool for teaching and learning in any learning situation. Correspondingly, in his study conducted in South Africa, Chikiwa (2016) states that language enables teachers to convey messages to students in their classrooms and also helps learners understand what they have learnt. Notwithstanding, over the past years scholars have been debating over various issues of language, which include the choice of language, the age at which a language may be introduced, the teaching of language, and language of specific discourses (Kanime, 2015). There are quite a number of reports on studies

that were carried out around the globe on language of teaching and learning and learners' home language.

For example, the Progress in International Reading Literacy Study (PIRLS) is an international comparative evaluation of reading literacy of Grade 4 learners, which involves about 50 countries in the world including African countries such as Botswana and South Africa. The PIRLS (2011) report by Howies, van Staden, Tshele, Dowse, and Zimmerman emphasises the importance of learners being actively engaged in reading and lessons because it enhances learner and teacher interaction in the classroom. Furthermore, the report reveals that African countries that participated in the study obtained low scores compared to other countries in the world. For example, the results for South Africa show that learners who took part in the study achieved below the international benchmark.

Similarly, the Trends in International Mathematics and Science Study (TIMSS) is a study that is conducted worldwide with as many as 58 countries participating. The aim of TIMSS is to survey learners' achievements in science and mathematics against what is expected to be taught in schools. The TIMSS report for 2011 reveals that science achievement was highest for students in schools where most students are familiar with English, the language in which the assessment was administered in, compared to students that were not familiar with English (Howie, 2011). The report also highlights that one of the contributing factors towards poor performance in science was language.

In Africa, for instance, most children are taught in a language neither they nor their teachers have mastered (Brock-Utne & Alidou, 2012). Yet, despite the fact that the language of teaching and learning in Africa leads to poor performance in schools, most African countries choose English as the Language of Learning and Teaching (LoLT). This could probably be because of its status as the language of access and global communication. Admittedly, English was chosen as a language of science and technology, and there is no other language that best fits science and technology education (Brock-Utne & Alidou, 2012). It is recognised, however, that even though science education in Africa is considered the main contributor towards national development and improvement in the quality of life of the Africans, English as a LoLT is a great constraint which hinders the expansion of science education (ibid.).

In Botswana, for instance, Trudell' (2016) report of the United Nations International Children's Fund (UNICEF) reveals that, after independence English remained the medium of instruction despite the fact that 80% of the population spoke Setswana as a first language. According to Trudell (2016), English is the second or third language for most learners, and Setswana is the first language for a significant majority of learners. Although this may be true, Botswana's government officials insisted that English was essential and more resourceful, regardless of the study findings by Brock-Utne and Alidou (2012) that revealed that students in the first year of secondary school had a significant better understanding of science concepts when taught in Setswana than their peers who were taught in English.

The research study carried out by Probyn (2006) on language and learning in South Africa reports that even though English was the medium of instruction, most teachers use a strategy of code-switching if they find that learners do not understand concepts. That is, they switch from English to isiXhosa to emphasise a point due to the poor English proficiency of the majority of learners.

Since teachers point out that poor English proficiency of the majority of learners is a contributing factor to poor performance of science learners (Brock-Utne, 2012), it is worth researching how the use of learners' home languages enables and/or constrains sense making of scientific concepts (Probyn, 2009). Furthermore, the potential of smuggling vernacular into science classrooms as a structured and systematic way to support learning has not been generally recognised as a pedagogical tool to alleviate problems that come with English language (ibid.).

In addition, Jawahar and Dempster (2013) affirm that switching to learners' mother tongues in South Africa's science classrooms provides a freely available pedagogical tool which can solve the problems that come with scientific English. In the same vein, Msimanga and Lelliot (2014) posit that switching between LoLT and learners' home language is appropriate for interaction during science lessons as learners seem to understand the teacher and each other better. To put it differently, Mavuru and Ramnarain (2019) emphasise that teachers should draw on learners' home languages in facilitating learning of scientific concepts. These, therefore, highlight the significance of learners' home languages in the education systems of African countries and the need to resort to a language of learning and teaching that most science learners understand better.

1.2.2 Namibian context

Namibia was first colonised by Germany from 1884 and later in 1915, the administration was entrusted to South Africa. Namibia did not have English as LoLT in schools. The languages of power were German and Afrikaans (Mensah, 2015). After independence in 1990, however, the government of Namibia introduced an education system that aimed at addressing the four goals of *access*, *equality*, *equity* and *democracy* in education (Namibia. Ministry of Education and Culture [MEC], 1993). This led to the development of a language policy that recommended English as a LoLT in all the Namibian Schools (Namibia. Ministry of Basic Education, Sport and Culture [MBESC], 2003).

Although English is the medium of instruction in Namibian schools, it is, however, a second or third language for most teachers and learners. This reality negatively impacts learners' understanding and performance of science content (Kamati, 2011). In consequence, the poor English proficiency of the majority of learners has resulted in many teachers resorting to a teaching strategy of code-switching (Probyn, 2006; 2009). In a study carried out by Mensah (2015) on language policy in a multilingual school, it was found that even though both teachers and learners at the school showed a higher English proficiency, teachers still code-switched in their classrooms. Arguably, teachers seem to code-switch to learners' home languages in order to increase learners' understanding of challenging concepts and to enable communication (Iipinge, 2013). However, Mavuru and Ramnarain (2019) state that teachers' limited vocabulary of African languages for scientific concepts limits the translation between English and the learners' home languages. As a result, learners encounter difficulties in answering test or examination questions in English, when they are accustomed to learning science through vernaculars (ibid.). Namibia is no exception to these challenges.

A number of studies have been conducted in Namibia, for example, Denuga (2014), Kanime (2015), and Nambahu (2017) on the use of code-switching between English and learners' home languages in the science classroom. These studies found that learners understood concepts better, expressed their views better, and their participation increased (Sedlacek & Sedova, 2017) when their home languages were acknowledged in science classrooms. However, my observation is that these studies did not focus on the use of code-switching to introduce a new science topic in the Namibian curriculum. Hence, there is a knowledge gap that my study

sought to fill as it focused on the use of learners' home language to mediate learning of chemical bonding as a new topic to Grade 8 learners, in the Namibian curriculum.

Chemical bonding is one of the challenging key concepts in chemistry due to scientific English (Tanen, 2011). In the same fashion, the Grade 10 Examiners' Reports for 2016, 2017 and 2018 revealed that many candidates lost marks on questions about chemical bonding because they generally showed little knowledge in this topic (Namibia. Ministry of Education, Arts and Culture [MEAC], 2016; 2017; 2018). The reports also highlighted that the concept of covalent bonding needs to be emphasised more by teachers, because candidates confuse it with ionic bonding. Based on my teaching experience as a Physical Sciences teacher, the LoTL of English poses a challenge to how learners understand these two concepts of chemical bonding. This is the reason why I chose to conduct the study in Grade 8 because this is where chemical bonding is introduced to learners in the Namibian curriculum. The Grade 7 NSHE syllabus states that learners should know that atoms combine to form compounds which are the building blocks of all materials (Namibia. MEAC, 2015). Therefore, the study also aimed to find out prior knowledge that learners might have, that might enable and/or constrain sense making of the aforementioned topic.

Based on the literature cited in the preceding paragraphs and from anecdotal evidence, code-switching is widely practiced in Namibia and in Africa at large, because of its potential pedagogic usefulness in science classrooms. Therefore, it is against this background that I decided to carry out a study to explore affordances and hindrances that Grade 8 Physical Science learners encounter when they are learning chemical bonding in their home language.

1.3 Expectations of the Namibian Curriculum for Basic Education (NCBE)

Article 20 of the Constitution of the Republic of Namibia [Namibia: CRN, 1998] states that all people have the right to basic education. It also stipulates that primary education shall be compulsory and the state should be responsible for providing reasonable facilities to render effective this right for every resident within Namibia. Basic education in Namibia is guided by the national curriculum for basic education (NCBE) which is the official policy for teaching, learning and assessment and gives direction to planning, organising and implementing teaching and learning (Namibia. MoE, 2016). The NCBE defines basic education as an education that children get from Grade 1 up to Grade 12.

The NCBE emphasises that the goal of basic education is to empower learners in order to make Namibia a knowledge-based society. It further states that for a knowledge-based society to be achieved, learners should use existing knowledge which is indigenous knowledge and national culture in order to create new knowledge. Furthermore, Semali and Kincheloe (1999) affirm that indigenous knowledge is a legacy of knowledge and skills, unique to an exact indigenous culture and involves wisdom that has been developed and passed on through generations (Kibirige & Van Rooyen, 2006). Equally important, Senanayake (2006) describes indigenous knowledge as the unique knowledge confined to a particular culture or society which is considered as a cultural capital of local people and is a main asset that they can invest in their education.

The NCBE (2016) stipulates that a knowledge-based society requires a learner centred education (LCE). LCE is described as a teaching approach in which learners influence the learning content and pace at which learning is taking place (Froyd & Simpson, 2008; Nyambe, 2008). In addition, Abdelmalak and Trespalacious (2013) allude that in LCE, learners' needs should be central in the learning process and emphasise the importance of creating learning opportunities that can enhance learners' learning opportunities. Language as an aspect of indigenous knowledge is a means of communication which learners need in education (Gorin, 2012). Thus, in this study the focus was on how learners' home language enables and/or constrains learners' sense making of chemical bonding in Grade 8 Physical Science.

The NCBE affirms that in order for the education system to provide learning opportunities to learners, communication skills play an important role in the production of a knowledge-based society. It further stipulates that learners have to master their home language along with the official language of instruction which is English. Moreover, Seifi (2014) elaborates that mother tongue plays an important role in learners' thinking and imagination, and concepts of the subject content are first formed in the mind with the mother tongue. Learning a concept in home language leads to a better understanding of the content and provides cognitive development of learners.

On the contrary, Kumar (2016) posits that LCE implementation faces many challenges such as lack of teachers and learners' interest, big class sizes and lack of teaching materials. In addition, teachers find it difficult to fully implement LCE at the level of practice, because it is not always easy to include learners in decision making and structural arrangements such as time-tabling,

sequencing of subject content and pace at which the syllabus will be covered (Nyambe & Wilmot, 2012). In terms of learners' home language, Chavez (2016) further posits that part of the problem is that teachers are not sufficiently trained to teach in indigenous languages, mostly due to the negative way in which society has come to view these languages. Furthermore, indigenous languages are not yet developed for teaching science concepts which poses a challenge for academics and other stake holders. There is therefore a need to scrutinise language policy in African schools.

1.4 The Language Policy for Schools in Namibia

The language of teaching and learning under the South African apartheid regime was Afrikaans (Chavez, 2016). After independence, the government felt that there was a need to shift to another language of teaching and learning as Afrikaans undermined the self-concept and cognitive growth of the African language speakers (Wolfaardt, 2005). This, according to Chavez (2016), was successfully accomplished through the development of a new language policy for schools in Namibia, by the Ministry of Education and Culture. This policy was detailed in a document entitled the *Language policy for schools: 1992-1996 and beyond* (Namibia. Ministry of Education and Culture [MEC], 1993). The *Language policy for schools: 1992-1996 and beyond* was implemented shortly after Namibia gained independence.

Nonetheless, this policy was not clear on how mother tongues should be used in schools and there were misinterpretations on the implementation of the language policy. Learners who were formerly disadvantaged by the language policy were further marginalised in this process, as non-English speaking teachers were expected to teach through the medium of English, rather than learners' home language. This led to a revised language policy which is entitled *Language policy for schools in Namibia* (Namibia. Ministry of Basic Education, Sport and Culture [MBESC], 2003). The following are some of the criteria that were taken into consideration when the policy was being revised:

- The expectation that a language policy should facilitate the realisation of the substantive goals of education;
- The equality of all national languages regardless of the number of speakers or the level of development of a particular language;
- The fact that language is a means of transmitting culture and cultural identity;

- The fact that for pedagogical reasons it is ideal for learners to study through their mother tongue, particularly in the early years of schooling when basic skills of reading, writing and concept formation are acquired; and
- The need for learners to be proficient enough in English, the official language, at the end of the seven-year primary school cycle in order to gain access to further education as well as to a language of wider communication (Namibia. MBESC, 2003, p. 2).

The Language Policy for schools in Namibia (Namibia. MBESC, 2003) states that, Grades 1-3 should be taught through the home language. It further states that schools that wish to use English as the medium of instruction in Grade 1-3 should get permission from the Ministry of Basic Education, Sports and Culture with convincing reasons as to why they wish to do so. Grade 4 becomes a transitional year when the change to English as medium of instruction should take place. In Grades 5-7 English should be the medium of instruction, however, mother tongue can be used in a supportive role and continues to be taught as a subject. Grades 8-12 should be taught through the medium of English, while the mother tongue will continue to be taught as a subject. Examinations will be taken through the medium of English, except for the mother tongue that is taken as a subject. The policy further states that English should be a compulsory subject in all grades in Namibian schools. All learners should study at least two languages as subjects from Grade 1 onwards; however, the emphasis is made that one must be English.

Nyqvist and Rintala (2018) accentuate that even though English was made the Language of Teaching and Learning in Namibian schools, the emphasis on learners' home language learning was brought forward as well. He further asserts that children taught in their home language plus in a second language are more advantaged than children only taught in a second language. In the same vein, Probyn (2015) avers that teaching learners in their home language and English seems likely to provide a better understanding and mediate mental processes in the learning of science.

This is because home language motivates learners in their learning processes and helps them to master the basics of subject content (Namibia. MEC, 1993). Namibia Education Research Association (NERA) (Legere, Trewby, & Van Grana, 2000) describes home language as the language learned and spoken from the earliest stage of childhood.

1.5 Reasons for Choosing English as a Language of Learning and Teaching for Namibian Schools

The choice of English as Language of Learning and Teaching in Namibian schools was motivated by a number of reasons. One of the reasons as stated by NERA (Legere et al., 2000) is that not all indigenous languages are fully developed to carry out instructions in some subjects. As a result, some parents and teachers are not aware of the pedagogical advantages of using learners' home language as the medium of instruction. Hence, English was chosen as a lingua franca language with the purpose to accord equal status and respect to all locally spoken languages (Nygvist & Rintala, 2018).

In light of this, Iipinge (2013) posits that English as a medium of instruction in Namibia was chosen based on educational and economic, cultural, political and linguistics reasons. To start with educational and economic reasons, Shaws and Melchers (2011) assert that providing materials in a multilingual country would be expensive and impossible. They further claim that a lack of learning materials in local languages would make learning more difficult if education were to be offered in learners' home languages. Iipinge (2013) further alludes that since English is spoken internationally, it provides opportunities to study in other countries. Furthermore, English unites people from various cultural backgrounds of Namibia, by making communication possible for people with different mother tongues. Based on the aforementioned reasons, it seems many schools wish to offer mother tongue instruction but do not have the resources to do so. It can be reasoned therefore that the choice of language of instruction offered by schools is often influenced by financial and political, rather than pedagogical, reasons (Chavez, 2016).

1.6 Statement of the Problem

Learning science through the medium of a second language poses a double challenge for mastering both science content and language of instruction (Rollnick, 2000). Although the language policy for schools in Namibia stipulates that the language of learning and teaching is English, I have observed that teachers, according to Probyn (2009), tend to smuggle learners' vernacular into science classrooms. This means that teachers use learners' home language to teach science concepts even though it is not authorised by the language policy.

There are some studies conducted in Namibia on the use of code-switching in science classrooms for example, Denuga (2014), Kanime (2015) and Nambahu (2017), which found

that learners understand concepts better, express their views better and increase their participation when taught using code-switching. However, no studies could be found on how the use of learners' home language enables and/or constrains sense making of chemical bonding in Namibia. Therefore, my study sought to close this gap. Chemical bonding is one of the challenging key concepts in chemistry and yet it is important in understanding material structures, properties and reactions (Tanen, 2011). The Grade 10 Examiners' Reports for the past three years state that learners showed little knowledge of chemical bonding and they often confused covalent bonding with ionic bonding. It is against this background, therefore, that I conducted an interventionist study in Grade 8 Physical Sciences classrooms to explore the affordances and hindrances when using learners' home language to teach chemical bonding. I chose to conduct the study in Grade 8 because this is the beginning of the Junior Secondary phase (8-10). The overall content of this phase is normally assessed in Grade 10, therefore if learners fail questions on chemical bonding in Grade 10, it means learners did not understand chemical bonding at the foundation of this phase which is Grade 8.

1.7 Purpose and Significance of the Study

The purpose of this study was to examine what prior knowledge Grade 8 Physical Science learners have on the concept of chemical bonding, and how the use of learners' home language in Grade 8 Physical Science lessons enabled and/or constrained learner participation and enhanced sense making of the aforementioned topic. It was hoped that the study might contribute towards filling the knowledge gap that exists on affordances and hindrances of using learners' home language to teach chemical bonding in Namibian science classrooms. It might also inform education policy makers on how the use of learners' home language as the medium of instruction enables and/or constrains learners' sense making of chemical bonding. Additionally, learners might see the value and benefit of their home language in terms of teaching and learning science concepts. Finally, the research findings might help me and other science teachers to improve our own practices on the use of learners' home languages as a resource in our science classrooms (Msimanga & Lelliot, 2014; Mavuru & Ramnarain, 2019).

1.8 Research Goal and Research Questions

In the next section, I discuss the research goal and research questions. I begin with the research goal.

1.8.1 Research goal

The main goal of this study was to examine the prior knowledge Grade 8 Physical Science learners have on the concept of chemical bonding and to explore affordances and hindrances when Grade 8 Physical Science learners' home language is used to mediate learning of the topic of chemical bonding.

To achieve this goal, the following research questions were addressed:

1.8.2 Research questions

1. What prior content knowledge do Grade 8 Physical Science learners have on the concept of chemical bonding?
2. How does the use of learners' home language in Grade 8 Physical Science lessons enable and/or constrain learner participation and sense making of chemical bonding?

1.9 Theoretical Framework

This study is informed by Vygotsky's (1978) Socio-Cultural Theory (SCT). Vygotsky (1978) believes that the process of making meaning is strongly played by the community in which individuals live (McLeod, 2014). Essentially, it draws more attention to the role of language in cognitive development. Vygotsky proposes that cognitive development is a result of an internalisation of language. In SCT, Vygotsky thus uses language as a mediational tool for communication in order to enhance learning and thinking. Within this theory, I focus on the following concepts: *mediation of learning*, *social interactions* and the *zone of proximal development (ZPD)*.

1.10 Data Gathering Techniques

- Testing (diagnostic test and post-intervention test);
- Observation;
- Journal reflections;
- Focus group interview; and
- Stimulated recall interview.

1.11 Definitions of Key Concepts

Physical Science: The science concerned with the study of inorganic natural objects, including physics, chemistry, astronomy and related subjects.

Chemical Bonding: A chemistry that deals with the nature of substances and their transformations (Bergyvist, 2017).

Code-Switching: The process of going from one language to the other in the middle of speech, provided that both speakers understand the same languages (Cook, 2001).

Home Language: The language that is native to a region and spoken by indigenous people.

Sense Making: The process of understand issues or events that are not clear and that may cause confusion (Maitlis, 2014).

Socio-Cultural Theory: A theory that focuses on learning and how knowledge is constructed in the dynamic interactions between people and their society (Vygotsky, 1978).

1.12 Thesis Outline

This thesis consists of six chapters:

Chapter One: Situating of the study: In this chapter, I explained the context of this study at international and national level. The expectations of the Namibian National Curriculum and the language policy for schools in Namibia were discussed. The chapter also provided the rationale as to why this study was carried out, which highlighted the purpose, the statement of the problem, significance of the study, research goal and questions. The theoretical framework and data gathering techniques were introduced. The chapter ended with the definitions of the key concepts.

Chapter Two: Literature review and theoretical framework: This chapter of the study provides an overview of related literature around the study topic. Firstly, I discuss the Oshikwanyama language as learners' home language, followed by the benefits of using learners' home language as a medium of instruction in science classrooms. I further unpack scientific language and definitions of code-switching and related terminologies. I also define code-switching in the context of this study and highlight some reasons why teachers code-switch in their classrooms. Furthermore, I explore literature around chemical bonding, visualisation, sense making and prior knowledge of learners.

Chapter Three: Research methodology: The third chapter of this study focuses on the research methodology. The research paradigm, research goals and questions, research site, participants

and sampling techniques are discussed under this chapter. It also describes the data gathering methods, data analysis process, validity and trustworthiness, my positionality as a researcher as well as ethical considerations.

Chapter Four: Presentation, analysis and discussion of quantitative data: This chapter presents, analyses and discusses data from the diagnostic test, post-intervention test and stimulated recall interviews. The discussion of the results is done with reference to the theoretical framework and literature.

Chapter Five: Qualitative data presentation, analysis and discussion: The fifth chapter of this study presents, analyses and discusses data from observation of lessons, learners' journal reflections and focus group interviews. The results are discussed with reference to the theoretical framework and literature discussed in Chapter Two.

Chapter Six: Summary of findings, recommendation and conclusion: The last chapter of this study outlines the summary of findings and recommendation for area for further research. The limitations of this study and some personal reflections are also presented. The chapter ends with a conclusion to the study.

1.13 Chapter Summary

This chapter described the context of the study at international and national level. The research goal and research questions were also discussed. The chapter also highlighted the theoretical framework and data collection techniques. Furthermore, the key concepts were defined and the thesis outline.

In the next chapter, relevant literature informing this study is reviewed and the theoretical framework underpinning the study is discussed.

CHAPTER TWO: LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Introduction

The main goal of this study was to examine the prior knowledge Grade 8 Physical Science learners have on the concept of chemical bonding and to explore affordances and challenges when using Grade 8 Physical Science learners' home language to mediate learning of chemical bonding. Chemical bonding is a key concept that plays a vital role in understanding other concepts in the field of chemistry, biology and agriculture. In the previous chapter, I discussed the context of the study at international and national level. The research goal and research questions were also discussed. The chapter also highlighted the theoretical framework and data collection techniques. Furthermore, the key concepts were defined and the thesis outlined.

In this chapter, I discuss literature relevant to my study. Firstly, I discuss the Oshikwanyama language as learners' home language and the benefits and challenges of teaching science using learners' home language. I also explore some features of scientific language and how they negatively impact learners' sense making of science concepts. The discussion of chemical bonding as well as the challenges faced when teaching this concept is also a core and important section in this chapter. The literature also looks at visualisation and learners' prior knowledge as contributing factors towards sense making of the concept of chemical bonding. Furthermore, I explore literature around code-switching whereby I discuss types of code-switching, the definition of code-switching in the context of this study and reasons that prompt teachers to code-switch in their science classrooms. The theoretical framework of Vygotsky's (1978) SCT and the constructs relevant to this study are also discussed.

2.2 Oshikwanyama Language as Learners' Home Language

According to Namwandi (1984), "Oshiwambo is a generic term which refers to all languages used by the Ovawambo people" (p. 311). In addition, Sheetheni (2005) states that Oshiwambo consists of other dialects such as Oshindonga, Oshikwambi, Oshingandjera, and Oshikwaluudhi. However, these dialects are not the focus of the study. Ovawambo speakers

are situated in the area called Owamboland which is also called Far Northern Namibia. Furthermore, Lusakalalu (2007) states that Oshiwambo is an Angola-Namibian cross-border language, because Angolan and Namibian people who live at Angola-Namibian borders can speak and understand Oshiwambo very well.

Oshikwanyama is an indigenous language of the Ovakwanyama people in the northern part of Namibia. The area where Ovakwanyama people live is called Oukwanyama, and it was named after the language that people speak in that area. Due to the increasing of socio-economic development, which includes job and educational opportunities, Ovakwanyama people are now found all over Namibia (Revolvy, n.d).

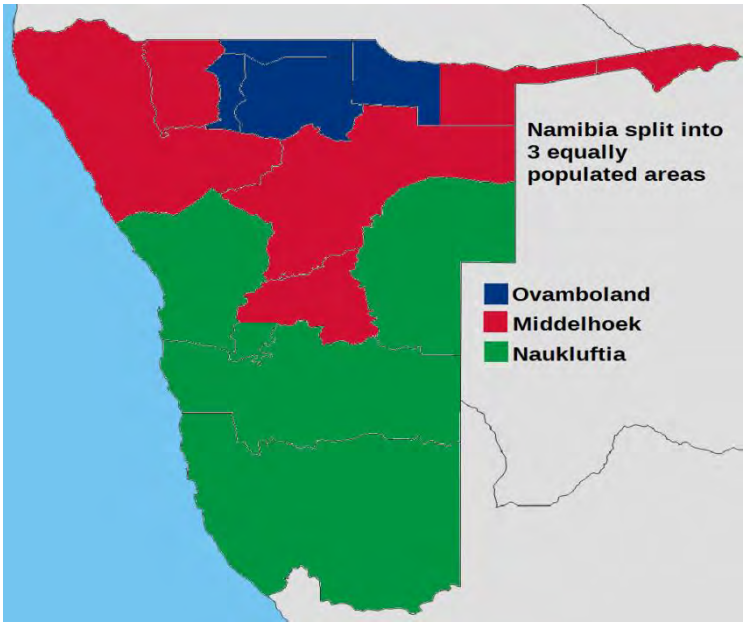

Figure 2.1: Shows the location of Owamboland in Namibia, where Oshikwanyama dialect of Oshiwambo is mostly spoken

Oshikwanyama is taught as a subject in some schools in Namibia, from Grade 1 to Grade 12. It is also used as a medium of instruction at the primary phase (Grade 1-3) as it is stipulated in the language policy for schools in Namibia (Namibia. MBESC, 2003) (see Section 1.4). Lusakalalu (2007) affirms that among other Oshiwambo dialects, Oshikwanyama is one of the two written varieties that enjoy official status as national languages, because it is competent in orthography unlike other dialects. The other Oshiwambo dialect with a standard written form is Oshindonga, however, this is not the focus of the study. In the context of this study,

Oshikwanyama as learners' home language was the right language to switch to, because all the learners in Grade 8 speak and understand it well.

Amaechi (2013) describes home language as a language that originated in a specified place and was not brought to that place from elsewhere; it is a language that is native to a region and spoken by indigenous people. In the same fashion, Ashofor, Ekele, and Milcah (2016) state that home language refers to the language of the immediate environment, which is accomplished in the environment in which the child lives. Home language and indigenous languages can be used interchangeably, and they are also called native languages or mother tongues (Ashofor et al., 2016). In this study Oshikwanyama is simply referred to as a home language. Williams and Snively (2008) refer to indigenous language as "aboriginal language that serve as store houses of experience and perspective that help maintain cultural identity, resist assimilation and interpret the relationship between society and environment" (p. 109). In addition to this, Ashofor et al. (2016) posit that home languages are major instruments that people use to identify themselves as members of a certain community. This provides the reason why Oshikwanyama speaking people are called Ovakwanyama.

Williams and Snively (2008) posit that the development of home language is an important skill for communicating with the members of the community, because it boosts the understanding of knowledge and lays the foundation for sustaining the culture, community and environment. In the context of this study, I believe that the use of learners' home language in the science classroom might help learners to understand the concept of chemical bonding better. In the hope of this, Olaoye (2013) accentuates that science can be well acquired and better understood through teaching in learners' home languages since learners clearly understand the language in which the content matter is being presented. In a like manner, Msimanga and Lelliot (2014) state that the use of learners' home languages for the purposes of engagement with difficult concepts might create opportunities for conceptual understanding to science learners.

2.3 Science Learners' Benefits of Home Language as a Medium of Instruction

Thiong'o (1986) states that using indigenous language to address important issues in a society brings about "decolonising the mind" (p. 22). Decolonising the mind enables people to believe in themselves once again and to have good levels of self-esteem and confidence. Moreover, it has been argued that learners taught the same topic by the same teacher, show greater understanding of concepts when they are taught in their home language compared to when they

are taught in English (Mberia, 2015). Similarly, in my view, learners understand better when the language they are familiar with is used to present certain concepts, specifically in science classrooms. To add to this, Ashofor et al. (2016) allude that young indigenous learners' self-esteem is boosted when home languages are incorporated into the school curriculum and this effectively leads to learners' engagement in the learning process. Nayfeld (2019) states that learners' engagement in the lessons makes it easier for teachers to clarify a misunderstanding or explain something in a better way to learners. Furthermore, Nayfeld (2019) emphasises that providing learners with opportunities to ask effective questions can reveal what they do not understand, giving teachers a chance to fill in the gaps and likely improve understanding for learners. Ashofor et al. (2016) further explains that:

> The children come to school already with a great deal of knowledge about their world, culture and language. That is what they bring because they have a language that they bring to school and it helps them to unpack what they learn at school. (p. 3)

This speaks to my study in the way that it places emphasis on teachers to make use of learners' cultural capital of their home language in order to learn new concepts.

Cummins (2000) emphasises the importance of preserving home language, noting that children who have a strong foundation in their home language tend to excel. Comparatively, it has been argued that teaching learners in their home language provides the basis for learning other languages (Ashofor et al., 2016). As alluded to by Cummins (2000), parents should help their children at home by giving them an opportunity to discuss and talk about the experiments they did at school in their home language, as this gives learners ample time to engage more in school activities using their home language. This is of great benefit to learners, as Fushan (2016) asserts that if children already understand a concept in their home language all they have to do is to acquire the labels for that concept in English. The United Nation Education Scientific and Cultural Organization (UNESCO) report by Price (1951) emphasises the importance of mother tongue and suggests that learners should begin their schooling through the medium of their home language. Teaching and learning through home language should be extended to later stages in education as far as is possible. To this end, Ashofor et al. (2016) accentuate that home language is more effective in learning than learning in any other language, hence, it should be used as the language of teaching and learning in science classrooms.

The role of learners' home language in the science classroom can be explained by adapting Chikamori, Tanimura, and Ueno's (2019) Transformational Model of Education for Sustainable Development (TMESD) framework. To Chikamori et al. (2019), the TMESD framework is composed of three learning sub-processes: 'knowing the present', 'past-present (retroduction)' and the 'future-present (retrodiction)' (see Figure 2.2 below).

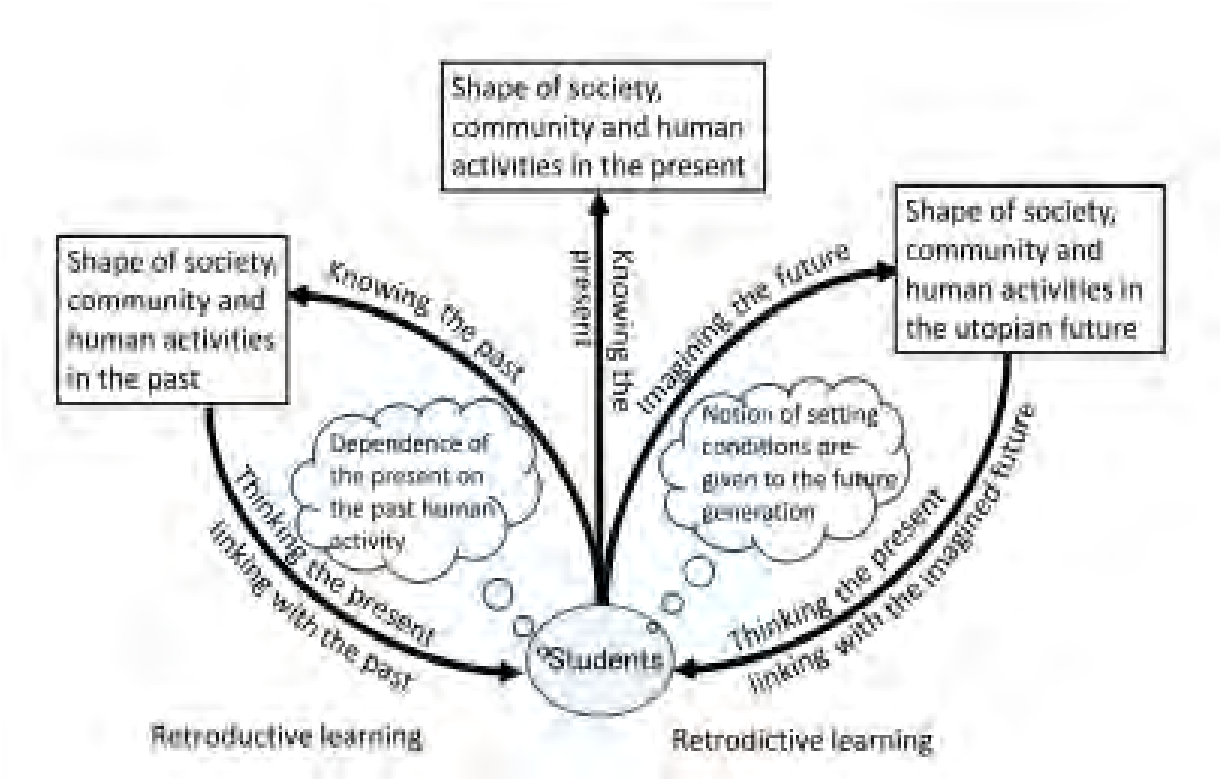

Figure 2.2: Chikamori et al. (2019, p.9) Transformational Model of Education for Sustainable Development (TMESD)

In my study, the adapted TMESD diagram bellow illustrates how learning of chemical bonding through indigenous language can take place in three sub-processes (see Figure 2.3 below).

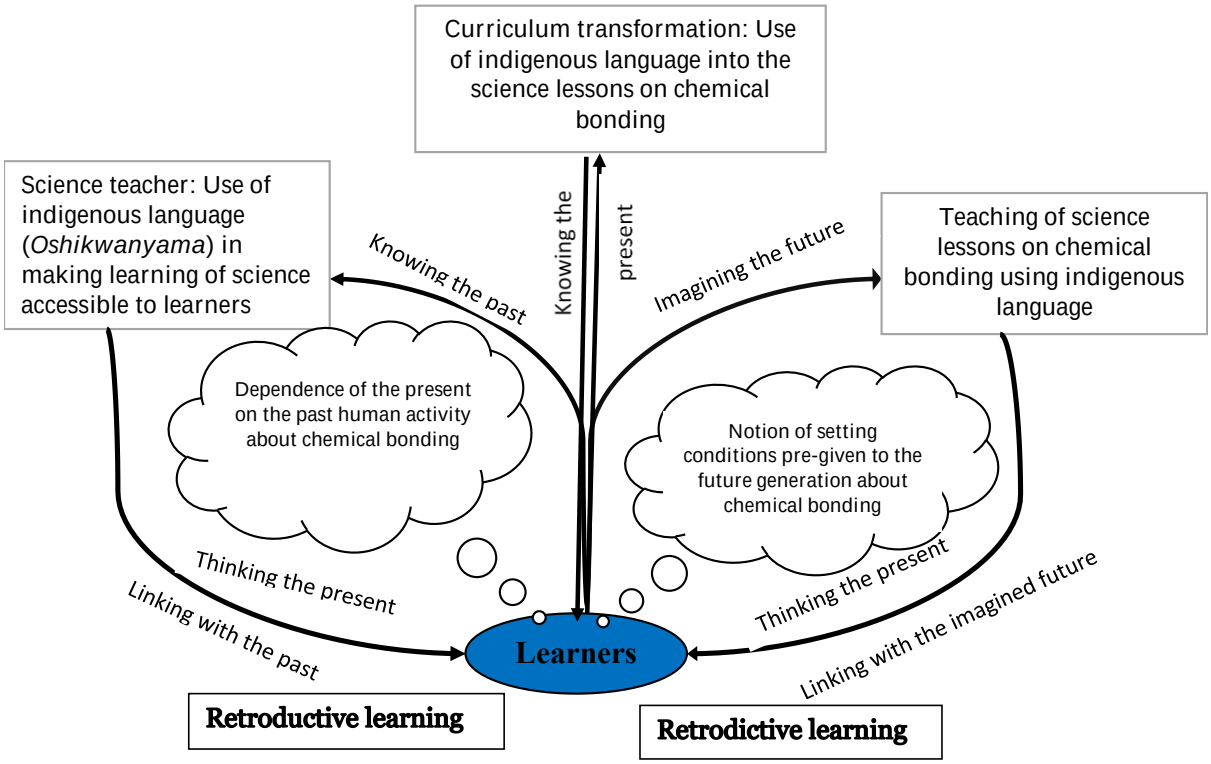

Figure 2.3: Shows the role of indigenous language in the science classroom (adapted from Chikamori et al. (2019, p. 9)

Considering the first sub-process of knowing the present, it is well stated in the past Grade 10 examiners' reports that learners fail most of the questions on chemical bonding. It is also known at present that science language poses considerable challenges to how learners assimilate science concepts. Hence, curriculum can be transformed by using indigenous language in science classrooms to mediate the concept of chemical bonding in order to make learners understand the aforementioned. Indigenous language can also play a role in a 'retroductive learning' process which is the second process of TMESD. In this process, teachers use learners' home language (Oshikwanyama) in order to make learning of chemical bonding accessible to learners. When the teacher presents the concept of chemical bonding, learners will link the concept to their prior knowledge (linking with the past) in order to understand the concept of chemical bonding (thinking of the present). This is because Chikamori et al. (2019) aver that learners intentionally consider the present, learned from the first learning sub-process, in relation to what they know of the past. When learners understand the concept of chemical bonding from 'retroductive learning', they will go through a retrodictive learning process. This means that in future, learners will be more likely to understand most of the concepts related to chemical bonding. Additionally, they will be motivated that the use of their home language

will help them to perform better as far as chemical bonding is concerned in the future. Learners will imagine a future scenario where the causes of the current language challenge is absent, and they will start to consider what would need to be changed to achieve this future (ibid.).

2.4 Challenges of Teaching and Learning Science in Home Languages

Ngugi (2015) elucidates that publishers have failed to translate many works to and from indigenous African languages for multiple reasons, from lack of financial interest to oral sounds which are untranslatable into print. Book publishers are only interested in translating a book if there is economic value in it, and where they can benefit at least from a portion of the profit (ibid.). Wolff (2018) similarly argues that teaching in home languages is costly in an African context, because there is a need to provide textbooks in different languages and it is also costly to train teachers to be able to efficiently disseminate science knowledge to learners.

Olaoye (2013) posits that "one of the greatest challenges in the optimal utilization of indigenous languages is that many do not have orthographies and those that are available are not well developed for literary use" (p. 5). In the context of this study, even though learners' home language of Oshikwanyama has orthographic competence, it lacks scientific vocabularies. Thus, Olaoye (2013) emphasises that indigenous languages require rehabilitation, re-orientation and optimal utilisation if they are to become part of national development and knowledge based society. In addition, Mashegoane (2017) alludes that the absence of certain science terminologies in indigenous languages pose a challenge to learners as well as to teachers, and this inhibits learners from excelling in science. Lack of terminologies in a language sometimes can cause a speaker to stutter (Sugunasiri, 1992). Stuttering from speech fluency happens when someone has difficulty in finding the correct words to express ideas (ibid.). For this reason, in my own view, the point often overlooked is that indigenous languages are not a good fit to be used as science mediums of instruction as they are not fully developed to express some of the scientific concepts (Wolff, 2018).

Mavuru and Ramnarain (2019) in their study affirm that learners' home language facilitates their understanding of science concepts. However, they admit that teaching science concepts in home languages is a challenging task because teachers have a limited vocabulary in African languages for scientific concepts. Consequently, this limits the translation between English and the learners' home language which often leads to the distortion of meanings. Furthermore, they argue that when learners are taught in their vernacular they get used to translations, which leads

to difficulties when answering tests and examination questions in English because there is no room for translation (Mavuru & Ramnarain, 2019). This in my own view, indicates how learners' home language might negatively impact the mediation of the Grade 8 Physical Science concept of chemical bonding.

2.5 Scientific Language

Halliday (1993) states that scientific language is different from everyday English language. This is because scientific language is a unique language register with its own unique features. These unique language features of science pose an obstacle in communication from science teachers to science learners (Howes, Kirbride, Kelty, Julian, & Kemp, 2014). These unique features of science language namely *information density*, *technicality, abstraction* and *authoritativeness*, hinder learners from understanding science content (Halliday, 1993). Furthermore, Howes et al. (2014, p. 2) assert that science language "is also characterized by hedging or using words and expressions such as 'may', 'should' and 'probably' that fall along a continuum of uncertainty or caution regarding a conclusion". I now expatiate on the unique features as stated by Howes et al. (2014).

Information density

Information density is described by Howes et al. (2014) as a high proportion of words carrying content in the text. A text can be written or utterances of a teacher, while content carrying words are nouns, the main part of the verb, adjectives and some adverbs (Fang, 2004). In science information, it is presented in a way that more content words are packed in a smaller text, which makes the text contain more information compared to its size. Under this circumstance, condensed information in scientific language negatively impacts learners' comprehension because of the information load they impose on human working memory (Miller, 1969). It has been further argued that learners may feel overwhelmed by the density of information during text processing which may confuse them, thus leading to misconceptions (Fang, 2004).

Technicality

Science language involves the use of technical vocabulary and verbs of relational processes which are referred to as terms and expressions (Fang, 2004). Technicality refers to the use of both specialised vocabulary and ordinary words with specialist meaning (Howes et al., 2014).

As a result of technicality in science language, Jawahar and Dempster (2013) assert that science learners point to science language as one of the factors impacting their performance in the subject of Physical Sciences. As a result, learners who do not know the meaning of technical vocabulary are prone to struggle with understanding science texts, because they lack grammatical resources required to accurately communicate and understand science ideas and knowledge. It is for this reason that emphasis is made that science teachers need to have a better understanding of the central role that language plays in shaping science learning (Fang, 2004).

Abstraction

Abstraction is another feature of scientific language in which information and ideas in science are omitted, generalised and decontextualised (Halliday, 1993). Abstraction is considered one of the fundamental concepts in science representations such as physicist's equations, chemical symbols and models (William, Russell, & Irwin, 2017). To Back (2014), abstraction hinders learners' understanding of science concepts, because generalised laws do not state the facts about how real objects behave, but instead how theoretical objects behave within models, which are often idealised. In terms of this study, I believe that abstraction might be one of the contributing factors towards poor understanding of chemical bonding for Grade 8 learners, as it leaves out important details and focuses only on an aspect, typically the central one. The highly abstract concepts associated with chemical bonding are: covalent bonds, molecules, ions, giant lattices and hydrogen bonds (Nahum, Naaman, Hofstein, & Taber, 2010).

Authoritativeness

Authoritativeness is another feature of science writing in which information is typically presented accurately and objectively, as well as in an assertive tone (Fang, 2004). It has been argued that when authors are presenting scientific information they distance themselves from the text by avoiding the use of first person references, direct quotes and hedges (Schleppegrell, 2004). In the final analysis, Fang (2004) states that as a result of authoritativeness, science language is different from everyday language, and learners might feel alienated from science content as they are generally used to everyday language. Due to communication barriers that science language poses to science learners, teachers resort to code-switching as a teaching strategy in order to help learners understand science concepts better (Probyn, 2006).

2.6 Code-switching and Related Terminologies

Under this section, I discuss code-switching and related terminologies. I also discuss code-switching in the context of this study, and reasons why teachers code-switch in science classrooms.

2.6.1 Code-switching

Bernstein (1971) affirms that the concept 'code' refers to any system of signals such as numbers and words which carry concrete meaning. A code can be used to refer to any kind of system that people employ for communication (Jingxia, 2010). To Jingxia (2010), when people decide on a particular code, they do not necessarily need to stick to it all the time but can change from one code to another as the need arises.

Code-switching is described by Baker (1993) as when an individual changes between two or more languages in a conversation or utterance. In the same fashion, Setati (1998) posits that "code switching is the use of more than one language in a single speech - it can involve a word, a phrase or a sentence, or it can also involve several sentences" (p. 34). Furthermore, Cook (2001) describes code-switching as the process of going from one language to the other in the middle of speech provided that both speakers understand the same languages. In addition, Chikiwa (2016) describes code-switching as the use of two or more linguistic varieties or elements from other languages within the same utterance or conversation.

Scholars such as Nguyen, Grainger, and Carey (2016) describe code-switching in relation to education, whereby more than one language is used to present the subject matter knowledge to learners. In the context of this study, code-switching refers to the shift from the language of teaching and learning to Oshikwanyama which is the home language of all the learners in the Grade 8 science class.

To Jingxia (2010), there are three different types of code-switching, namely, tag, inter-sentential and intra-sentential. Tag switching is described by Azlan and Narasuman (2012) as the insertion of words anywhere within the boundary of a sentence or speech without violating the grammatical rules of a sentence. Correspondingly, Jingxia (2010) explains tag-switching as the insertion of a tag phrase from one language into a sentence. Tags are easily inserted at a number of points in an utterance without violating syntactic rules, because they are subject to minimal syntactic restriction (ibid.).

Intra-sentential switching takes place within the clause or sentence (Jingxia, 2010). Similarly, Azlan and Narasuman (2012) state that intra-sentential switching occurs when words or phrases from another language are inserted into a sentence of the first language. According to Jingxia (2010), this form of switching is considered the most complex form of code-switching. As a result, Azlan and Narasuman (2012) highlight that when two different languages are used in a sentence, proficiency in both languages is a prerequisite in avoiding structural errors.

Inter-sentential switching involves a switching at a sentence, paragraph or clause boundary (Romaine, 1989). According to Yletyinen (2004), this happens, for example, when the clause or sentence has been in the first language before changing to the second language. To Rommaine (1989), inter-sentential switching requires greater fluency in both languages since major portions of the utterance must obey the rules of both languages. Concurring, Karsperczyk (2005) echoes that inter-sentential code-switching is known as mechanical switching, which is also called code-mixing.

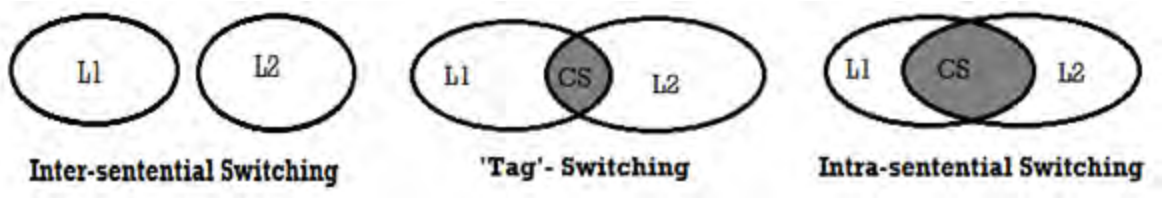

Figure 2.4: Types of code-switching and their varying degrees (Poplack, 1980, p. 615)

2.6.2 Code-mixing

Code-mixing is defined by McCormick (1995, p. 194) as "speech in which the alternation between the two languages used consists of shorter elements often just one single word". Code-mixing occurs when a speaker is momentarily unable to remember a term but is able to recall it in a different language (Karsperczyk, 2005). Equally important, Ho (2007) and Kamwangamalu (1989) further explain code-mixing as a mixture of any linguistic elements of two or more languages in the same utterance. Notwithstanding, Chikiwa (2016) states that code-switching is distinguished from code-mixing and borrowing. Code borrowing is explained in the next paragraph.

2.6.3 Borrowing

Borrowing is another form of language alternation in which a term or terminology is borrowed from another language for a specific purpose (Brice & Roseberry-Mckibbin, 2001). According to

Bokamba (1988), borrowing is "the introduction of single words or short idiomatic phrases from one language into the other" (p. 25). In the same fashion, Hughes, Shaunessy, and Brice (2006) also explain borrowing as a means of using one primary language but mixing in words or ideas from another different language or languages. Borrowing of words is useful in an utterance because it is used to fill up lexical gaps of the second language. Borrowing makes it possible for a speaker or an author to find appropriate words and phrases that may be used to name something or describe an event that may never have existed in that language (Brice & Roseberry-Mckibbin, 2001). An example of borrowing is: *Ochemical bonding ohai holokapo ngeenge uu electrons tava di ko ka atom kamwe vauka ku kakwao* (Translation: Chemical bonding occurs when electrons are transferred from one atom to another). Chemical bonding, electrons and atoms are borrowed words from English, because they do not exist in Oshiwambo.

2.6.4 Code-switching in the context of this study

Even though there are many descriptions and definitions of code-switching in the literature, there is no standardised definition of code-switching (Huerta-Macias & Quintero, 1992). For this reason, code-switching in this study refers to the use of more than one language, which is English and learners' home language of Oshiwambo, in a single speech to mediate chemical bonding to Grade 8 Physical Science learners. This might involve a word, a phrase or a sentence, or it can also involve several sentences. All the types of code-switching: tag, inter-sentential, intra-sentential, code-mixing and borrowing are simply referred to as code-switching in this study.

2.6.5 Reasons for code-switching in the classroom

Azlan and Narasuman (2013) point out some factors that influence code-switching by teachers. They state that these factors serve as a framework of motives for code-switching in a communicative event in the classroom:

- Lack of facility;
- Lack of register;
- Mood of the teacher;
- To emphasise a point;
- Habitual experience;
- Semantic significance;
- To show identity with a group;
- To address a different audience;
- Pragmatic reasons and

- To attract attention. (p. 460)

According to Mati (2004), code-switching can be regarded as an adaptable strategy which can be adopted by individual speakers in order to communicate more effectively. Concurring, Sert (2005) explains the functionality of code-switching in classrooms as a repetitive function. Teachers code-switch in order to transfer the necessary knowledge to the learners for clarity (ibid.). Furthermore, Ahmedand and Josoff (2009) assert that teachers code-switch in specific situations such as when explaining new vocabulary, make jokes to relax the learners, explain grammar, talk about class tasks and assessment rubrics and establish contact with learners. These are some of the main reasons why code-switching is chosen as a teaching and learning intervention in this study.

In conclusion, Crystal (1987) posits that teachers code-switch in order to build unity and friendly relations with their learners. In support of this, Sert (2005) ascertains that sometimes teachers resort to code-switching in order to express emotions. In this respect, teachers build solidarity and intimate relations with the learners as they create a supportive language environment in the classroom. In the context of this study, I believe that a supportive learning environment in the classroom is essential in order for the Grade 8 learners to learn the concept of chemical bonding successfully.

2.7 Chemical Bonding

The syllabus for Physical Science Grade 8-9 (Namibia. MEAC, 2015) emphasises that for a learner in Grade 8 to complete the Junior Secondary Phase, they should and are expected to be able to:

> Understand that atoms combine to form the building blocks of all materials, ionic and covalent bonding, properties and reactions within the Periodic Table. Understand covalent bonding and know how to illustrate covalent bonding as the sharing of electrons when atoms bind (restricted to H_2O, H_2, O_2, CO_2, CH_4, diatomic molecules of group 7 & N2). (p. 5)

The syllabus also prescribes that a learner should know chemical bonding in order to be able to be promoted to the Senior Secondary Phase. To Nahum et al. (2010), chemical bonding is one of the basic concepts in chemistry and yet it is inherently an abstract and complex concept which most learners struggle to understand. Science language might be one of the contributing factors towards learners' misunderstanding of the concept of chemical bonding, because science language has unique features which are different from everyday English language (Halliday, 1993). Chemical bonding is also one of the key concepts in the study of chemistry, and is important in understanding

material structures, properties and reactions (Tanen, 2011). This suggests that if learners lack understanding of chemical bonding at the early stage, they will find it difficult to pursue further study in the field of chemistry.

Shen and Hartwig (2007) refer to chemical bonding as "an attractive force between atoms strong enough to permit the combined aggregate to function as unit" (p. 10). In addition, Bergyvist (2017) describes chemical bonding as chemistry that deals with the nature of substances and their transformations, which are essentially abstract. Similarly, Atkins (n.d.) describes chemical bonding as any of the interactions of atoms that result in molecules, ions, crystals and other stable species that make up the substances of the whole world. As to why atoms undergo bonding, Niekerk (2008) posits that atoms take part in chemical bonding for them to achieve full outer shells, which can be achieved either by losing or gaining electrons, or by sharing electron between atoms.

Most chemical bonding is governed by the Octet rule, which states that atoms gain, lose and share electrons for them to have eight electrons on their outer shells (Atkins, n.d.). An Octet rule is also called a noble gas configuration which is a very stable electron configuration (ibid.). A noble gas configuration means that all shells of the atoms achieve full outer shells, just like for noble gas elements.

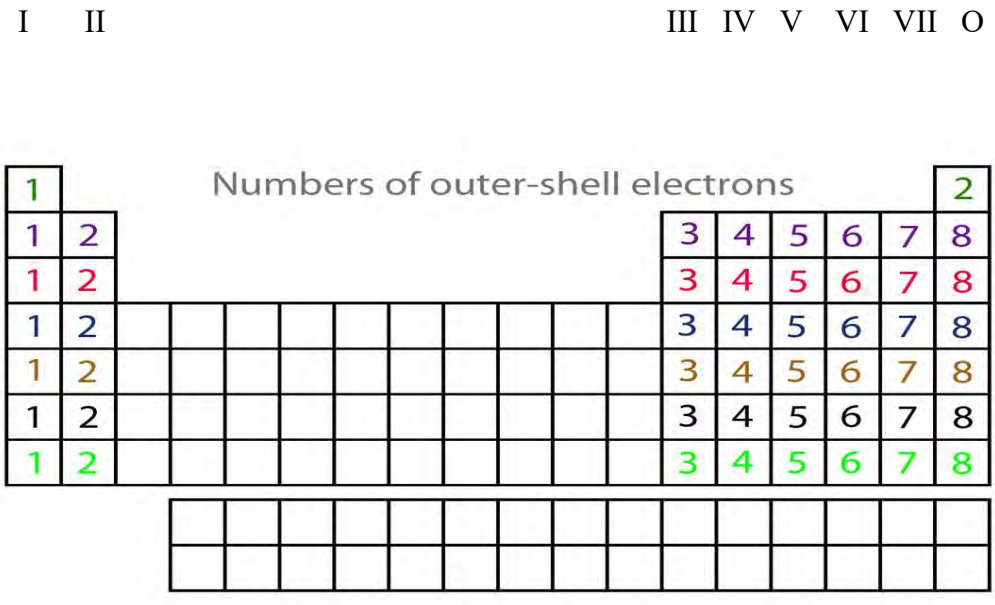

Figure 2.5: The Periodic Table with the numbers of outer-shell electrons (Parks, 2013, n.p.)

Figure 2.5 above shows the Periodic Table which focuses on the number of electrons elements have on their outer shells. Elements in the Periodic Table have different valance numbers depending on their group numbers. A valence number "is a number of electrons an atom needs to lose, gain or share in order to achieve a noble gas configuration" (Niekerk, 2009, p.74). All elements in group one have one electron on the outer shell, elements in group two have two electrons on their outer shell and the trends continue up to group eight, except for helium. The electrons on the outer shell determine the number of electrons an atom will lose, gain or share. All the elements from group one up to group seven take part in the chemical bonding in order to achieve group eight electrons configuration.

The syllabus for Physical Science Grade 8-9 emphasises three different types of chemical bonding which are determined by how the valence electrons are shared among the bonded atoms; these chemical bondings are "covalent bonds, ionic bonds and metallic bonds" (Niekerk, 2008, p. 27). Furthermore, Niekerk (2008) describes ionic bonding as the transfer of electrons from metals to non-metals for them to achieve a noble gas configuration. On the other hand, Bergqvist (2017) describes metallic bonding as consisting of cations surrounded by the metal atoms' delocalised valance electrons which form an electrons-sea of delocalised electrons. This study will focus on covalent bonding only, because Grade 8 learners are only expected to know covalent bonding and continue with ionic and metallic bonding in Grade 9.

Covalent bonding is described in terms of the sharing of electrons pairs between two atoms (Bergqvist, 2017). In the same vein, Niekerk (2008) defines covalent bonding as the sharing of electrons between non-metals for them to achieve full outer shells. Similarly, Dhindsa (2009) adds that covalent bonding is formed by sharing of valence electrons between non-metal atoms. Bergqvist (2017) also explains chemical bonding in terms of the Lewis model as:

> The sharing of electrons pairs between two atomic centers, with the nuclei and the bond resulting from the attractive electrostatic interactions between the negative shared electrons and the positive nuclei. (p. 33)

Gatti (2005) avers that each electron in a shared pair is attracted to the nuclei of both atoms and this causes the attraction between atoms resulting in outer shells of the participating atoms. Concurring, Bergqvist (2017) affirms that what causes the atoms to bind together is electrostatic forces. The Grade 8-9 Physical Science syllabus stipulates that Grade 8 learners should be able to explain covalent bonding as the electrostatic attraction between the nuclei of a pair of atoms and

the shared electrons between those atoms. Nevertheless, the Grade 10 Examiners' Reports for 2016, 2017 and 2018 revealed that many learners lost marks on questions about chemical bonding due to little knowledge of this topic.

2.8 Challenges Facing the Teaching and Learning of Chemical Bonding

Chemical bonding is a very important concept in chemistry. Yet, it is perceived by both science teachers and science learners as a challenging concept to teach and comprehend, respectively (Nahum et al., 2010). It is regarded as a concept that causes many misconceptions for science learners often due to over-simplified models or incorrect pictures of chemical bonding in textbooks.

Gudyanga and Madambi (2014) state that chemistry is dominated by the use of models which are sometimes complex, and it is these complicated models that are used in chemistry to explain chemical bonding which often contributes to learners' misconceptions in the topic. Learners sometimes fail to recognise the model which leads to confusion. The use of models in the topic of chemical bonding can also be a considerable challenge for teachers as they might not understand the model and therefore find it difficult to disseminate the necessary knowledge that learners need (ibid.). Bergqvist (2017) affirms that models play an important role in science classrooms, but sometimes cause students difficulties in understanding the topic at hand. Models are sometimes the reasons why learners find chemical bonding a demanding topic (ibid.).

Scientific language also poses a threat to science learners because it sounds foreign and is uncomfortable for them. This is because everyday language is sometimes used in science classrooms, but with different meanings, which leads to learners' misconceptions (Gudyanga & Madambi, 2014). Nahum et al. (2010) state that science language poses a double challenge to science learners, because they have to struggle with understanding the language used and at the same time try to understand the concept that is being presented.

2.9 Visualisation

As it is stated in the Physical Science syllabus for Junior Secondary Phase, learners in Grade 8 should be able to draw Bohr structures to illustrate chemical bonding (Namiba. MEAC, 2015). Since chemical bonding involves drawing of atomic models and compounds, visualisation is essential to mediate the topic of chemical bonding. Visualisation is when symbols and images are used to transmit information and ideas (White, 2003). Presmeg (1986) describes visualisation in

relation to education as a teaching and learning approach that involves the use of pictures, either on paper or digitally, and symbolic representations such as numbers, letters and symbols in order for learners to master a specific concept. Equally, Lioyd (2015) defines visualisation as "a language of images" (p. 5) which can be shapes, colours, forms, lines, patterns, objects, people and numbers.

To Jandhyala (2017), it is important for teachers to use visuals in their classrooms because it helps to boost learners' learning of new concepts and it also helps learners to remember what they have been taught. Visualisation as a teaching and learning approach to science is only effective when the teacher understands the effects of visual stimulation on brain development (ibid.). In the context of this study, the teacher will create lesson plans and activities that will reflect visualisation in order to enhance the learning of the concept of chemical bonding for Grade 8 learners.

Louis (2017) enumerates that most learners, approximately 65%, are visual learners. She further states that visual learners are those that need to see images in order to conceptualise ideas. Therefore, it is important to use visuals in science teaching because it increases learning for large groups of learners in classes. Images are effective ways to make sure that the information gets stored in long-term memory (ibid.). This suggests that visualisation plays an important role on how learners make sense of science concepts.

2.10 Sense Making

Weick (1995) defines sense making as "a process that is grounded in identity construction, retrospective, enactive of sensible environments, social, ongoing, focused on and by extracted cues, driven by plausibility rather than accuracy" (p. 17). Agreeing, Maitlis (2014) describes sense making as the process through which people work to understand issues or events that are not clear and that may cause confusion. The process of sense making starts when people encounter moments of uncertainty and seek to clarify what is going on by interpreting all the possibilities from their environment (ibid.).

Figure 2.1 by Ito and Inohara (2015) illustrates the process of sense making. At first individuals experience new information and apply a reasonable meaning that brings about a certain outcome. The outcome will determine how a person makes sense of the new experience as time goes on.

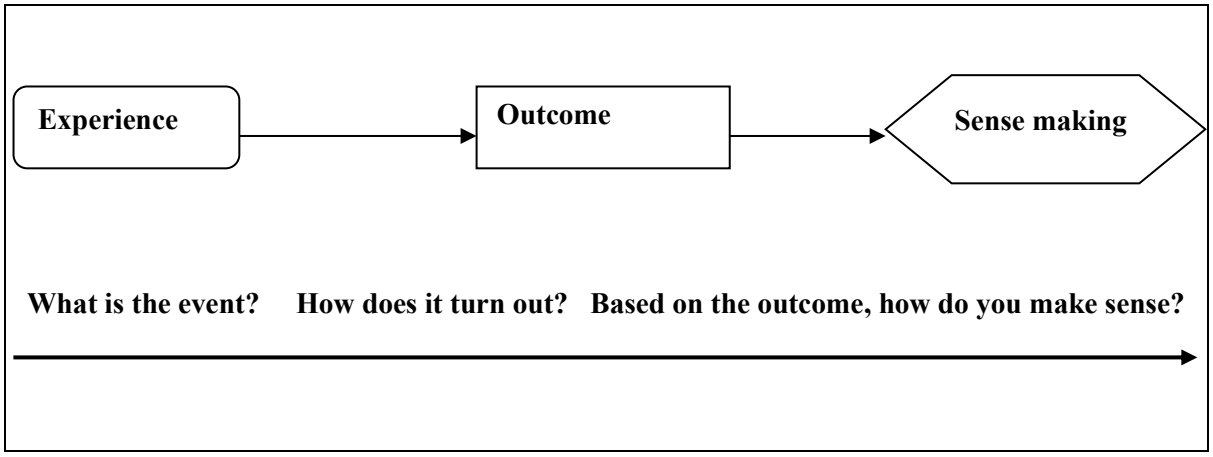

Figure 2.6: The conceptual model of sense making process (Ito & Inohara, 2015, p. 146)

In the context of this study, learners were afforded an opportunity to experience the new concept of chemical bonding and brought in their prior knowledge that they had acquired from Grade 7. The outcome, after applying their prior knowledge, determined how they made sense of chemical bonding.

According to Crowder (1996), learners are involved in meaning making when they start to reason through verbal or gestural cues in classroom talk. Similarly, Seeley (2016) states that for learners to make sense of new concepts they have to develop the ability to think, analyse situations, understand relationships and adapt what they already know in order to understand new concepts.

Weick, Sutcliffe, and Obsteld (2005) state that communication is a central component of sense making of circumstances in which people collectively find themselves, and of the events that affect their understanding. These scholars further state that effective sense making takes place in the classroom when communication is involved, taking place in interactive talk and drawing on the resources of language. Essentially, as espoused by Vygotsky (1978), language is a mediational tool for sense making. Concurring, Mortimer and Scott (2016) posit that language that teachers use in their classrooms plays a crucial role during the sense making process as learners will then be able to link new concepts to their prior knowledge in order to make sense of them.

2.11 Prior Knowledge

The concept of chemical bonding introduced in Grade 8 has its roots in the previous grade which is Grade 7. The knowledge learnt in earlier grades is required by learners in order to be

able to make sense of new concepts. This is because Okanlawon (2012) argues that before learners are engaged in formal instructions they already have information that they bring from previous interactions. Roschelle (1995) states that there is evidence that proves that learning tends to proceed from prior knowledge towards what learners do not know. Similarly, Campbell and Campbell (2008) aver that learners learn best when they already have knowledge about a content area and when concepts in that area are relevant to their particular background or culture. That is, learners are expected to use their prior knowledge from Grade 7 to learn the concept of chemical bonding in Grade 8.

Roschelle (1995) defines prior knowledge as the learning experience that forces a theoretical shift to the viewing of learning as a conceptual change. In the same vein, Biemans and Simons (1996) define prior knowledge as all knowledge learners have when entering a learning environment that is potentially relevant for acquiring new knowledge. In agreement with these definitions, Campbell and Campbell (2008) state that prior knowledge is the raw material that shapes learning. That is, learners who do not have enough prior knowledge or are not able to activate what they know, struggle in a subject area or school itself (ibid.).

It is important for teachers to identify what learners already know before the introduction of a new concept, because prior knowledge acts as mental hooks where new information and skills are lodged (Campbell, 2005). Prior knowledge increases the interest of learners since they already have a basic idea of the topic to be introduced. Furthermore, learners tend to engage in the discussions during the lesson presentations (Sedlacek & Sedova, 2017). To Mavuru and Ramnarain (2017), learners feel that their socio-cultural background is acknowledged when teachers take their prior knowledge into consideration.

On the contrary, even though this study maintains that prior knowledge is necessary to enhance learners' learning of new concept, it however has shortcomings. Some learners' prior knowledge contains misconceptions which lead to misunderstandings of new concepts. Through assessments, teachers can identify misconceptions or errors that might persist amongst learners. It can also be surmised that assessment should be primarily used to seek clarity and address learners' errors (Dann, 2014). Therefore, it is a teacher's responsibility to identify and correct learners' misconceptions as soon as possible in order to ensure that effective teaching and learning of science concepts takes place (Mavuru & Ramnarain, 2017). Based on the literature, prior knowledge might enhance Grade 8 learners' learning of the concept of chemical

bonding, and it might also hinder their understanding of the aforementioned concept if misconceptions are not correctly addressed as soon as possible. Therefore, it is against this background that one of the research questions of this study aimed at finding out the prior knowledge that Grade 8 learners have on the topic of covalent bonding. All in all, prior knowledge determines learners' interest in a certain concept or subject that in turn influences their dispositions (Campbell, 2005).

2.12 Dispositions

Thornton (2006, p. 62) defines dispositions as "habits of mind including both cognitive and affective attributes that filter one's knowledge, skills, and beliefs and impact the action one takes in classroom or professional setting". To Damon (2005), disposition are patterns of manners that are demonstrated habitually and deliberately in the absence of coercion that lead a person to follow certain choices or experiences. In the same vein, Da Ros-Voseles and Fowler-Haughey (2007) state that disposition is all about the way someone thinks about a certain situation.

Disposition and attitude cannot be detached, because attitude is an individual's disposition to react with a certain degree of favourableness or unfavourableness to an object, behaviour, person or institution (Ajzen, 2014). In like manner, Adolphe (2002) describes attitudes as a non-observable emotional construct whose incidence can be only realised from the behaviour exhibited. Bohner and Dickel (2011) aver that attitude comprises anything a person may hold in mind, for instance from the mundane to abstract, that includes people, groups, ideas and things.

Bennett (2003) accentuates that there are two types of attitudes: positive and negative. A positive attitude motivates learners to perform well academically while a negative attitude results in poor performance. Similarly, Anwer, Igbal, and Harrison (2012) emphasise that if learners have a positive attitude towards learning science, they may score better marks than those with a negative attitude. According to Yara (2009), attitude towards science means the interest or feeling towards studying science, therefore, it is the students' disposition towards liking or disliking science. Due to the fact that science language has unique features that pose an obstacle in communication from science teachers to science learners (Howes et al., 2014), it is the teachers' responsibility to apply different teaching and learning approaches that may enable learners to be positively motivated and have an interest in science (Sheldrake, Mujtaba,

& Reiss, 2017). As a result, Mati (2004) suggests that code-switching can be an adaptable strategy which can be adopted by teachers in order to communicate more effectively in science classrooms.

Orujlou and Vahedi (2011) accentuate that the language of teaching and learning plays a role in the positive disposition of learners toward learning of new concepts. Learners need quality instruction, input, interaction and opportunities in the classroom for them to have a positive attitude toward a certain subject. In addition to this, Ben-Chaim, Ron, and Zoller (2000) state that learners' positive disposition is also influenced by motivation. Therefore, a good teacher must tap into the sources of intrinsic motivation and find ways to connect them with external motivational factors that can be brought to a classroom environment. Orujlou and Vahedi (2011) state that when learners understand the language of instruction well, their disposition tends to increase. Shiota, Keltner and John (2006) state that positive disposition can be manifested by joy, also sometimes referred to as happiness. Joy is a "high-arousal emotion felt when the environment signals and imminent improvement in resources" (p. 64). In addition, Agunbiade et al. (2017) avers that enjoyment is also an indicator of positive disposition.

Attalah, Bryant, and Dada (2010) propose six disposition indicators that researchers can use to measure the disposition of individuals. These are: ability, attitudes, expectations, learning approaches, perceived value and evidence. Therefore, this study looked at the following disposition indicators, namely, ability, attitudes and expectations. These indicators were used to measure the ability of learners to make sense of the concept of chemical bonding when their home language was used in science lessons. How learners' attitudes towards the use of Oshikwanyama in science lessons impact the learning of science and what they are expected to achieve after they were taught the concept of chemical bonding in their home language.

In this study, disposition and attitudes are used interchangeably because both attitudes and disposition have to do with the personal feelings of an individual toward objects, ideas and people. It thus focused on attitudes of learners towards the use of their home language in the teaching of the concept of chemical bonding. Moreover, I have used attitude to describe disposition.

2.13 Theoretical Framework: Socio-cultural Theory

This study aimed to explore affordances and hindrances when using learners' home language to mediate learning of the concept of chemical bonding to Grade 8 Physical Science learners. Since the study employed code-switching between two languages, that is, English and learners' home language, which is Oshikwanyama, as an intervention, I therefore believe that Vygotsky's (1978) SCT was appropriate as a theoretical framework. This is because language is central to the SCT. In my view, it was hoped that this theory would help to explain how learners understand the concept of chemical bonding when their home language is used during science lessons.

Vygotsky's SCT emphasises the fundamental role of social interaction in the development of cognition, as he believes that the process of making meaning is strongly influenced by the community in which individuals live (McLeod, 2014). Furthermore, the SCT accentuates that interaction, historical and individual factors are significant to human development, of which the environment in which children grow up influences how they think and what they think about.

Vygotsky's (1978) SCT draws more attention to the role of language in cognitive development. Furthermore, Vygotsky proposes that cognitive development is a result of an internalisation of language. In SCT, Vygotsky thus uses language as a mediational tool for communication in a social setting, in order to enhance learning and thinking. In addition, McRobbie and Tobin (1997) state that knowledge is personally constructed through social mediation as a result of cultural experiences and interaction with others in that culture. Even though it is acknowledged that in reality learning is personally oriented, individual learning is mediated by the actions of others in a social setting and the culture in which learning is situated. Consequently, actions and interactions of those who participate in an educational setting shape individual constructions of new knowledge (ibid.). McLeod (2014) states that interaction in a social setting can only be achieved through the use of language.

McLeod (2014) extends Vygotsky's work further by explaining that socio-cultural theory views thoughts and language as initially separate systems from the birth of a child that merge around three years into their development leading to the production of verbal thoughts. According to Vygotsky (1978), language plays two critical roles in cognitive development of a child: it is the central means adults use to transmit information to children and language itself

becomes a very powerful means of intellectual adaptation. Within this theory, I will focus on the following concepts: *mediation of learning*, *social interactions* and the *zone of proximal development*. I now discuss each of these below.

Mediation of learning

One of the important constructs in Vygotsky's theory and one that is also relevant to this study is mediation, because it provides a means of studying social processes involved in learning new knowledge and how language can be used in the construction of new knowledge. Vygotsky (1978) explains mediation as parts played by significant people in order to enhance learners' learning experiences. He also states that mediation is a link between teachers and learners that directly affects learners' understanding of knowledge and skills in science. Additionally, Ramasike (2016) describes mediation as a learner-centred skill which supports the social constructivist perspective, which is also referred to as a theory that increases learners' sense making of abstract scientific concepts in order to acquire intellectual development.

Donato and Mccormick (1994) state that the sources of mediation are either a material tool, a system of symbols, notably language or the behaviour of another human being in social interaction. In the same vein, Brown and Botha (2017) posit that our actions cannot only be mediated by physical tools, but often by interactions with other people. Vygotsky (1978) emphasises that the most extensive tool for mediation in many social contexts is language. Since this study aims at exploring how learners' home language enables and/or constrains Grade 8 science learners sense making of the concept of chemical bonding, language as a mediational tool is central to this study. Science teachers as mediators of scientific knowledge use language to help learners move through the ZPD. As a teacher researcher, I used learners' home language as an intervention to mediate teaching and learning of the concept of chemical bonding which would hopefully shift learners' ZPD.

Social interaction

Vygotsky (1978) emphasises that learning by children takes place through social interaction with a more knowledgeable other. According to him, social interactions can also take place between different social groups interacting with other people to orientate and share the expectations to those new to the situation. For interaction to take place, language plays a vital role as a mediational tool. In addition, Kersaint, Thompson, and Petkova (2013) posit that

language is the primary tool in learning and for overall intellectual development of learners in the classroom. In the context of my study, learners will interact between themselves and with the teacher in the science classroom. Learners' home language will be used in order to help Grade 8 learners move through their ZPD towards sense making of chemical bonding. The teacher as a MKO will switch from language of learning and teaching (LoLT) of English to learners' mother tongue of Oshikwanyama, in order to help learners learn the concept of chemical bonding. The use of learners' home language to teach the concept of chemical bonding might promote greater social interaction between the teacher and learners, as they understand the language in which the concept will be discussed. To this end, language plays a significant role in encouraging learners' participation and collaborative group work in the classroom (Goos, 2004).

Zone of Proximal Development (ZPD)

Vygotsky (1978) alludes that learners develop within a ZPD which involves social interactions, dialogue and mediated activities between learners and their teachers. ZPD is "the distance between the actual development zone as determined by independent problem solving and level of potential development as determined through problem solving under or in collaboration with more capable peers" (Vygotsky, 1978, p. 86). As for Stott (2016) the actual development zone is described as the skills a learner has which can be used to solve a given problem without assistance. According to Khaliliaqdam (2014), the ZPD normally takes place when a novice and an expert person engage in an interactive activity in which they cooperate with each other to complete the intended task.

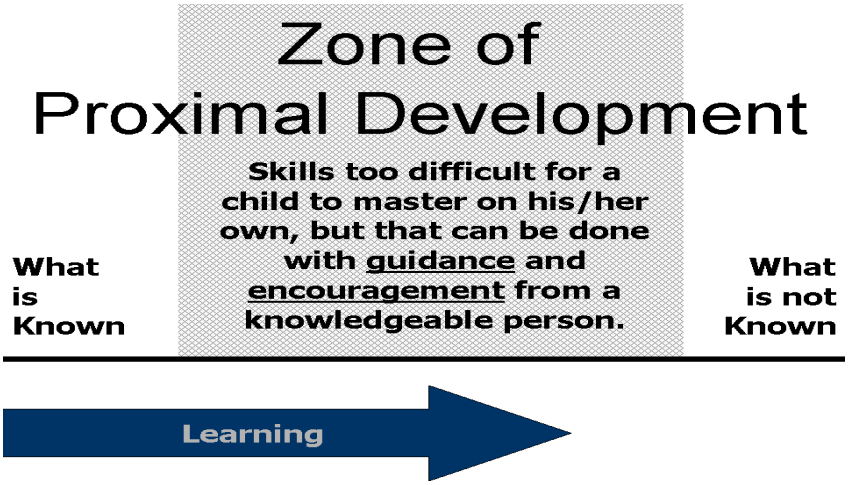

Figure 2.7: Shows the Zone of Proximal Development (McLeod, 2019, n.p.)

For Vygotsky (1978), there are three categories of zones in ZPD, namely *Comfort Zone* (what learners can do at present without any assistance), *Zone of Proximal Development* (what learners can do with the assistance of a more knowledgeable person) and an *Anxiety Zone* (what learners cannot do even with assistance from a more knowledgeable person). He further suggests that people tend to have larger ZPDs when they are working in groups, compared to individually.

Since the study focused on language, it embraces the adapted definition by Fani and Chaemi (2011) that states the ZPD is the distance between the actual developmental level as determined by individual linguistics production, and the level of potential development as determined through language produced collaboratively with a teacher or a peer. This literally means that it includes all of the knowledge and skills that a person cannot yet understand or perform on their own but is capable of understanding and performing with the guidance from a MKO, through the use of language (Khaliliaqdam, 2014). To Cole and Cole (2001), the term proximal indicates that the assistance provided goes just slightly beyond the learner's current competence, complementing and building on their existing ability.

In the context of this study, learners have to move through the ZPD from English as LoLT to their home language by means of mediation by a teacher who is regarded as an MKO. According to Mcleod (2014), an MKO refers to someone who has a better understanding than the learners with respect to a particular concept. With regard to this study, the MKO refers to a teacher who has a better knowledge in the concept of chemical bonding, in English as the language of learning and teaching, and in learners' home language.

2.14 Chapter Summary

In this chapter, I discussed various relevant literatures that informed this study. Firstly, I discussed Oshikwanyama as learners' home language, and scientific language and its unique features. I also explored literature around code-switching and related terminologies. This was followed with a discussion of chemical bonding and the challenges faced in the teaching and learning of this concept. Thereafter, visualisation, sense making and prior knowledge were also discussed. The chapter ended with a discussion of Vygotsky's (1978) SCT as the theoretical framework of this study.

In the next chapter, I describe the research methodology used in the study.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

The main goal of this study was to examine the prior knowledge Grade 8 Physical Science learners have on the concept of chemical bonding and to explore affordances and hindrances when Grade 8 Physical Science learners' home language is used to mediate learning of the topic of chemical bonding. To achieve this goal, the following research questions were addressed:

1. What prior knowledge do Grade 8 Physical Science learners have on the concept of chemical bonding?
2. How does the use of learners' home language in Grade 8 Physical Science lessons enable and/or constrain learner participation and sense making of chemical bonding?

Different research techniques were needed in order to achieve the goal of the study. In the previous chapter, I discussed Oshikwanyama as the learners' home language, and the scientific language and its unique features. I have also explored literature around code-switching and related terminologies. This was followed with a discussion of chemical bonding and the challenges facing the teaching and learning of this concept. Thereafter, visualisation, sense making, and prior knowledge were also discussed. Finally, the theoretical framework of Vygotsky's (1978) social-cultural theory was also discussed.

In this chapter, I thus discuss the research methodology that underpinned this study, the research paradigm, and the research design. Lastly, the chapter ends with a summary. I now discuss the research paradigm.

3.2 Research Paradigm

This study was located in the interpretive paradigm. The interpretive paradigm aims at understanding the nature of human experiences and is concerned with the individual actions or interpretations during a certain process (Cohen et al., 2018). According to Bertram and

Christiansen (2015), an interpretive paradigm aims to describe and understand how people make sense of their actions. An interpretive paradigm was deemed appropriate in this study as it aims to develop a deeper understanding of how learners make sense of chemical bonding when their home language is used in the science classroom.

Moreover, I believe that this paradigm is most suitable to this study because it seeks to gain deeper insights into the affordances and hindrances that learners' home language might have on Grade 8 Physical Science learners' participation and sense making of the topic of chemical bonding. Cohen et al. (2018) state that an interpretive research is aimed at providing a rich description of the phenomenon in order to establish an answer to a research question. This therefore provides a reason why this study took an interpretive approach in order to get a clear understanding of the practice of using the learners' mother tongue within the context of Physical Science classes. Notwithstanding, one of the criticisms of the interpretive paradigm is that it focuses on descriptions rather than explanations. To counteract this criticism within the interpretive paradigm, a case study approach was used in this study, because "it provides a chronological narrative of events relevant to the case" (Cohen et al., 2018, p. 378).

3.3 Research Design

Kothari (2004) explains that research design is the procedure for gathering and exploring data in a way that aims to address the research purpose. To Bertram and Christiansen (2015), the research design is often determined by the types of data the researcher needs to collect in order to answer research questions. Similar to Kothari (2004) and Bertram and Christiansen (2015), Cohen et al. (2018) describe a research design as "a plan or strategy that is drawn up for organizing the research and making it practicable, so that research questions can be answered based on evidence and warrants" (p. 173).

Creswell (2014) avers that a research design provides guidance to the procedure to be followed in conducting the research. In addition, Cohen et al. (2018) emphasise that a research design focuses on the evidence that the researcher has collected in answering the research questions, and how the researcher has collected the data. In designing the research, the researcher has to consider the issues of how to choose a research project, how to plan it, and how to ensure that the project is practicable (Cohen et al., 2018). Under this section I will discuss the case study, the research site and sampling, positionality, data gathering methods, research process, data analysis, validity, and ethical considerations.

3.3.1 Case study

Bertram and Christiansen (2015) describe a case study as when a person, a group of people, a school, a community, or an organisation is being studied systematically and in-depth in its context. To Creswell (2014), a case study is a comprehensive analysis of a confined system which assists the researcher to gain a comprehensive understanding of the phenomenon under study. In the same fashion, Cohen et al. (2018) describe a case study as a specific instance that is normally designed to demonstrate a more general principle.

I opted to use a case study because it uses a range of data gathering methods. A variety of evidence from different data sources enabled me to make inferences and interpretations based on evidence (Cohen et al., 2018). In light of this, I found that a case study could provide me with in-depth understanding of how learners make sense of chemical bonding when their home language is used in a Physical Science classroom. The case in this study was therefore the Grade 8 Physical Science learners' learning of chemical bonding when their mother tongue is used, and my unit of analysis was learners' participation and sense making when their mother tongue is used to teach chemical bonding. In this study, both qualitative and quantitative data were gathered; hence a mixed method approach was used.

According to Creswell (2014), a mixed method research is when the researcher collects, analyses, and mixes both qualitative and quantitative data in a single study. Christensen, Johnson and Turner (2015) explain that mixed methods can be concurrent or sequential. The study can employ the QUAL design (where the study is dominated by qualitative data) or QUANT design (study dominated by quantitative data) (ibid.). The main aim of combining qualitative and quantitative approaches is to provide a better understanding of my research problem than either approach alone (ibid.). Data were collected through the sequential method (Cohen et al., 2018). In the sequential method, quantitative data were collected and analysed (diagnostic test and post-intervention test) prior to qualitative data (interviews, observations, and journal reflections) which were informed by performance in the tests. This study employed the QUAL design, where the quantitative data are dominated by qualitative data.

3.3.2 Research site, participants, and sampling

In this section, I provide the information on the research site, participants, and sampling. I begin with the research site.

3.3.2.1 Research site

The research was carried out at Omega Combined School (pseudonym) in the Oshana region in the northern part of Namibia. The school is a rural government boarding school which starts from the pre-primary grade to Grade 9 in the Oshakati circuit. It consists of 16 teachers, two institutional workers and 427 learners. The teacher-learner ratio at this school is 1:27. The school has neither a laboratory nor a library but has a storeroom that is used as a library. Physical Science is one of the compulsory subjects at the school which is taught in the medium of English, despite the fact that all learners and teachers speak the same vernacular, Oshikwanyama.

The location of Omega Combined School in the Oshana region

Figure 3.1: Shows the Namibian map with the different regions

3.3.2.2 Research participants and sampling

Sampling has to do with making decisions about which people, settings, events, or behaviours to include in the study (Bertram & Christiansen, 2015). To Cohen et al. (2018), sampling is the process used to select a given number of people from a population. There are two main methods of sampling: random sampling and purposive sampling. In the case of my study, purposive sampling is suitable to be used by researchers in the interpretive critical paradigms who will be using a case study style of research (Bertram & Christiansen, 2015).

My study therefore used purposive sampling which is defined by Cohen et al. (2018) as a selection of strata that fits the purpose of the study. The school where the study was conducted was selected purposively and conveniently, with the reasons being that all learners at the school speak the same home language and possess similar prior knowledge of chemical bonding due to the similar environment in which they live. Due to COVID-19 social distancing, the study involved 17 Grade 8 learners at the school, myself as a teacher-researcher, and a critical friend. Grade 8 was also selected purposively because this is where chemical bonding is introduced in the Namibian curriculum.

A critical friend was also selected purposively based on the fact that the critical friend is someone who I trust, who asks provocative questions, and has a good professional relationship with me. This is in line with Storey and Wang's (2017) assertion that the key elements of critical friendship are trust, provocative questioning, professional development, and a professional relationship. The teacher's qualifications are a Basic Education Teachers Diploma (BETD), Advanced Certificate in Education (ACE), and Bachelor Honours Degree in Education (BEd). At the time of this study, my critical friend was studying towards a master's degree in science education.

All learners wrote a test before the intervention in order to elicit their prior knowledge on the topic of chemical bonding so that the results could inform my intervention. This enabled me to answer the first research question. After a diagnostic test, I presented my three lessons with an intervention in learners' home language, while my critical friend observed and video recorded all three lessons. I then watched the recorded videos after lesson presentations, together with my critical friend. All learners wrote reflections after each lesson presentation and they also wrote a post-intervention test after all three lessons for summative purposes. After learners wrote the post-intervention test, which was different from the diagnostic test, six learners who were actively participated during the lesson presentations were chosen to take part in a focus group interview. Given (2008) argues that by using purposive sampling to choose focus group participants, a researcher will be able to obtain relevant information from the participants. Six learners were also chosen to take part in a stimulated recall interview. Post-intervention tests, focus group interviews, observation and reflection assisted me to identify the enabling and/or constraining factors in the sense making of the topic of chemical bonding.

3.3.3 Researcher positionality

Moser (2008) describes positionality as factors that influence the way we do our research and how the research participants perceive us. As a matter of fact, Cohen et al. (2018) aver that relationships between the researcher and participants are not the same in terms of power, due to a number of factors that influence the power relationship. These factors include gender, race, ethnicity, religion, age, position, and the power dynamics related to it. It has been argued that it is often the case of those with more power researching those with less power (Cohen et al., 2018). Agreeing to this, Merriam et al. (2001) affirm that positionality is determined by where one stands in relation to the others in terms of studying our own culture or other's cultures.

As a teacher researcher, I was aware of uneven power relations between me and my research participants. Since I was a Physical Science teacher of the learners who were my research participants and I was also a member of the Disciplinary Committee at the school, this could influence the way participants interacted with me during the research process. In order to address this power dynamic issue, I established rapport and trust with learners by explaining to them that although the study was conducted on them at the school, it had nothing to do with any of the school activities because it was not part of normal teaching. All the participants agreed to take part in the study and signed the consent forms.

3.3.4 Data gathering techniques

Data gathering techniques are the range of approaches used in educational research to gather data (Cohen et al., 2018). Researchers need to vary the methods used to gather research data for the purpose of triangulation. I therefore used observations, journal reflections, a diagnostic test, and a post-intervention test. I now discuss each of the data gathering strategies below.

3.3.4.1 Testing: Diagnostic test and post-intervention test

Testing is used to collect data in an interpretive experimental research together with other data collection methods (Bertram & Christiansen, 2015). All 17 Grade 8 learners wrote a test before the intervention (diagnostic test) (see Appendix D1) and then wrote a test again after the intervention (post-intervention test) (see Appendix D4). Learners were given a pre-test that was developed with consideration of the curriculum requirements as stated in the Grade 8 Physical Science syllabus, and it was validated by two Chemistry university lecturers who did their PhD in Chemistry education, my two supervisors, my critical friend, and my fellow master's

students. The diagnostic test was used to establish learners' prior knowledge in chemical bonding in particular. The data collected from the diagnostic test helped me to provide answers to the first research question and also to get some insight on the possible enabling and constraining factors for learners in the topic of chemical bonding, and to inform the intervention. After I presented the three lessons using the strategy of code-switching as a teaching intervention, all 17 Grade 8 learners then wrote the post-intervention test that was different from the diagnostic test, in order to assess their overall understanding of the topic of chemical bonding. The data from the post-intervention test helped to answer the second research question. Both marks for the diagnostic test and post-intervention test were recorded for analysis purposes.

3.3.4.2 Observation (videotaped lessons)

Observation is the systematic process of recording the behavioural patterns of participants, objects, and occurrences without necessarily questioning or communicating with them (Maree, 2010). When observing, the researcher is an insider to that scene (Bertram & Christiansen, 2015) and this allows a researcher to obtain first-hand information and to report on what they have witnessed with their own senses. I planned three lessons that were co-developed with my critical friend who also observed my lessons. The critical friend also videotaped all three lessons. After the lessons, my critical friend helped me to watch the videos in order to identify enablers and constraints when teaching chemical bonding using learners' home language. The observation schedule was adapted from Iyambo (2015, p. 91) and Silvanus (2017, p. xii). Since Silvanus' study was on developing learners' scientific English to make sense of energy, while my study focused on whether learners' home language can enable or constrain their sense making of the topic of chemical bonding, it was necessary to adapt only a part from Silvanus's (2017) observation schedule (see Appendix D2). I only adapted the part – "behaviour that shows learners making sense of the concept" and then added the indicators for my critical friend to know exactly what to look for when observing. From Iyambo (2015), I adapted indicators on the usage of teachers' language.

3.3.4.3 Journal reflections

In an academic arena, journal reflections are used to help participants highlight observational skills, explore feelings, assess progress, and evaluate (Suzanne, 1995). Gay, Mills, and Airasian

(2009) describe learners' journals as tools that can provide teachers with windows into learners' daily classroom experiences which need to be considered for teaching practice. Concurring, according to Goker (2016), reflections are commonly used in many educational contexts and considered as important tools in order to enhance understanding. After each of the three lesson presentations learners were afforded an opportunity to write down their thoughts on how their home language impacted their understanding of the topic of chemical bonding. In this study, journal reflection (see Appendix D3) helped me to identify learners' understanding and to identify what enabled and/or constrained their understanding of chemical bonding. Journal reflection was adapted from Silvanus (2017, p. xii). I did not change much on Silvanus' (2017) journal reflection apart from adding a question that required learners to specifically reflect on the use of their home language.

3.3.4.4 Focus group interview

A focus group interview is a form of group interview in which interactions are made within the group to discuss a topic supplied by the researcher (Uushona, 2013). A focus group interview is one of the techniques of conducting an interview. Cohen et al. (2018) accentuate that one of the advantages of group interviews is to generate a wider range of responses than in individual interviews. During a focus group interview, interviewees can support, influence, complement, agree, and disagree with each other. Although this is the case, the unit of analysis is the view of the whole group and not the individual members.

Rabbiee (2004) avers that in a focus group interview, participants are purposively selected. Six learners (three girls and three boys) participated in the focus group interview (see Appendix D5). These learners were selected by their peers based on the reasons that they were active during lesson presentations and on their ability to answer the questions in the class. Given (2008) argues that by using purposive sampling to choose focus group interview participants, a researcher will be able to obtain relevant information from the participants.

3.3.4.5 Stimulated recall interview (see Appendix D6)

Mackey and Gass (2005) describe stimulated recall interview as a subset of introspective research methods which accesses participants' reflections or mental processes. Furthermore, stimulated recall interviews provide room for one to investigate the cognitive processes of participants, by inviting them to recall what happened during a certain event. Sime (2006) states

that one advantage of this approach is that stimulated recall data allows research participants to explain their decision making.

Stimulated recall interviews frequently use both audio and video recordings to stimulate participants' thinking during a certain event (Mackey & Gass, 2005). However, in the context of my study, the stimuli are learners' answers based on the diagnostic test and post-intervention test. I chose two top learners, two middle and two with low marks and interviewed them based on the answers given in the tests.

As I explained earlier, the diagnostic test aimed to explore the prior knowledge learners brought with them from earlier grades, specifically Grade 7. A post-intervention test was also administered to measure learners' overall achievement after learners' home language was used to mediate the concept of chemical bonding. From the diagnostic test and post-intervention test, some mistakes, misconceptions, and problems emerged. Therefore, some answers that learners provided needed to be elaborated on further, in order to gain an in-depth understanding of learners' responses and why they gave these answers, as well as to gain information on learners' prior knowledge.

Table 3.1: Summary of the data gathering techniques used in this study

Technique	**Purpose**	**Research question**
Diagnostic test	To identify learners' prior knowledge and to inform the intervention.	1
Observation	To identify the enablers and constrains when teaching chemical bonding using learners' home language.	2
Journal reflection	To identify learners' understanding and to identify what enables or constrain learners' understanding of chemical bonding.	2
Post-intervention test	To assess learners' overall understanding of the topic of chemical bonding.	2

Focus group interview	To find out how learners' home language enabled and/or constrained the understanding of chemical bonding.	2
Stimulated recall interview	To gain an in-depth learners' understanding of these responses and why they gave these answers as well as to gain learners' prior knowledge.	1

3.3.5 Research process

According to Creswell (2014), a research process entails plans and procedures that the researcher will use to gather data. My study was conducted in the following phases.

***Phase 1*:** Before learners entered the classroom, I made sure that all COVID-19 protocols were observed. The seating arrangement was done in a way that learners would sit at least 1 meter from each other in order to make sure that social distancing was observed. After that, I made sure that all learners put on face masks and then took their temperature using thermo guns, recorded the temperature in the temperature record book and sanitised them. After that, learners were seated and I briefed them about what COVID-19 is and how they were expected to behave during all the lessons presentations in order to curb the spreading of the virus. I also explained to learners that there would only be an exchange of paper such as notes and tests between the learners and the teachers, and that would always only be done after we all sanitised our hands. After all the COVID-19 protocols were observed, I explained the objectives and goals of my research to my participants. Thereafter, a diagnostic test was administered. Seventeen learners wrote a diagnostic test for me to gain insight into their prior knowledge on the topic of chemical bonding and to inform my intervention. This also enabled me to identify language challenges learners had, based on their responses. In this phase, I was able to gather data that formed part of the answer to the first research question and identify some enablers and constraints that learners had in the chemical bonding topic.

***Phase 2*:** I presented a series of three lessons on chemical bonding, while my critical friend carried out an observation and videotaped all the lessons. The recording focused more on the learners in order to capture their reactions that might show how they made sense of the topic of chemical bonding. I also watched the videos with my critical friend after the lesson presentations. Additionally, all learners wrote journal reflections after each lesson presentation.

This helped me to gain some insights into learners' sense making of chemical bonding and to examine how their home language enabled and/or constrained their sense making of the concept of chemical bonding.

***Phase 3*:** After the lesson presentations, all learners who took part in the study wrote a post-intervention test in order to assess their overall understanding of the concept of chemical bonding. After learners wrote the post-intervention test, I asked learners to select from their peers those who would take part in the stimulated recall interview. Six learners who actively participated during the lesson presentations were selected and formed part of a focus group interview. This helped me to determine how learners' home language enhanced Grade 8 learners' sense making of the topic of chemical bonding. Since learners were siting far from each other and had their masks on during the focus group interview, this affected the quality of the voice notes recorded. This made it difficult to easily transcribe the focus group interview.

Phase 4: I chose six learners to take part in the stimulated recall interview. I chose two top learners, two middle and two who had low marks and interviewed them based on the answers they gave in the diagnostic and post-intervention tests. The stimulated recall interview aimed to provide room for learners to elaborate on some of the answers they provided in the diagnostic and post-intervention tests. These gave the researcher a chance to gain an in-depth understanding of the learners' responses and why they gave these answers, as well as to gain information on learners' prior knowledge.

3.3.6 Data analysis

Gay at el. (2009) describe data analysis as a process of making sense of data collected, interpreting what has been seen, and what has been said. In the same fashion, Cohen et al. (2018) describe data analysis as the process that involves organising, explaining, and reducing data for it to make sense. In this study, data were analysed quantitatively and qualitatively. In a quantitative data analysis, a descriptive statistics and inferential statistics method were used to analyse the data collected from the pre-test and post-test. In a descriptive statistics method, data is described by compiling it into a graph, table, or other visual representation (Bundly, 2003). Descriptive statistics summarise the data in simple numerical expressions. Firstly, the mean (central measurement), which is the sum of all scores divided by the number of scores, is calculated. Secondly the standard deviation (measure of variability) is calculated. The standard deviation is calculated to determine the spread distribution of scores from the mean

(Connolly, 2007). To Cohen et al. (2018), "the standard deviation is a measure of the dispersal or range of scores, calculated as the square root of the variance, yielding the average of all the individual deviations of scores from the mean" (p. 727). The larger the standard deviation the wider the distribution is spread). However, there are some critiques on the use of standard deviation when working with a small sample of participants because the research findings cannot be generalised. Inferential statistics was used to measure the difference in learners' performances in the diagnostic test and the post-intervention test, in order "to make inferences about the similarity of a sample to the population from which the sample is drawn" (McMillan & Schumacher, 2014, p. 142). In inferential statistics, a t-test was used to establish the significant difference of data collected.

The data from observation schedules, learners' journals, a focused group interview, and a stimulated recall interview were analysed qualitatively. In a qualitative data analysis, the researcher makes sense of data in terms of the participants' definitions of the situation, noting patterns, themes, categories, and regularities (Cohen et al., 2018). For this study, a thematic analysis was used to analyse the data qualitatively. Miguire and Delahunt (2017) define thematic analysis as "the process of identifying patterns or themes within qualitative data" (p. 3352).

Furthermore, the SCT was used as a lens in order to analyse learners' sense making of chemical bonding through social interactions in the science classroom using learners' home language, and how the Grade 8 learners engaged in social interactions during presentations of the concept of chemical bonding. I analysed how the learners' home language was used to mediate sense making of chemical bonding. ZPD was used to see if there was a shift in the sense making through observation, reflection and post-testing. Moreover, all data were labelled with codes and themes.

3.3.7 Validity, trustworthiness, and reliability

Validity is the measure of what the study intends to measure (Gay et al., 2009). Bertram and Christiansen (2015) posit that validity and trustworthiness of the study can be enhanced when the researcher uses various tools to collect data. In this study, various data collection techniques were used that allowed triangulation, which is defined as the use of a variety of methods for data collection (Cohen et al., 2018). The diagnostic test and post-intervention test were validated by two Chemistry university lecturers who did their PhD in Chemistry education and

my two supervisors. The observation schedule which was adapted from Iyambo (2015) and Silvanus (2017), and journal reflection (adapted from Silvanus, 2017) were compiled by the researcher and validated by the critical friend and fellow master's students and my two supervisors. I watched the videos together with my critical friend and had stimulated recall discussions, as this strategy lends itself to being a data validation tool. This also helped reduce any possible researcher bias. The focus group interview questions were set by me and validated by my critical friend and my two supervisors. Furthermore, my critical friend and I discussed which questions from the diagnostic and post-intervention tests needed more elaboration from the learners.

3.3.8 Ethical considerations

Ethics in research concerns what researchers should and should not do in their research and research behavior (Cohen at el., 2018). Bertram and Christiansen (2015) state that ethics has to do with the behaviour that is considered right or wrong in conducting research. In this section, I therefore discuss various ethical issues that were taken into consideration in this study.

3.3.8.1 Respect and dignity

Before the beginning of the research, the rights of all the participants were addressed and respected in this study. Before the participants signed informed consents forms (see Appendix C2) and assent forms (see Appendix C4), they were all informed that their participation in the study was voluntary and they had the liberty to withdraw from it at any time without any explanation. The participants were also informed that their welfare, anonymity and privacy were protected at all times. I explained to the participants that all three lessons would be videotaped with their consent. To ensure that everything I wrote in the thesis did not violate the dignity of the participants, I was thoughtful of the data that I presented in this thesis since it is in the public domain.

3.3.8.2 Transparency and honesty

The aim, the research process and responsibilities of all the participants were explained in detail before the learners signed the consent forms. Since the research involved minors, the letters of consent to parents were written in English and translated into Oshiwambo (see Appendix C3) in order to ensure proper understanding of the content. Moreover, permission to carry out this

study was requested and obtained from the school principal and the Director of Education of the Oshana region, and all their responses were positive.

3.3.8.3 Accountability and responsibility

I did not misuse my position as a teacher-researcher in this study for any personal gain and any conflict of interest. All the participants were treated equally regardless of their cultural, political and religious backgrounds. I had to guarantee my participants that the information they provided during the research would be treated as confidential by keeping all the data gathered in a safe and secured place.

3.3.8.4 Integrity and academic professionalism

This study is my own product, using my own words and ideas, and where I have drawn from other people's ideas, I have acknowledged and referenced them in accordance with Rhodes University's protocols. There were no fabrications, manipulations and misrepresentation in the data presentation.

3.4 Chapter Summary

In this chapter, I discussed the research design and methodology used in this study. I started with the research design which was followed by the paradigm as well as the research methods. I also outlined the research goal and questions of this study. The research site, participants, the sampling and positionality were also highlighted. The data gathering techniques and how the data were analysed was explained. Furthermore, validity and trustworthiness were described and finally ethical issues were discussed.

In the next chapter, I present, analyse and discuss the quantitative data generated from the diagnostic and post-intervention test, as well as stimulated recall interviews.

CHAPTER FOUR: DIAGNOSTIC TEST, POST-INTERVENTION TEST AN STIMULATED RECALL INTERVIEWS

4.1 Introduction

The aim of the study was to explore the affordances and hindrances when using Grade 8 learners' home language to mediate learning of chemical bonding. Tanen (2011) states that chemical bonding is one of the challenging key concepts in chemistry due to its scientific language. In the same fashion, the Grade 10 Examiners' Reports for 2016, 2017 and 2018 revealed that many candidates lost marks on questions about chemical bonding because they generally showed little knowledge in this topic. This triggered my interest to conduct a study to explore affordances and hindrances that Grade 8 Physical Science learners encounter when they are learning the concept of chemical bonding using the strategy of code-switching between English and learners' home language (Oshikwanyama). This is because according to my anecdotal evidence and from a number of literature, code-switching is widely used in Namibia and in Africa at large, because of its potential pedagogic usefulness in science classrooms.

In the previous chapter, I discussed the research methodology used in this study. In this chapter, I first present, analyse and discuss the quantitative data that were generated from the diagnostic test and post-intervention test. As the name suggests, the diagnostic test aimed at eliciting learners' prior knowledge that they brought with them from earlier grades. On the other hand, the post-intervention test aimed to assess the overall achievement of learners after the intervention. I also present, analyse and discuss data generated from stimulated recall interviews. A stimulated recall interview provided windows for me to gain an in-depth understanding of learners' responses in the diagnostic and post-intervention test, and why they gave these answers. This also afforded me an opportunity to gain some insights into learners' prior knowledge. The quantitative data sets from the diagnostic and post-intervention tests were analysed using tables and graphs, while data from the stimulated recall interview was analysed qualitatively in order to answer my research question one:

What prior knowledge do Grade 8 Physical Science learners have on the concept of chemical bonding?

4.2 Analysis of Data

In this section, I present, analyse and discuss the quantitative data gathered from the diagnostic and post-intervention tests, as well as qualitative data from the stimulated recall interview.

4.2.1 Presentation, analysis and discussion of data from diagnostic and post-intervention test

I administered a diagnostic test to 17 Grade 8 learners before my intervention on using code-switching between English and Oshikwanyama, which is the learners' home language. Notably, I only managed to work with a group of 17 learners due to COVID-19 19 protocols and regulations that require social distancing of 1.5 meters. The aim of administering the diagnostic test was to get an insight into learners' prior knowledge on the topic of chemical bonding in order to inform my intervention. Prior knowledge learnt at earlier stages helps learners to be able to make sense of new concepts (Campbell & Campbell, 2008; Roschelle, 1995). Therefore, it is important for teachers to know learners' prior knowledge because it acts as mental hooks where new information and skills are lodged (Campbell, 2005).

After the diagnostic test, a post-intervention test was administered after the intervention in order to establish whether mediating learning of the concept of chemical bonding using code-switching enabled and/or constrained sense making of Grade 8 learners. All the marks of the 17 learners who wrote the tests were analysed and learners are coded as learner 1- learner 17 (L1- L17) throughout the analysis. Both tests were out of 20 and learners' marks were converted to percentages and the results are presented in Table 4.1 below.

Table 4.1: Shows results of the diagnostic test, post-intervention test and shifts in the tests

Learner	Diagnostic test	Post-intervention test	Shift
Learner 1 (L1)	40	45	+5
Learner 2 (L2)	45	75	+30
Learner 3 (L3)	50	70	+20
Learner 4 (L4)	60	80	+20
Learner 5 (L5)	60	70	+10
Learner 6 (L6)	65	40	-25
Learner 7 (L7)	45	75	+30
Learner 8 (L8)	45	60	+15
Learner 9 (L9)	60	70	+10
Learner 10 (L10)	35	65	+20
Learner 11 (L11)	45	60	+15
Learner 12 (L12)	35	70	+35
Learner 13 (L13)	45	50	+5
Learner 14 (L14)	20	60	+40
Learner 15 (Ll5)	65	70	+5
Learner 16 (L16)	50	85	+35
Learner 17 (L17)	60	40	-20
Total	**825**	**1085**	**+250**

The results from Table 4.2.1 above show that eight learners (47%) out of the 17 learners who wrote the diagnostic test performed above 50%. Eight learners (47%) scored between 35% - 45% and only one learner (6%) scored 20% in the diagnostic test. This shows that Grade 8 learners have prior knowledge of the concept of chemical bonding. To Campbell and Campbell (2008), learners learn best when they already have knowledge about content area and when concepts in that area are relevant to their particular background.

Furthermore, the results from the diagnostic and post-intervention test above show that 15 (88%) learners out of 17 learners performed better in the post-intervention test compared to the diagnostic test. Even though the overall shift is 250, there were, however, two learners whose marks obtained in the post-intervention test were lower than their marks obtained in the diagnostic test. Even though Mavuru and Ramnarain (2019) state that home language facilitates learners' understanding of science concepts, they however admit that teaching a science concept in a home language often leads to the distortion of meaning which results in poor understanding of the concepts. Additionally, another reason this might have caused the poor performance of these two learners is that sometimes prior knowledge contains misconceptions which leads to misunderstanding of new concepts (Sedlacek & Sedova, 2017).

The learners' marks from tests were further presented in intervals based on the marks they obtained. The Namibian Curriculum for Basic Education (NCBE) stipulates that for a learner to pass Physical Science they are expected to obtain at least 40%. These percentage intervals are shown in Figure 4.2.1 below.

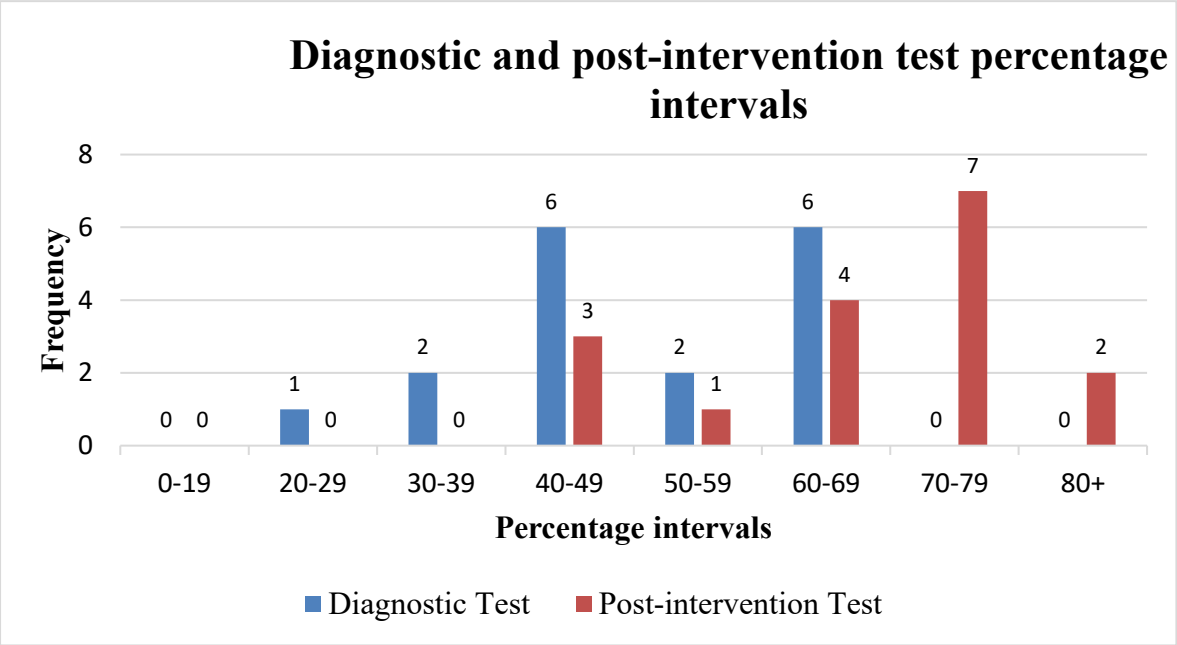

Figure 4.1: Shows percentage intervals for pre-and post-tests

Figure 4.2.1 shows that in the diagnostic test, three learners (18%) scored less than 40%, while 14 learners (82%) scored 40% and above. Nevertheless, no learner scored below 40% in the post-intervention test. To put it differently, all 17 learners (100%) scored 40% and above in the

post-intervention test. This suggests that after the intervention of code-switching between English and learners' home language (Oshiwambo), the learners' performance had increased. Consequently, all three learners who scored below 40% in the diagnostic test managed to score above 40%.

The results also show that no learner scored above 70% in the diagnostic test, however, nine learners (53%) scored above 70%, with two learners (12%) scoring 80% and above. From the results above, it could be inferred that the intervention had an influence on the sense making of the concept of chemical bonding. To Chikamori et al.'s (2019) Transformational Model of Education for Sustainable Development (TMESD) framework, curriculum can be transformed by using indigenous language in science classrooms to mediate the concept of chemical bonding in order to help learners understand it. Additionally, learners' home language can also play a role in retroductive learning, whereby teachers use learners' home language (Oshikwanyama) in order to make learning of chemical bonding accessible to learners.

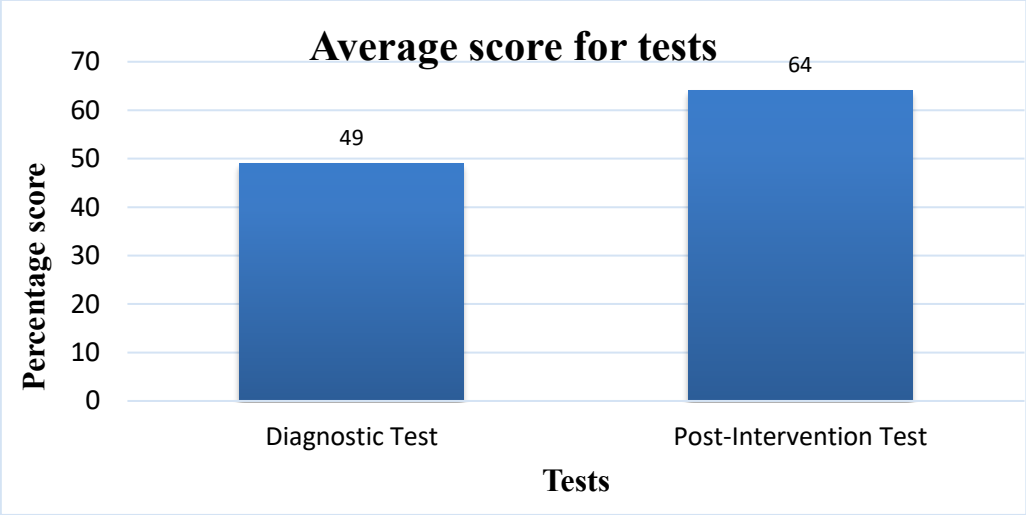

Figure 4.2: Shows average percentage scores for diagnostic and post-intervention tests

The graph above shows the central value of diagnostic and post-intervention tests' marks. The results indicate that the performance of learners in the diagnostic test was 49% while in the post-intervention test it was 64%. Furthermore, the results show a shift of 15% between the diagnostic and post-intervention test. Therefore, it could be surmised that the integration of learners' home language in the lesson presentations of chemical bonding had an influence on the learners' performance. Hence, Mberia (2015) argues that learners taught the same topic by

the same teacher, show greater understanding of concepts when they are taught in their home language compared to when they are taught in English.

The results from learners' diagnostic and post-intervention tests were analysed by calculating the standard deviation. Cohen et al. (2018) state that in calculations involving statistics, it is important to determine the standard deviation. In this study, standard deviation was used to determine the distribution of marks from the mean. From the tests results, the average of the learners in the diagnostic test was 49% and in the post-intervention test it was 64%. However, the distribution of learners' marks are not shown by the average. Therefore, the distribution of learners' marks obtained is shown by calculating the standard deviation as shown in Table 4.2 below.

Table 4.2: Shows mean and standard deviation of a diagnostic and post-intervention test

Tests	**Mean ($\bar{x}$)[1]**	**Standard deviation**
Diagnostic test	49	12.22
Post-intervention test	64	13.41

Table 4.2.2 above shows that the sample standard deviation for the diagnostic test was 12.22 while the sample standard deviation for the post-intervention test was 13.01. This shows an increase in sample standard deviation of the diagnostic test and post-intervention test with 1.19, after an intervention of code-switching between English and learners' home language (Oshikwanyama). The standard deviation for the diagnostic test was smaller and this suggests that the learners' marks were distributed closer to the mean. In contrast, the standard deviation for the post-intervention test was larger after an intervention. This suggests that the learners' marks were more widely distributed. Connolly (2007) describes that the larger the standard deviation, the wider the distribution is spread.

The learners' marks from the diagnostic and post-intervention tests were further analysed to identify the difference in the mean as shown in Table 4.3.

Table 4.3: Shows mean difference in diagnostic test and post-intervention test

Variable	mean	std. error	std. deviation	t	df	sig (2 tailed)
Diagnostic test	48.53	2.96	12.22	-3.46	16	.05
Post-Intervention test	63.82	3.25	13.41			
Difference	-15.29	4.42	14.28			

Table 4.3 shows the results of the *t*-test to determine the significant difference of using learners' home language. The samples are not independent so a paired *t*-test of dependent groups was done. This output provides useful descriptive statistics for the diagnostic test and post-intervention test performance of the learners under comparison. These statistics include the mean and standard deviation, as well as actual results from the paired *t*-test. Looking at the mean column, learners during the diagnostic test had lower marks (48.53) than those obtained in the post-intervention test (63.82). There is a mean difference between the post-intervention test and diagnostic test of 15.29412 (Mean) with a standard deviation of 14.28 (Std. Dev.) and a standard error of the mean of 4.424003 (Std. Err.) Statistical significance was conducted with a t-value (critical value) equal to -3.46 and it was obtained from 16 degree of freedom (df). The significance of the t-value was tested under the null hypothesis of no difference in means (H_0: mean (diff) = 0) versus the alternative hypothesis that there is a difference in the means of two sets (H_a: mean (diff) ≠ 0). The significance level of the test was 0.05 used in a two tailed test. It can be concluded, therefore, that there is a statistically significant difference between our two variable scores (diagnostic test and post-intervention test). In other words, the difference between the two variables is not equal to zero. Hence, the intervention had an influence on the sense making of the concept of chemical bonding.

4.2.2 Presentation, analysis and discussion of data from stimulated recall interviews

After learners wrote a diagnostic and post-intervention test, I chose one learner who obtained the highest marks, one learner who obtained middle marks and one learner who obtained the lowest marks in each test. I interviewed these learners one by one based on their responses they provided in the diagnostic and post-intervention test. This is because some of their answers

needed more elaboration, as to why they responded in the manner they did (Sime, 2005). The names used in the stimulated recall interviews are all pseudonyms which learners chose for themselves.

Figure 4.3: Shows learners and teacher/researcher during stimulated recall interviews

The interviews are presented in the sequence in which they were conducted. There was no planned order in which the interviews took place. Instead, learners were interviewed according to times that were convenient to them after school. I now present, analyse and discuss data from a diagnostic test.

4.2.2.1 Stimulated recall interviews based on the diagnostic test

Two learners, Monika and Filly were interviewed about their answers they provided in the diagnostic test on how they understand the concept of covalent bonding (see Appendix F1). The first vignette is from the interview with Monica explaining more on her response that *"I understand the covalent bonding better"* as it is shown in Figure 4.2.4 below.

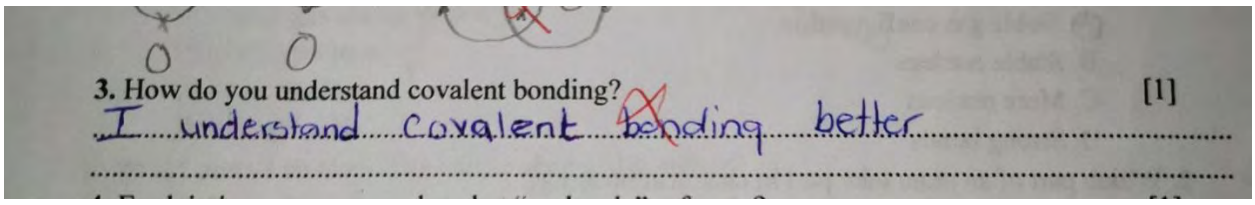

Figure 4.4: Extract of Monika's response on how she understands covalent bonding

I now present the excerpt from Monika's interview.

Int: *Mo testa yoye yotete owa hololа kutya ou uditeko nawa kutya ochemical bonding oshike,hasho?* (In your diagnostic test you indicated that you understood the concept of chemical bonding better, is it so?)

Mnk: *Oshoshili Sir* (it is true Sir)

Int: *Okwali wushi uditeko ngahelipi?* (How did you understand it?)

Mnk: *Otashiti oku kanyatela kumwe* (it means to stick together)

Int: *Oku kanyatela kumwe ngahelipi? Penge utale oshi holelwa.* (To stick together how? Can you give me an example?)

Mnk: *Ngaashi ngeno tolongifa oka glue kenya hakutiwa oka quick bond ngeenge totula kumwe oshiima shateka* (For instance when you are using a glue called a quick bond to put broken things together.)

The interview above indicated that there is a misconception between covalent bonding and the term 'bond' which can be defined as "a connection between two surfaces or objects that have been joined together, especially by means of an adhesive substance, heat, or pressure" (Cambridge Dictionary, p. 43). The misconception on covalent bonding is an aspect of prior everyday knowledge of the term 'bond' that learners use in their everyday contexts. This finding corroborates with Halliday's (1993) study that found that scientific language is different from everyday English language, because scientific language is a unique language register with its own unique features. Furthermore, these unique language features of science pose an obstacle in communication between science teachers to science learners (Howes et al., 2014). I now present a vignette from the interview with Filly which was also based on how he understands covalent bonding. Filly responded that covalent bonding *"is a relationship between people"* as Figure 4.2.5 shows.

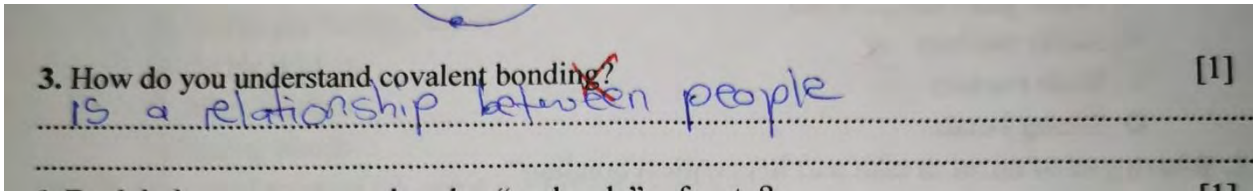

Figure 4.5: Extract of Filly's response on how he understand covalent bonding

When the learner was asked to elaborate more on what he meant about the response above, this is what the learner had to say:

Fly: *Okwali nda hala okutyaa… eshi ndi uditeko bonding okutya ekwatafano liwa pokati komunhu nomunhu ngaashi ngaashi ngeno ekwatafano liwa eli lilikala pokati kameme wange name.* (I wanted to say, the way I understand bonding is like a good relationship between a person and a person, for instance the bond between my mother and I)

Int: How did you understand the word covalent?

Fly: *Aaye kakwali ndi shiudite kutya otashiti ngaipi kaya* (No I did not understand the meaning of covalent)

Int: *Kuudite ashike kutya otashiti ngaipi nande nande?* (You did not understand it at all?)

Fly: uuh aaye… mbela ….

Int: But after the lessons on chemical bonding, do you now understand what covalent bonding is? *Oto dulu okushi fatululila nge?* (Will you be able to explain it to me?)

Fly: Yes Sir

Int: *Shi fatululile nge utale*. (Can you please explain it to me)

Fly: Ommh … covalent bonding … is … the sharing of electrons between atoms of non-metals to have full outershells.

Int: wow! This is wonderful!!!

The interview with Filly above suggests that the learner had a misconception of the concept of covalent bonding. The learner was confused between the everyday English word of "bond" and that of science. Unlike Monika, Filly knew the "bond" which is defined in the Oxford English Dictionary as "a relationship between people or based on shared feelings, interest, or

experiences" (1989, p. 81). This finding is similar to that of Gudyanga and Madambi (2014) who found that because everyday language is sometimes used in science classrooms, but with different meanings, this can lead to learners' misconceptions of science concepts.

In the interview with Mossy, I asked him to elaborate more on his answer he provided on question 4 that required learners to explain in their own words, what 'molecule' refers to. Figure: 4.2.5 shows how Mossy responded to the question in the diagnostic test:

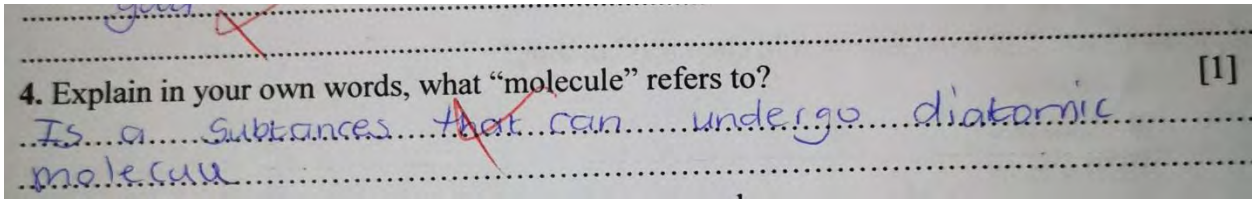

Figure 4.6: Extract of Mossy' response on how he explained what "molecule" refers to

I now present a vignette from the interview I held with Mossy which was based on his answer above.

Int: *Okwali wahala okutya ngaipi* (what did you mean)

Msy: *Okwali ndahala okutya eemolecule dimwe ohadi ufanwa eediatomic molecule* (I wanted to say some molecules are call diatomic molecules)

Int: *Oo … oto dulu oku pange o example yo diatomic molecule?* (Oo … are you able to give me an example of a diatomic molecule?)

Msy Example MgO

Int: So MgO is a diatomic molecule? Why?

Msy *Shaashi oya ningwapo keelement mbali* (because it is made up of two elements)

Int: *Owahala okutya shama o compound yaningwapo keelemente mbali ngaho o diatomic molecule?* (So you mean as long as a compound is made up of two elements it is a diatomic molecule?)

Msy: Yes Sir

From the excerpt of the interview above, it can be deduced that Mossy's prior knowledge on molecules contained misconceptions. Mossy thought that whenever a compound is made up of two elements, then it can be referred to as a diatomic molecule.

From all three interviews with learners above, it can be surmised that learners' prior knowledge contained misconceptions. According to Mavhunga and Rollnick (2013) and Mavuru and Ramnarain (2017), misconceptions lead to misunderstandings of new concepts if they are not addressed properly at an early stage. Therefore, teachers should identify learners' prior knowledge and misconceptions as early as possible because if learners lack understanding of chemical bonding at an early stage, they will find it difficult to pursue further studies in the field of chemistry (Tanen, 2011).

4.2.2.2 Stimulated recall interview based on the post-intervention test

In the first interview with Inge on the post-intervention test, I asked her to explain why in the first question she chose 'salt' as one of the molecules (see Appendix F2). The following excerpt is from an interview with her.

Ing: *Shaashi owati eemolecule odedi daningwapo kee non-metal da ninga ocovalent bonding* (Because you said molecules are those that are made of non-metals covalently bonded together)

Int: *Ashike omongwa ohau ningwapo ngeenge ometal no non-metal da bonding.* (But salt is usually made of a non-metal and a metal bonded together ionically)

Ing: *Oo … osho kwali shapukifnge osho* (Oo … that is what confused me)

Int: Oshike wafiilapo "oil"? (Why did you leave oil?)

Ing: *Uhh …. Opo aike andi dimbuluka paife kutya moclass owati eeliquid andishe eemolecule shaashi andishe oda ningwapo keenon-metals*. (Uhh … I am just remembering now that in the lesson you said all the liquids are molecules, because they are all made up of non-metals)

The interview with Inge above shows that some learners may know something, but due to being confused, they ended up losing marks on the post-intervention test. This is evident from the learner's responses during the interview. The learner stated that she chose salt because during the lesson the teacher said, *"Molecules are those that are made of non-metals covalently bonded together"*. It can be deduced that the learner did not know the nature of elements that usually bond to make up salt. When Inge was asked why she did not choose 'oil' she said: " *I am just remembering now that in the lesson you said all the liquids are molecules, because they are all made up of non-metals".* This shows that Inge knew what molecules are, but she was confused when she was writing the test.

The interview with Ndapewa was a very short one. I asked her to elaborate the answer she gave in question 6 that instructed learners to rewrite a sentence in their own words. This is how Ndapewa responded to question 6, as is shown in Figure: 4.7.

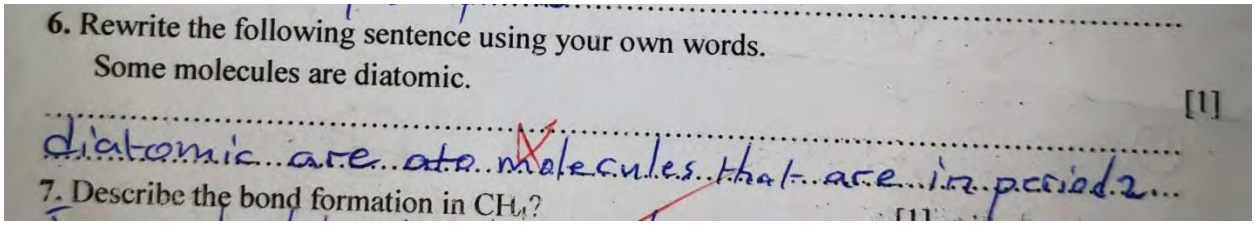
6. Rewrite the following sentence using your own words.
Some molecules are diatomic.
[1]
diatomic are ato molecules that are in period 2
7. Describe the bond formation in CH_4?

Figure 4.7: Extract of Ndapewa' response to question 6

I now present the whole interview with Ndapewa since it was very short.

Int: Good afternoon Ndapewa? I have a very short question for you.

Npw: Okay Sir

Int: Epulo 6 okwali talipula wu shangulule etumbulo miitya yoye mwene owashanga toti: "diatomic are molecules that are in period 2". Omolwashike watila ngaha?

Npw: *Kakwali ndeluudako nawa kaya Aaye epulo* (I did not understand the question well)

Int: *Paife ou li udite nee?* (Do you understand the question now?)

Npw: *Yes, diamolecule eemolecule edi daningwapo kuu aatom vavali vaninga obonding yo covalent* (yes diamolecules are those that are made up two atoms bonded together covalently)

Int: Oh good!!! You are correct. Thank you for you for clarifying and have a nice day.

Npw: Okay Sir have a nice day too Sir.

From this interview, it could be deduced that the leaner has a language barrier. This is because after the teacher had explained in the learner's home language what the question meant, the learner understood the question well. This is in line with Olaoye's (2013) study that found that science can be well acquired and better understood through teaching in learners' home languages since learners clearly understand the language in which the content matter is being presented. However, like in the case of Ndapewa, when learners are taught in their vernacular they get used to translations which leads to difficulties when answering tests and examination questions in English because there is no room for translation (Mavuru & Ramnarain, 2019).

In the interview with Mike, I asked him to explain the diagram he drew in question 2.b. The question asked learners to draw a diagram to show covalent bonding in chlorine (Cl_2) as the Figure 4.8 shows. Mike's diagram is shown in the extract below from his post-intervention test.

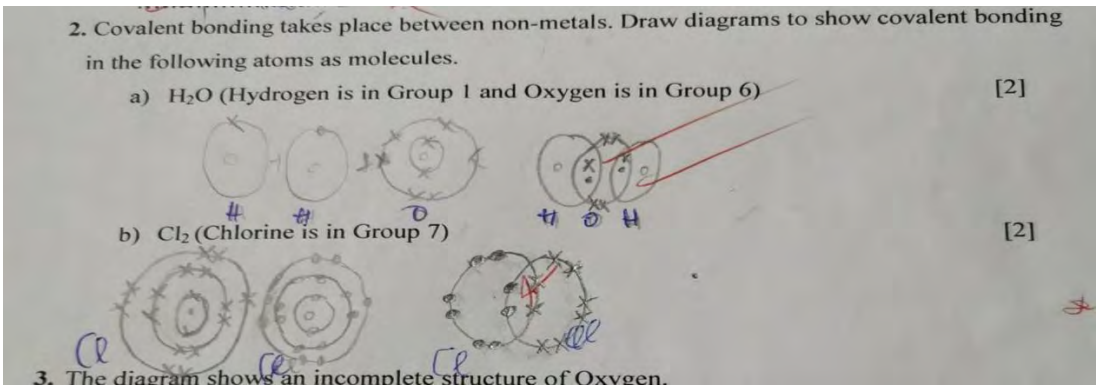

Figure 4.8: Extract of Mike's response on question 2. b)

When Mike was asked why he drew a molecule of chlorine (Cl_2) he seemed to not think there was anything wrong with the diagram until the teacher explained what was wrong. The following excerpt is from Mike' interview.

Mike: Ohoo…

Int: *Ouwete kutya onda hala okutya ngaipi?* (Are getting what I want to say?)

Mike: Yes Sir, *mboli inandi ku uda nawa eshi kwali to explain*. (Yes Sir, it seems like I did not understand you well when you were explaining)

Int: *Ondati ngaipi hano mo class?* (What did I say in the class?)

Mike: *Owati oshell yalast ohai yada kuu electrons veli 8 kekale kwaai yotete… maar okwali ndishi ondili mondjila shaashi keshe ko shell onda tula ko uulectrons vavali ... maar mboli avashe ovelilepo eeshell adishe*. (you said the last shell is full when it holds 8 electrons except for the first on that holds two electrons only … but I thought I was correct because I put two electrons on each shell … but now realised that all the electron inside the bond are for all atoms)

Int: *Okay, paife ouwete kutya epuko olili peni?* (Do you now see where the problem is?)

Mike: Yes Sir

Int: Paife oto dulu oku faneka ostructure yo Cl_2? (Are you now able to draw the structure of Cl_2?)

Mike: Yes sir

From the excerpt above it can be hypothesised that the learner did not understand how to draw covalent bond's structures. The learner knew that the outer shell of an atom is full when it contains eight electrons except for the first shell that holds two electrons only, but he did know how to draw it. In their study, Gudyanga and Madambi (2014) state that chemistry is dominated by the use of models which are sometimes complex, and it is these complicated models that are used in chemistry to explain chemical bonding that contribute to learners' misconceptions on the topic.

4.3 Discussion of the Quantitative and Qualitative Data

Prior to the intervention of code-switching from English and Oshikwanyama to mediate the concept of chemical bonding to Grade 8 learners, learners obtained an average score of 49%, with the lowest score of 20% and the highest score of 65% in the diagnostic test. This finding corroborates with Biemans and Simons (1996) who state that all learners tend to have some knowledge about a certain concept prior to entering a learning environment. In the same vein, Okanlawon (2012) argues that before learners are engaged in formal instructions they already

have information that they bring from previous interactions. The higher score of 65% may have arisen because these learners had learned about how atoms combine to form compounds in Grade 7, as the NSHE syllabus stipulates that Grade 7 learners should know that atoms combine to form compounds which are the building blocks of all materials (Namibia. MEAC, 2015). As a result, in this study many learners were able to score more that 40% which is the passing requirement of Physical Science. This gave me a clear picture of where to start with the intervention. This concurs with Campbell (2005) who states that it is important for teachers to identify what learners already know before they introduce them to a new concept, because prior knowledge act as mental hooks where new information and skills are lodged.

Notably, after the intervention the learners' marks increased. For instance, the average score increased from 49% to 64% with the lowest score of 40% and the highest score of 85%. This showed that the intervention had an influence on the learners' understanding of the concept of chemical bonding. This finding concurs with Ashofor et al. (2016) who accentuate that home language is more effective in learning than learning in any other language. Likewise, Olaoye (2013) accentuates that science can be well acquired and better understood through teaching in learners' home languages, since learners clearly understand the language in which the content matter is being presented. These findings are also similar to those of Msimanga and Lelliot (2014) who conclude that the use of learners' home languages for the purposes of engagement with difficult concepts creates opportunities for conceptual understanding for science learners. The standard deviation also showed that before the intervention the marks were distributed closer to the mean and post intervention the marks became widely spread as a result of a larger standard deviation. The results from a t-test showed that the significance level of the test was 0.05 used in a two tailed test. It can be concluded that there is a statistically significant difference between the two variable scores (diagnostic test and post-intervention test). In other words, the difference between the two variables was not equal to zero. Hence, the intervention had an influence on the sense making of the concept of chemical bonding.

The stimulated recall interviews on the diagnostic and post-intervention test revealed that learners had prior knowledge on the concept of chemical bonding. However, some of their prior knowledge contained some misconceptions. For instance, some learners confused the everyday English word 'bond' with that of science. This was revealed when they were asked to elaborate on their answers on how they understood the concept of covalent bond. This finding concurs with Gudyanga and Madambi's (2014) study that found that, because everyday language is

sometimes used in science classrooms but with different meanings, this can lead to learners' misconceptions of science concepts.

The results from stimulated recall interviews on the post-intervention test revealed that learners tended to understand instructions better when they were explained in their home language. This coheres with Mati's (2004) findings which state that code-switching can be regarded as an adaptable strategy which can be adopted by individual speakers in order to communicate more effectively. Teachers usually code-switch to learners' home language to transfer necessary knowledge to learners and clarify new information (Ahmedand & Josoff, 2009; Sert, 2005). The results also revealed that learners were finding it difficult to draw the structures of some molecules. To Bergqvist (2017), models are sometimes the reasons why learners find chemical bonding to be a demanding topic.

4.4 Chapter Summary

In this chapter, I provided the presentation, analysis and discussion of quantitative data from the diagnostic test and post-intervention test using the literature reviewed in Chapter Two. The findings of the study revealed that before the intervention learners had some prior knowledge of the concept of chemical bonding. However, data from the stimulated recall interviews revealed that some of the learners' prior knowledge contained some misconceptions. The findings also revealed that after the intervention the learners' performance in this topic improved. The result from the t-test also revealed that the difference between the diagnostic and post-intervention test was not equal to zero and it could be hypothesised that learners' home language had an influence on the learners' sense making of the concept of chemical bonding.

In the next chapter, I present, analyse and discuss qualitative data from lesson observations, learners' journal reflections and focus group interviews.

CHAPTER FIVE: OBSERVATIONS, JOURNAL REFLECTIONS AND FOCUS GROUP INTERVIEWS

5.1 Introduction

The main aim of the study was to explore affordances and hindrances when using learners' home language of Oshikwanyama to mediate learning of the concept of chemical bonding to Grade 8 Physical Science learners. In the previous chapter, I presented, analysed and discussed quantitative data from the diagnostic test and post-intervention test. A diagnostic test was used to gather data on the prior knowledge that Grade 8 Physical Science learners had on concepts of chemical bonding and also to inform my intervention. A post-intervention test was used for summative purposes in order to establish whether Grade 8 learners' home language enabled and/or constrained the mediation of the concept of chemical bonding. I also presented qualitative data from the stimulated recall interviews.

In this chapter, I thus present, analyse and discuss data generated from observations, journal reflections and focus group interviews. Data generated from these data gathering techniques aimed at addressing my research question two:

> How does the use of learners' home language in Grade 8 Physical Science lessons enable and/or constrain learner participation and sense making of chemical bonding?

In my discussion, I also link the findings to the theoretical framework and literature reviewed in Chapter Two.

5.2 Development of Sub-themes and Themes

Data generated from observation of three lesson presentations on chemical bonding using learners' home language as illustrated in Figure 5.2.1 below were analysed. In addition to observations, 17 learners' journal reflections were analysed as well as transcripts from the focus group interview with six learners. I used different data gathering techniques so that they could complement each other as well as for the purpose of triangulation. The observation

schedules were coded, for example, OSL1 for Observation Schedule for Lesson 1, OSL2 for Observation Schedule for Lesson 2 and OSL3 for Observation Schedule for Lesson 3. The learners' journal reflections were coded as L1JR1M for Learner 1 Journal Reflection 1 who is male and L13JR2F for Learner 13 Journal Reflection 2 who is female, and so on. The focus group interview was coded as FGIL1 for Focus Group Interview for Learner 1 and FGIL3 for Focus Group Interview for Learner 3 and so forth.

Figure 5.1: Shows learners during the lesson presentation of chemical bonding

Learners who participated in the focus group interview were selected by their peers based on reasons that they were active and on their ability to answer the questions in class. When I asked learners why they thought they were chosen by their peers, they revealed that they believed that they were chosen because their fellow learners trusted that they could answer questions freely. The total number of learners who took part in the focus group interview was six learners, three girls and three boys.

Figure 5.2: Shows learners taking part in a focus group interview

All the data from observation, journal reflections and the focus group interview were colour coded in order to identify sub-themes (see Appendix E). After checking for similarities and

differences from observation, journal reflections and the focus group interview, the sub-themes were created. These sub-themes were then combined into four themes as shown in Table 5.1 below.

Table 5.1: Shows the themes and sub-themes emerged from the qualitative data

Themes	**Sub-themes**	**Data source**
Learners' views and experiences toward learning of Science in Oshikwanyama and/or English	Disposition and interest of learners towards learning science through their home language	Focus group interview Journal reflections Observation
	Disposition and interest of learners towards learning science through English	
	Language for assessment (tests and examinations)	
Benefit of using learners' home language to teach the concept of chemical bonding	Enhance participation in the lessons	Focus group interview Journal reflections Observation
	Enhance understanding of the concept	
	Clear instructions and clear language for lesson presentation	
Hindrances of using learners' home language to teach the concept of chemical bonding	Teacher's language barriers	Focus group interview Observation Journal reflections
	Lack of vocabularies in learners' home language	
Other enablers and constraining factors of teaching and learning the concept of chemical bonding	More examples on the chalkboard	Reflection
	Teacher's subject content and pedagogic expertise	
	Many models in chemical bonding	

The four themes are described with supporting theory/literature as shown in Table 5.2.

Table 5.2: Themes and supporting theory/literature

Themes	**Theory/literature**
Theme 1: Learners' views and experiences toward learning of science in Oshikwanyama and/or English • Disposition and interest of learners towards learning Science through learners' home language • Disposition and interest of learners towards learning science through English • Language for assessment (tests and examinations)	Attallah et al. (2010), Shiota at el. (2006), Agunbiade (2015), Orujlou & Vahedi (2011), Bennett (2003), Mavuru & Ramnarain (2019)
Themes 2: Benefit of using learners' home language to teach the concept of chemical bonding • Enhance participation during the lessons • Enhance understanding of the concept • Clear instructions and clear language for lesson presentation	Ashofor et al. (2016), Nayfeld (2019), Olaoye (2013), Msimanga & Lelliot (2014), Weick, Sutcliffe & Obsteld (2005), Vygotsky (1978), (McLeod, 2014), Inohara's (2015), Kersaint et al. (2013), Sert's (2005), Mati (2004), Chikamori et al's (2019), Iipinge (2013), Denuga (2014); Kanime (2015), Nambahu (2017)
Themes 3: Hindrances of using learners' home language to teach the concept of chemical bonding • Teacher's language barriers • Lack of vocabularies in learners' home language	Olaoye (2013), Mashegoane (2017), Sugunasiri (1992), Mavurus & Ramnarain (2019), Fang (2004), Howes et al. (2014), Wolff (2019)
Theme 4: Other enablers and constraining factors of teaching and learning the concept of chemical bonding • More examples on the chalkboard • Teacher's subject content and pedagogic expertise • Many models in chemical bonding	Halliday (1993), Back (2014), Jandhyala (2017), Louis (2017), Kersaint et al. (2013), Nahum at el. (2010)

I now discuss each of the themes that emerged from the data in relation to the theory and literature. During the interpretation of data, I combined the findings, theory and literature.

5.2.1 Learners' views and experiences of learning science in Oshikwanyama and/or English

The concept of chemical bonding was taught using a strategy of code-switching between English and Oshikwanyama. During the three lesson presentations, observation was done by a critical friend who indicated that the language that was used the most was Oshikwanyama. As alluded to earlier, the lessons were aimed at exploring how learners' home language enables and/or constrains Grade 8 learners' sense making and participation in the topic of chemical bonding. The indicators for disposition as proposed by Attalah et al. (2010) were observed during the intervention. These indicators were observed in relation to the learners' ability to make sense of the concept of chemical bonding when learners' home language was used in the lessons, the attitude towards the use of learners' home language, and the expectations after learners' home language was used.

The critical friend observed that learners enjoyed being taught in their home language when learning chemical bonding. From the lesson observations (see Appendix E), it seems that the use of learners' home language in the science classroom influenced their disposition towards learning of science. The critical friend indicated that.

> *The overall lesson presentation was enjoyable. Learners were in the mood for the lesson and this was proven by the way they were actively participating. (OSL2)*
>
> *Learners enjoyed the lesson. Learners become more interested in the concept of chemical bonding and this was evident by the way they are participating in the lesson. (OSL3)*
>
> *Learners were excited and happy to take part in answering and asking questions during the lesson. (OSL1)*

The quotes above indicated that learners enjoyed and were happy to be taught in their home language. This could be an indication that they acknowledged the use of their home language in the science lessons. It could also be interpreted that the use of learners' home language positively influenced the dispositions of these learners towards learning the concept of chemical bonding. In light of this, Shiota at el. (2006) accentuate that positive dispositions are manifested by joy which is referred to as happiness.

In addition to observations, learners wrote journal reflections after each of the three lesson presentations on the concept of chemical bonding (see Section 3.3.4.3). Most learners reflected

in their journal reflections that they enjoyed the lesson and the lesson was lively. This is more evidence that learners' home language influenced learners' dispositions towards learning of chemical bonding as some learners indicated that they liked to be taught in Oshikwanyama and that the teacher should continue to teach in their home language.

For example, one learner stated that: *"Olesson ondi enjoya nawa you okwali in oshimwenyo oshikwanyama ondishi udite ko nawa lela"* (Translation: The lesson was live and enjoyable, I understand oshikwanyama well) (L1JR1M). Another learner indicated that: *"Otundi kakwali yasuwaka okwali yiwa yoo oyalongange shihapu kombinga yotopic"* (Translation: The lesson was not boring, it was very good and it taught me many things about the topic). *"I want the teacher to repeat that good thing of teaching us in Oshikwanyama every lesson"* (L2JR2F). Additionally, another learner commented on the third lesson that: *"Elongifo loshiwambo motundi yo Physical Science oshiima shiwa lela shaashi omunhu okwali ashike wu uditeko nawa"* (Translation: The use of Oshiwambo in Physical Science lesson is a good thing because I understood well) (L4JR3M).

The excerpts above indicated that the use of learners' home language positively influenced their dispositions. These findings are similar to that of Agunbiade et al. (2017) who finds that the enjoyment of learners in the science classroom is a positive view that shows the learners' positive disposition. Learners also indicated that they like science lessons in Oshikwanyama because they understand the language very well. Apart from journal reflections, learners were also interviewed in a group on their views about the use of their home language in Physical Science lessons. This is what some learners had to say:

> *Fimbo limwe ihandi kala ndiu diteko nawa kutya omulongi otati, nande efimbo limwe oshiima eshi tamu longwa oshipu ashike, ndee molwaashi kandi uditeko nawa oshiinglisha ohashikala ashike shidjuu* (Translation: Sometimes I do not understand what the teacher is saying, even though what the teacher is teaching is easy, but because I do not understand English things turn out to be difficult). (FGIL2)

> *Ngeenge haandi longwa moshiingilisha ohandi kala ngoo ndiu diteko, ashikengeenge omulongi afatulula moshiwambo ohandi kala ndiuditeko nawa unene shaashi oitya aishe ondi yuuditeko nawa* (Translation: When I am being taught in English I use to understand a little bit, but when the teacher explain in Oshikwanyama, I use to understand everything because I understand all the words). (FGIL3)

Learners stated that during the Physical Science lessons they understood the content well because they understand the language of instruction well. This is similar to the research study

by Orujlou and Vahedi (2011) who believe that the language of teaching and learning plays a role in the positive disposition of learners toward learning of new concepts. Moreover, these scholars state that when learners understand the language of instruction well their positive dispositions tend to increase.

Although some learners were satisfied by the intervention, there were also some who were not satisfied. For instance, some learners complained that when the teacher speaks in Oshikwanyama, they sometimes do not understand well and it can be confusing. Some said that the teacher taught well in English compared to when he was teaching in Oshikwanyma. In light of this, one learner reflected that: "*The home language is not good. When the teacher talks in the home language sometimes I cannot understand well*" (L13JR1F). Another learner stated that *"English makes me to understand Physical Science well, shaashi omulongi wetu okushi oku longa nawa moshiingilisha shidulife ngeenge ta longo moshikwanyama"* (Translation: Because our teacher knows to teacher well in English than in Oshikwanyama) (FGIL5). This showed that learners did not enjoy the lesson, which is an indication of a negative disposition toward the use of their home language in the science lessons. Bennett (2003) states that a negative disposition may demotivate learners to perform well academically.

Another learner reflected that that *"The teacher must teach in one language only, two languages confuses me a little. The teacher must speak English only"* (L15JR1M). This concurs with Mavuru and Ramnarain (2019) who in their study found that even though learners' home language facilitates their understanding of science concepts, African languages have limited science vocabulary. Consequently, this limits the translation between English and learners' home language which results in the distortion of meanings.

During the focus group interview, learners were asked how they found asking and answering questions in their home language (Oshikwanyama) during chemical bonding lessons. Learners revealed that:

> *Oshali shiwa unene oku pula noku nyamuka moshikwanyama, ashike uudjuu ouliaike apa ngeenge tokapulwa omapulo mo test ile mekonaakono oto mono ashike eshi tonyamukula omapulo moshikwanyama. oto kiihaluka ashike wadopa shaashi inolongifa elaka lopambelewa.* (Translation: It was a very good thing to ask and answer questions in Oshikwanyama, however the problem is when you will be asked to answer questions in a test or examination, you may end up answering in

Oshikwanyama. This will make you fail because you did not use the official language). (FGIL3)

Another learner said that:

> *Naame ohandi tu kumwe na Maria (pseudonym) shaashi ame kandi wete naana shiwa, shaashi otashi tuningi tuvandede ndee hatukala aike tuhole oku pulanokunyamukala moshikwanyama, omanga omapulo meetest nomekonaakono hama pulwa moshiingilisha.* (Translation: I am also agreeing with Maria (pseudonym) because I do not think is a good thing, because it is making us lazy that we will only want to ask and to answer questions in Oshikwanyama, while questions in tests and examinations are asked in English. (FGIL6)

From the excerpts above it could be deduced that even though learners' home language plays an important role in their understanding, some leaners felt that it might negatively affect their academic performance in the assessments. The findings are similar to that of Mavuru and Ramnarain (2019) who argue in their study that when learners are taught in their vernacular they get used to it which leads to difficulties when answering tests and examination questions in English. This is because the language policy for schools in Namibia (Namibia. MBSEC, 2003) states that assessments and examinations should be done through the medium of English except for the mother tongue that is taken as a subject.

5.2.2 Benefits of using learners' home language to teach the concept of chemical bonding

One of the benefits that emerged on the use of learners' home language was enhancement of learners' participation during science lessons. For instance, when learners were taught chemical bonding using the strategy of code-switching, they indicated that it is easy for them to ask questions using the language that they speak at home. This is what learners had to say:

> *Okupula nokunyamukala omapulo moshiwambo oshiima shiwa lela shaashi omunhu iho sekela vali nokwiipula kutya epulo ile enyamukulo otoli tula moshiingili ngaipi, oho pula ashike nokunyamukula wamanguluka.* (Translation: Asking and answering questions in Oshikwanyama is a very good thing, because you do not have to worry about how to put the answer or question in English, you just ask and answer freely). (FGIL4)

> *Okupula noku nyamukula moshikwanyama oshipu shaashi ngeenge to pula moshiinglisha oho kala vali to kondjifa oku tula iitya kumwe.* (Translation: To ask and answer questions in Oshikwanyama is easy, because when ask questions in English you have to struggle to put words together). (FGIL5)

From these excerpts, it could be hypothesised that the use of learners' home language afforded them an opportunity to ask and answer their questions freely during the science lessons. The critical friend also observed that: *"Learners were engaging freely with the teacher in Oshikwanyama. More questions were asked by learners which makes the teacher to explain more and in details"* (OSL2). This finding resonates with Iipinge (2013) who states that teachers code-switch to learners' home language in order to increase learners' understanding of challenging concepts and to enable communication. In support, Ashofor et al. (2016) allude that young indigenous learners' self-esteem is boosted when home languages are incorporated into the school curriculum and this effectively leads to learners' engagement in the learning process. In the same vein, Nayfeld (2019) posits that learners' engagement in the lessons makes it easier for teachers to clarify a misunderstanding of concepts and explain things in a better way to learners.

From the journal reflections, one learner echoed that: *"The lesson was nice, because we participate well"* (L13JR2F). Another learner also said: *"Lesson in home language is good, shaashi omunhu oho kala aike wamanguluka oku ponya nokupula omapulo"* (Translation: because you are free to speak and to ask questions) (L3JR3F). This resonates with Williams and Snively (2008) who accentuate that the development of home language is an important skill for communicating with the members of the community, because it boosts the understanding of knowledge.

Apart from enhancement of learners' participation during science lessons (Sedlacek & Sedova, 2017), enhancement of learners' understanding also emerged as a result of using learners' home language when mediating learning of the concept of chemical bonding. During the second lesson presentation, for instance, the critical friend observed that: "*Most of the learners showed that they understand the concept of chemical bonding by nodding their heads and showing excitement on their faces*" (OSL2). In the third lesson presentation, a similar observation was again made that: "*Most of the learners show that they understand the concept of chemical bonding by nodding their heads and showing excitement on their faces".*

From these excerpts, it could be surmised that learners made sense of the concept of chemical bonding when Oshikwanyama was used in the science lessons. This corresponds with Olaoye (2013) who propose that science can be well acquired and better understood through teaching in learners' home languages since learners clearly understand the language in which the content

matter is being presented. Correspondingly, Msimanga and Lelliot (2014) state that the use of learners' home languages for the purposes of engagement with difficult concepts might create opportunities for conceptual understanding to science learners.

When learners were asked in a focus group interview as to how they understood chemical bonding when they were taught in Oshikwanyama, one learner stated that: "*Ochemical bonding onde yuudako nawa"* (Translation: I understood chemical bonding very well) (FGIL1). When the teacher asked the same learner why she understood chemical bonding well, the learner explained: "*Because elaka eli lalongifwa ondilishi nawa* (Translation: Because I know well the language that was used). Another learner echoed the same sediments: "*Ame onde yuudako nawa shaashi oyalongwa melaka olo handi udu nawa loo nog ondi lihole* (Translation: I understand it well because it was taught in the language that I understand well and I like it). This is an indication that learners understood the concept of chemical bonding as a result of good communication that took place during the lessons when learners' home language was used to present the concept. In support of this argument, Weick, Sutcliffe and Obsteld (2005) conclude that communication is a central component of sense making of circumstances in which people collectively find themselves, and of the events that affect their understanding. These scholars further state that effective sense making takes place in the classroom when communication is involved, taking place in interactive talk and drawing on the resources of language.

According to Vygotsky's (1978) social-cultural theory, social interactions play a fundamental role in the development of cognition, because sense making is strongly influenced by the community in which individuals live (McLeod, 2014). Furthermore, Vygotsky proposes that sense making is a result of an internalisation of language which is an important mediational tool central to learners' sense making of the concept of chemical bonding. Vygotsky's (1978) theory resonates with what most of the learners stated in their journal reflections that: *"I understand chemical bonding well because I understand the language"* (see Appendix D3).

Learners' sense making during the lesson presentations of chemical bonding can be explained by making use of Ito and Inohara's (2015) conceptual model of sense making process. The model illustrates that learners were given an opportunity to experience a new concept of chemical bonding and tap into the cultural capital of their home language that they brought

from their homes and community (Chikamori et al., 2019). After learners made use of their home language, the outcome was better sense making of the concept.

Kersaint et al. (2013) posit that language is the primary tool in learning and for overall intellectual development of learners in the classroom. During the lesson presentations, learners were interacting between themselves and with the teacher in the science classroom. Learners' home language was used in the science classroom in order to help them move through their ZPD toward sense making of chemical bonding. Vygotsky (1978) explains that learning by children takes place through social interaction with a more knowledgeable other. This concurs with what learners stated that: *"Omulongi okwa longifa elaka nawa yee okushi oPhysical Science nawa opo shituningile shipu oku udako melaka letu eli hatupopi noshoyo melakapambelewa"* (Translation: The teacher used the language well and he knows Physical Science well and this made it easier for us to understand) (L10JR3F).

In this study, the learners indicated that the teacher for Physical Science knew the subject well which made the teacher the More Knowledgeable Other (MKO) who switched from English to learners' home language, in order to help them learn the concept of chemical bonding. In this study, learners moved through the ZPD from English as language of learning and teaching (LoLT) to their home language by means of mediation by the teacher who is regarded as the MKO (Mcleod, 2014).

These results from the observations also indicated that the use of learners' home language in science lessons makes instructions and lesson presentations clearer. Similar to Sert's (2005) study, when teachers code-switch between different languages, learners tend to get the necessary knowledge and clear instructions compared to when they are taught in a single language. To triangulate the results from the observations, learners also got an opportunity to express themselves through journal reflections and the focus group interview. For instance, one learner stated that:

> *Good, shaashi okwali ndi uditeko nawa iinima aishe ngaashi omalombwelo aeshe ndee naashi omulongi kwali talongo, iinima aishe okwali yayela nawa.* (Translation: Good, because during the lesson I understood everything for instance the instructions and lesson content, everything was very clear). (L17JR3M)

The excerpt above indicated that with the use of learners' home language, learners can clearly get the instructions and lesson content during the science lessons. It can be inferred that

learners' home language is an appropriate language for giving instructions and presenting lesson content to learners in science classrooms. In this regard, Mati (2004) explains that code-switching can be regarded as an adaptable strategy which can be adopted in order to communicate more effectively.

The enhancement of using learners' home language in the science classroom to enhance learners' participation, sense making of chemical bonding and to provide clear instructions and lesson content can be explained using Chikamori et al.'s (2019) Transformational Model of Education for Sustainable Development (TMESD). The TMESD framework emphasises the link between past, present, and future. The teacher used the past experience of indigenous language (Oshikwanyma) in order to promote the sense making of learners in the topic of chemical bonding. In this study, teachers smuggled the indigenous language (Probyn, 2009) into the classroom in order to transform the curriculum. As is shown by the results from the interviews, observation and journal reflections, learners seemed to have learned the concept of chemical bonding. This in the future as a retroductive learning process (Chikamori et al., 2019), will ensure that teachers and learners prioritise making use of learners' home language in science classrooms because they know it enhances the sense making of the learners.

According to Denuga (2014), Kanime (2015), and Nambahu (2017), code-switching between English and learners' home languages to teach science concepts was found to afford learners opportunities to understand concepts better, express their views better and also increased their participation.

5.2.3 Hindrances in using learners' home language to teach the concept of chemical bonding

One of the negative aspects that emerged from using learners' home language in science lessons was teachers' language barrier with the learners' home language. For instance, when the teacher was presenting the lesson on chemical bonding using Oshikwanyama, they were struggling to give clear lesson content to the learners, which led to learners' confusion during the lesson. From the lesson observation, it was found that when the teacher was giving instructions, asking questions and presenting the lessons, "*The teacher is finding it difficult to ask questions and give instructions in Oshiwambo only. The teacher is struggling with some words in Oshikwanyama that sometimes lead to confusion of learners"* (OSL1).

During the focus group interview, some learners also criticised the use of Oshikwanyama in the science lessons. One of the learners lamented that:

> *Okwali ndi uditeko nawa eshi omulongi talongo, ashike peembinga dimwe okwali handi hale oku ngwangwana shaashi omulongi okwali tanyengwa koshikwanyama.* (Transation: I understood well when the teacher was teaching, but at some point I almost got confused because the teacher was struggling with Oshikwanyama). (GFIL2)

This revealed that as much as teaching science in learners' home language promotes learners' understanding of science concepts, it is however a challenging task for some teachers. This suggests that teachers need to be empowered on how to teach in a second language whereby they use code-switching. Another learner echoed the same sentiments in the journal reflection about the views on the use of home language in the science lesson: "*The home language is not good for use by the teacher who did not learn that language as their subject. The teacher struggles too much"* (L14JR2F). These findings have affinity to Olaoye' (2013) study that found that the greatest challenges in the optimal utilisation of indigenous languages is that many do not have orthographies and those that are available are not well developed for literary use. In the same vein, Mashegoane (2017) concludes that indigenous languages are not developed to the extent of being used to present scientific concepts. Consequently, the underdevelopment of indigenous languages poses a challenge to learners as well as to science teachers, and this constrains learners from understanding science concepts.

Another constraining factor of using learners' home language in science classrooms has been that learners' home language lacks scientific vocabularies and this resulted in the teacher stammering when presenting the lessons. For instance, one learner stated that:

> *Ongaashi ashike vakwetu veshi popya nale, iitya imwe yomo shiingilisha kainaeemeaninga moshiwambo naashi okwali nee sha eta omulongi wetu akale talongonuundjuu mo lesson yee okwali takokoma unene ngeenge talongo moshikwanyama.* (Translation: Just like it was mentioned earlier by my colleagues, some words in English have no meanings in Oshikwanyama, and this made our *teacher* to really struggle in the lesson and he was stuttering too much). (FGIL4)

In support of the statement above, Sugunasiri (1992) explains that lack of terminologies in a language sometimes causes speakers to stutter because they have difficulty in finding the correct word to express ideas. To concur with this, Mavuru and Ramnarain's (2019) study that found that, even though learners' home language facilitates their understanding of science

concepts, it is however a challenging task to science teachers because they have limited vocabulary in African languages for scientific concepts. As a result, this limits the translation between English and the learners' home language which often leads to the distortion of meanings of science concepts. In like manner, another learner stated that: *"Uupyakadi umwe ulipo oyou kutya iitya imwe yomoshiinglisha oina omeaning imwe moshikwanyama"* (Translation: The problem is that some words in English have one meaning in Oshikwanyama) (FGIL5).

When the teachers asked the learners to give examples of those words this is what the learner had to say: "*Ngaashi toti carbon dioxide gas, moshikwanyama omhepo yo carbon dioxide ashike.so gas omhepo, air omhepo no wind omhepo, aishe moshiwambo omhepo ashike"* (Translation: For example carbon dioxide gas in oshikwanyama is omhepo, so gas is omhepo, air is omhepo and wind is omhepo too, so gas, air and wind are all omhepo in oshikwanyama) (FGIL5).

The excerpts above indicate that science language uses special words called technical vocabulary that indigenous languages do not have (Fang, 2004). Howes et al. (2014) state that technical vocabularies refer to the specialised and ordinary words with special meanings. Therefore, for this reason, Wolff (2019) concludes that indigenous languages are not a good fit when used as science mediums of instruction as they are not fully developed to express some of the scientific concepts. However, I do not agree with this, because most of the learners in their journal reflections and interviews stated that they understood everything when their home language was used during the lessons.

5.2.4 Other enablers and constraining factors of teaching and learning the concept of chemical bonding

In the science classroom, language alone cannot successfully make learners fully understand scientific concepts; this is because information in science is presented in an abstract manner (Halliday, 1993). In order to unpack abstract information and make learners understand what the information represents, teachers need to make use of many diagrams, models and equations when presenting the lessons for learners to make sense of the science concepts (Back, 2014). This was the reason why the teacher used diagrams of the atomic structure and chemical bonding as illustrated below.

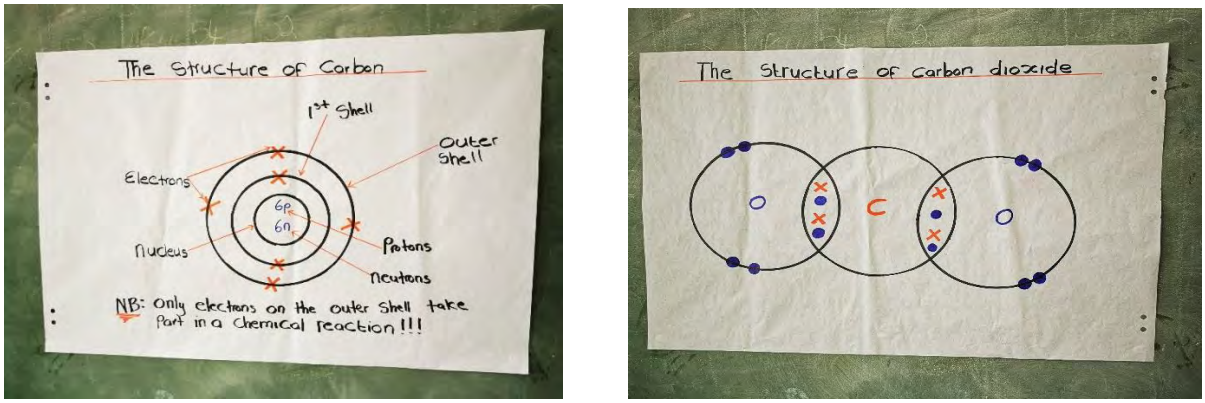

Figure 5.3: Shows atomic structure and chemical bonding diagram used during the lesson presentations

When learners were asked to say anything they wanted about the lesson in their journal reflections, one learner stated that: *"Omuhongi nakale hetupe iihopaenenwa ihapu opo tu udeko nawa"* (Translation: The teacher needs to give us more examples on how to draw atoms on the chalkboard, so that I would understand better) (L2JR1M).

This revealed that learners learn the topic of chemical bonding best when they are taught using many diagrams and examples. Another learner when asked what she thinks the teacher could have done to help her understand the topic, stated that: *"The teacher need to give us many many examples on the chalkboard nghene eebonding handi fanekwa"* (on how to draw bondings) (L7JR2M). From these quotes it can be deduced that visualisation plays a fundamental role in the way learners make sense of the concept of chemical bonding. In support of this, Jandhyala (2017) accentuates that it is important for teachers to use visuals in science classrooms, because it helps learners to better learn new concepts and to remember what they have been taught. In addition, Louis (2017) predicts that most learners, approximately 65%, are visual learners. Therefore, she further concludes that it is important to use visuals in science teaching because it increases the learning potential of large groups of learners in science classrooms.

The learners also stated that the lessons were good because they understood the topic of chemical bonding due to the fact that the teacher knows how to teach the subject and is well equipped in terms of the subject content of Physical Science. This is what some of the learners had to say: *"The lesson is good to me because Mr. Shilongo he know how to teach"* (L4JR2M) and *"I got more education, Shaashi (because) Mr. Shilongo he knows how to teach well"* (L7JR1F).

As it can be seen from the excerpts above, learners had learned the topic of chemical bonding through interacting with the teacher who is regarded as a more knowledgeable other. During the focus group interview, another learner said: *"The teacher knows to teach and he knows physical science well"* (FGIL3). This concurs with Vygotsky's (1978) SCT that emphasises that learning by children takes place through social interaction with a more knowledgeable other. During the lesson presentations the teacher and learners interacted with each other using the language of Oshikwanyama in order to mediate the learning of chemical bonding. For instance, one learner stated that: "*Mr Wilhelm you teach so nice, bonding is a thing that is easy, I don't think there is anyone who will fail this. Thank you for Oshikwanyama"* (L9JR1F). In support, Kersaint et al. (2013) propose that language is the primary tool for learning and the overall intellectual development of learners in the classroom.

One constraining factor that emerged from data was that learners find the topic of chemical bonding difficult because it consists of many models and rules when drawing the structure of chemical bonding. Halliday (1993) states that information in science is presented in an abstract way in which some information and ideas are omitted, generalised and decontextualised. In the journal reflections, one of the learners stated that: "*Inandi udako nawa shaashi otopika oina iinima ihapu yoo oina eemango nomafano mahapu* (Translation: I did not understand well the topic because it has many things and many rules as well as many pictures) (L1JR1M). From this quote, it can be deduced that learners find the topic of chemical bonding difficult because it consists of highly abstract concepts such as covalent bonds, molecules, and hydrogen bonds (Nahum at el., 2010).

5.3 Chapter Summary

In this chapter, I provided the presentation, analysis and discussion of data generated from classroom observations, learners' journal reflections and focus group interviews. The findings of the study revealed that learners better understood the concept of chemical bonding when their home language was used in the science classroom. It is evident that using learners' home language in a Physical Science classroom has the potential to enhance learners' participation and sense making and it provides clear instructions to learners. Even though the data revealed that there are some challenges facing the teaching and learning of science concepts in learners' home language, learners showed a positive disposition and interest towards learning science

through Oshikwanyama. In the next chapter, I present the summary of findings, recommendations and the conclusion.

CHAPTER SIX: SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

6.1 Introduction

In the previous chapters (Chapters Four and Five), I presented, analysed and discussed the data generated from the diagnostic test, post-intervention test, lesson observations, learners' journal reflections, focus group interviews and stimulated recall interviews. In this chapter, I present a summary of findings from my study and provide some recommendations thereof. The limitations of this study and my personal reflections are also presented.

6.2 Overview of the Study

The aim of the study was to explore the affordances and hindrances when using Grade 8 learners' home language to mediate learning of chemical bonding. To achieve the aim, the following research questions were addressed:

1. What prior knowledge do Grade 8 Physical Science learners have on the concept of chemical bonding?
2. How does the use of learners' home language in Grade 8 Physical Science lessons enable and/or constrain learner participation and sense making of chemical bonding?

To answer these two research questions, I used a number of data gathering techniques. I used the diagnostic test, post-intervention test and stimulated recall interview to answer research question 1. These data gathering techniques helped to identify Grade 8 learners' prior knowledge they brought to the classroom from previous grades. The data generated from research question 1 were presented, analysed and discussed in Chapter Four. For research question 2, I used observations, journal reflections and a focus group interview and the data were presented, analysed and discussed in Chapter Five. These data gathering techniques helped me to find out how learners' home language affords and/or hinders Grade 8 learners' sense making of the concept of chemical bonding.

6.3 Summary of Findings

The data were gathered and analysed in order to answer my two research questions. Therefore, I present the summary of the findings in relation to each research question as illustrated below. I start with research question 1:

Research Question 1

> What prior knowledge do Grade 8 Physical Science learners have on the concept of chemical bonding?

As stated earlier in Section 4.2.1, a diagnostic test was administered before an intervention of code-switching between English and learners' home language to mediate the concept of chemical bonding to Grade 8 learners. The aim was to get an insight into learners' prior knowledge they brought with from previous grades and to inform the intervention. After the intervention, learners wrote a post-intervention test in order to assess the overall achievement of the learners after their home language was used to mediate the concept of chemical bonding.

The results showed that even though learners' marks were lower in the diagnostic test compared to the marks in the post-intervention test, learners had prior knowledge (Okanlawon, 2012) on the concept of chemical bonding. For instance, 47% of 17 learners who wrote a diagnostic test scored above 50%, 47% of 17 learners scored between 35%-55% and only 6% of 17 learners scored 20%. Learners' average of 49 % in the diagnostic test also showed that learners brought with them more prior knowledge from previous grades. It can be surmised that learners made sense of the concept of chemical bonding better during the intervention when using learners' home language. This is because Campbell and Campbell (2008) state that learners who have enough prior knowledge make use of them, enabling them to excel in subject areas better when compared to those who have less prior knowledge of the concept.

After the intervention, learners obtained an average of 64% in the post-intervention test compared to 49% average they obtained in the diagnostic text. This indicated that there was a shift of 15% between these two tests. In the diagnostic test, three learners (18%) scored less than 40%, while in the post-intervention test all 17 learners scored more than 40%. This suggests that all learners passed the post-intervention test because The Namibian Curriculum for Basic Education (NCBE) stipulates that 40% is the pass rate for learners in Physical Science. The results also showed that no learner scored above 70% in the diagnostic test,

however, nine learners (53%) scored above 70% in the post-intervention test. Two learners (12%) managed to score 80% and above in the post-intervention test. Hence, it could be inferred that the intervention of code-switching between English and learners' home language had an influence on the learners' sense making of the concept of chemical bonding.

The sample standard deviation calculated from the two test results showed that the standard deviation for the diagnostic test was 11.86 while the sample standard deviation of the post-intervention test was 13.01. This indicates an increase of 1.15 in sample standard deviation of the two tests. This suggests that learners' diagnostic marks were distributed closer to the mean while learners' post-diagnostic test marks were distributed more widely. This resonates with Connolly's (2007) findings that state that the larger the standard deviation the wider the distribution is spread.

Even though the result from the diagnostic test revealed that Grade 8 learners had prior knowledge on the concept of chemical bonding, the result from the stimulated recall interview however revealed that learners' prior knowledge contained misconceptions. Learners confused everyday English words of 'bond' with that of science. For instance – 'bond' for connection between two objects joined together by adhesive substance and 'bond' – for relationship between people. Gudyanga and Madambi (2014) state that everyday language is sometimes used in science classrooms, but with different meanings, which leads to learners' confusion about science concepts.

From the stimulated recall interviews on the post-intervention test, it was found that learners had English language barriers. This was evident from the learners' responses that they understood the instructions and questions better when their home language was used to explain them (Olaoye, 2013). To put it differently, when the teacher used learners' home language to explain the same question that the learners had failed in the post-intervention test which was administered in English, learners understood the questions well. Therefore, code-switching can be regarded as a teaching strategy that teachers can use to communicate with learners more effectively (Mati, 2004). Learners did not understand the questions in the test, because during the test there was no room for translating the test questions from English to learners' home language, which caused learners to not understand the questions well (Mavuru & Ramnarain, 2019). The drawing of chemical bond diagrams was also a problem that emerged from the

stimulated interviews; this was because chemistry uses models that are sometimes complicated to explain chemical bonding (Gudyanga & Madambi, 2014).

Research Question 2

> How does the use of learners' home language in Grade 8 Physical Science lessons enable and/or constrain learner participation and sense making of chemical bonding?

The aim of this research question was to find out how learners' home language of Oshikwanyama affords and/or hinders Grade 8 learners' sense making of the concept of chemical bonding. Three lessons were conducted that were observed by the critical friend. Learners wrote journal reflections after each lesson presentation. After all three lesson presentations and after learners wrote a post-intervention test, six learners took part in a focus group interview.

The findings revealed that learners enjoyed and were happy to be taught in their home language. This could be an indication that learners' home language positively influences their disposition toward learning of the concept of chemical bonding. For example, the critical friend observed that: *"Learners were excited and happy to take part in answering and asking questions during the lesson"* (OSL1). This resonates with Shiota at el. (2006) who state that a positive disposition is manifested by happiness. Furthermore, some learners indicated that they liked to be taught in their home language because it made the lessons more enjoyable as they understood the language very well. These findings are similar to that of Agunbiade et al. (2017) who found that the enjoyment of learners in the science classroom is a positive view that shows that learners had positive dispositions. Learners stated that during the Physical Science lessons they understood the content well because they understood the language of instruction well. This resonates with Orujlou and Vahedi's (2011) study's findings that teaching and learning plays a role in learners' positive dispositions toward the learning of new concepts.

Another finding discovered that some learners preferred to be taught in one language only, specifically English. Some learners said the teacher taught well in English compared to when he was teaching in Oshikwanyama. This showed that learners did not enjoy the lesson, which is an indication of a negative disposition toward the use of their home language in science lessons. This negative disposition may demotivate learners from performing well academically

(Bennett, 2003). Some learners also stated that the use of Oshikwanyama in science classrooms might negatively affect their academic performance in the assessment. In support of this, one learner stated that: *"It is making us lazy that we will only want to ask and to answer questions in Oshikwanyama, while questions in tests and examinations are asked in English"* (FGIL6). The findings are similar to that of Mavuru and Ramnarain (2019) who argue in their study that when learners are taught in their vernacular, they get used to it which leads to difficulties when answering tests and examination questions in English.

Moreover, the study findings indicated that the use of learners' home language in science classrooms enhanced learners' participations during lesson presentations, which also enhanced learners' understanding of the concept of chemical bonding. For instance, during the focus group interview one learner stated that: *"Asking and answering questions in Oshikwanyama is a very good thing, because you do not have to worry about how to put the answer or question in English, you just ask and answer freely"* (FGIL4). When another learner was asked how she understood chemical bonding when she was taught in Oshikwanyama, she stated that: "*I understood the chemical bonding very well, because I know well the language that was used"* (FGIL1). This resonates with Iipinge (2013) who states that teachers code-switch to learners' home language in order to increase learners' understanding and to enable effective communication in the classroom. Additionally, sense making of chemical bonding is a result of an internalised language that learners understood well, because language is an important mediational tool central to sense making of new concepts (Vygotsky, 1978).

These results from the observations also indicated that the use of learners' home language in science lessons made instructions and lesson presentations clearer. To triangulate the results from observation with that from journal reflections and the focused group interview, one learner stated that: *"I understood everything for instance the instructions and lesson content, everything was very clear"* (L17JR3M). From this excerpt, it could be inferred that learners' home language is an appropriate language for giving instructions and presenting lesson content to learners in science classrooms. Correspondingly, Mati (2004) accentuates that code-switching can be regarded as an adaptable strategy which can be adopted in order to communicate more effectively. To put it differently, code-switching between English and learners' home language was found to afford learners opportunities to understand the concept of chemical bonding better, express their views better and increase their participation in the science classroom (Denuga, 2014; Kanime, 2015; Nambahu, 2017).

Even though the study found that learners' home language in science classrooms afforded Grade 8 learners an opportunity to learn the concept of chemical bonding, some hindrances when using learners' home language to teach the concept of chemical bonding also emerged. The study's findings indicated that the teacher was struggling to give clear lesson content to the learners, because the teacher had a language barrier with the learners' home language. One learner stated that: "*The home language is not good for use by the teacher who did not learn that language as their subject. The teacher struggles too much"* (L14JR2F). This finding has affinity to Mashegoane's (2017) study that found that indigenous languages are not fully developed to be used to present scientific concepts which can lead to misunderstandings of science concepts.

The study also found out that learners' home language lacks scientific vocabularies and as a result, the teacher was stammering when presenting the lesson. This finding is similar to that of Sugunasiri' (1992) study that found out that lack of terminologies in a language sometimes causes the speakers to stutter because they have difficulty in finding the correct word to express ideas. It was also found that some words in English have one meaning in Oshikwanyama, for instance one learner gave examples of the words that: *"For example carbon dioxide gas in oshikwanyama is omhepo, so gas is omhepo, air is omhepo and wind is omhepo too, so gas, air and wind are all omhepo in oshikwanyama"* (Translation: For example gas, wind and air are all refered to as omhepo in oshikwanyams) (FGIL5). This is because indigenous languages do not fit to be used as science medium of instruction as they are not fully developed to express some of the scientific concepts (Wolff, 2019). However, I do not agree with this, because most of the learners in their journal reflections and interviews stated that they understood everything when their home language was used during the lessons.

The findings from this study also revealed that language alone cannot successfully make learners fully understand complex scientific concepts such as chemical bonding. This was revealed by learners in their journal reflections, for instance one learner stated that: *"The teacher needs to give many many examples on the chalkboard on how to draw bondings"* (L7JR2M). From this excerpt it can be hypothesised that visualisation is central to Grade 8 learners' sense making of the concept of chemical bonding. Therefore, Louis (2017) concludes that it is important for teachers to use visuals in science classrooms, because it can boost the learning potential of a large group of science learners up to approximately 65%. The study also revealed that the teachers' subject expertise played a role in the learners' sense making of the

concept of chemical bonding. For example, one learner reflected that: *"The teacher knows to teach and he knows Physical Science well"* (FGIL3). This concurs with Vygotsky's (1978) social-cultural theory that emphasises that learning by children takes place through social interaction with a more knowledgeable other.

There was one constraining factor that emerged from data. The data revealed that learners found the topic of chemical bonding difficult because it consists of many models and rules when drawing the structure of chemical bonding. Some learners stated that they did not understand the topic well because it has many rules and many pictures. This finding resonates with Nahum at el.'s (2010) findings that state that the learning of chemical bonding is difficult because it consists of highly abstract concepts such as covalent bonds, molecules and hydrogen bonds.

6.4 Recommendations

Based on the findings of this study, I recommend that teachers should always find out learners' prior knowledge before they introduce new concepts to science learners. This allows the teachers to identify misconceptions learners might have so that they can address them before learners are introduced to new science concepts. Furthermore, teachers should be aware that misconceptions about a certain concept leads to misunderstandings of new concepts (Sedlacek & Sedova, 2017). Moreover, I recommend that whenever science words have another meaning in different contexts, teachers should emphasise the differences between the scientific meaning and everyday English meaning. This will help to correct the misconceptions learners might have on the concept under study (Gudyanga & Madambi, 2014).

I also recommend that learners' home language should be incorporated into Physical Science lessons, especially when the teacher is teaching challenging concepts such as chemical bonding. This is because the learners' home language influences learners' positive disposition towards learning of chemical bonding. Furthermore, learners' home language helps learners understand better and boosts learners' participation during the lessons. Additionally, since teachers struggle with teaching in learners' home language, I also recommend that teachers should get training on how to use learners' home language in science classrooms.

6.5 Area for Future Research

I recommend that this research could be extended on the same topic this study addressed. However, it could be done by exploring ways that science teachers can be helped in order to be able to effectively mediate learning of the concept of chemical bonding in Grade 8 using learners' home language. This is because one of the findings of this study revealed that learners' home language has the potential to enhance learners' participation and understanding of science concepts, however, teachers found it difficult to use learners' home language in science lessons which sometimes led to confusion for Grade 8 science learners.

6.6 Limitations of the Study

The study was limited to 17 Grade 8 Physical Science learners at Omega Combined School (pseudonym), who all speak and understand the same home language (Oshikwanyama). I could have used a larger group of Grade 8 learners, for instance, the whole class group of 33 learners, but it was not possible due to COVID-19 regulations that emphasise social distancing. Hence, the research findings cannot be generalised to all Grade 8 Physical Science learners in the whole region or country. However, some knowledge and insights on how Grade 8 Physical Science learners made sense of the concept of chemical bonding when learners' home language was integrated in lessons, were obtained from this study.

6.7 Personal Reflections

In the final year of my honours degree in 2018, it was a requirement for me as an honour's student to do a mini research proposal. As a science degree honour's student, I was afforded an opportunity to come up with three possible research titles. The three research titles were based on 'prior knowledge', 'Indigenous knowledge (IK)' and 'language in science'. Based on how well students formulated one of the three research tittles, we were then divided into three groups.

I was placed in the group for 'language in science' because I formulated an interesting research topic about language in science. My proposed research topic was: An investigation on how lexical density in formative and summative assessments enables or constrains learners' performance in the topic of chemical bonding in Grade 10 Physical Science'. This indicates that I was interested in exploring why learners perform poorly in the topic of chemical bonding and this is evident in this study as I explored the affordances and hindrances of using Grade 8 learners' home language to mediate the concept of chemical bonding.

Through the process of doing a mini-research proposal on the aforementioned topic and given the fact that I always obtained good marks on the mini-research assignments, I developed an interest to do my master's in Science Education. Consequently, I applied to study for my master's degree because I wanted to continue with the research topic that I did on the mini-research proposal. Unfortunately, I was rejected due to the lecturer's capacity for the year 2019-2020 and told that I should apply for the 2021-2022 intake.

This did not sit well with me and I must say I was very disappointed, because I wanted to strike the master's degree while the iron was still hot from my honours degree. What should I do? My study colleagues were admitted to do their master's and I was left alone. I approached Sabina Hashondili, whom I regard as my big sister and explained my problem to her. She told me to *"just ask Prof Ken and Zuki to take you in, those two are very good people I am sure they will just take you".* That is what I did and one very blessed morning I received an email of hope from Prof Ken, and the most interesting part of the email was: "*after a long deliberation between Zuki and I, we decided to take you as our master's degree student".* This was the beginning of my research journey.

My research journey was a bit challenging, however, it was quite a rewarding experience. For instance, it was challenging to abandon the research topic that I did for my honours degree and come up with a new research topic and the relevant theory to be used in the study. It was also challenging to obtain relevant and up to date literature, and to decide how to analyse my data. Nonetheless, the spirit of Ubuntu, which is characterised by members of a society helping each other in order achieve a common goal, by my two supervisors (Prof Ken and Dr Nhase) and my fellow scholars made it possible for me to overcome such anxiety.

I thought studying for a master's degree would be an easy exercise which was not the case. The whole process required a lot of time and critical thinking in order to make all the parts of the thesis talk to each other. Being a full time teacher, it was not easy to strike the balance between my study and my school related activities. However, I was always reminded by Dr Nhase that "*we must keep the momentum".* The COVID-19 pandemic also negatively affected my study. I was supposed to gather my data around May 2020, but due to the closure of all the schools in the country I ended up collecting my data in September when the schools reopened. It was also a challenge to reduce the number of my research participants in order to observe the COVID-19 protocol of social distancing. Learners were traumatised due to COVID-19,

however, I managed to counsel them and their responses throughout the research process were satisfactory.

The study made me realise the importance of using learners' home language in teaching challenging science concepts. This was based on how learners responded in their journal reflections, stimulated recall interviews and focus group interview. I learned that learners' home language stimulated learners' interest in learning new concepts and enhanced learners' understanding and participation during the science lessons. This is similar to Vygotsky's (1978) social-cultural theory which states that language is central to mediation of knowledge through social interaction.

6.8 Conclusion

In this chapter, I provided a summary of the research findings. My first research question revealed that learners had prior knowledge on the concept of chemical bonding, however, their prior knowledge contained misconceptions that led to learners' confusion. Moreover, the main findings of the study concluded that learners' home language had an influence on their dispositions toward learning of chemical bonding, enhancing sense making and participation of learners in the science classrooms. Additionally, the study also concluded that learners' home language stimulated learners' interest in learning new concepts and enhanced learners' understanding and participation during the science lessons.

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Appendices

Appendix A: Ethical Clearance

Human Ethics sub-committee
Rhodes University Ethical Standards Committee
PO Box 94, Grahamstown, 6140, South Africa
t: +27 (0) 46 603 8055
f: +27 (0) 46 603 8822
e: ethics-committee@ru.ac.za

www.ru.ac.za/research/researchethics
NHREC Registration no. REC-241114-045

28/04/2020

Prof Kenneth Ngcozo

Email: k.ngcozo@ru.ac.za

Review Reference: 2020-1154-3438

Dear Prof Kenneth Ngcozo

Re: Exploring affordances and hindrances when using Grade 8 Physical Science learners' home language to mediate learning of chemical bonding

Principal Investigator: Prof Kenneth Ngcozo

Collaborators: Mr Wilhelm NShilongo

This letter confirms that the above research proposal has been reviewed by the Rhodes University Ethical Standards Committee (RUESC)– Human Ethics (HE) sub-committee and **PROVISIONALLY APPROVED PENDING GATEKEEPER PERMISSION**.

Gatekeeper permission is required from:

a) Department of Education Oshana Region - Namibia

Once the Gatekeeper permission letters have been received please forward it to the Ethics Coordinator, (s.mangele@ru.ac.za) in order to finalize your ethics approval.

Sincerely,

Prof Arthur Webb

Chair: Human Ethics Sub-Committee, RUESC - HE

Appendix B: Gate Keepers Permission

Appendix B1: Directorate letter of consent

REPUBLIC OF NAMIBIA
OSHANA REGIONAL COUNCIL
DIRECTORATE OF EDUCATION, ARTS AND CULTURE
ASPIRING TO EXCELLENCE IN EDUCATION FOR ALL

Tel: 065 - 229800/25
Fax: 065 - 229834

Private Bag 5518
Oshakati

Enquiries: Hileni M Amukana

To: Wilhelm N. Shilongo
P. O. Box 3462
Ongwediva
Cell: 0813934377

SUBJECT: PERMISSION TO CONDUCT RESEARCH IN OSHANA REGION

Your letter dated 29 April 2020 on the above caption bears reference.

[redacted]nformed that permission is hereby granted to conduct research study at [redacted] Combined School in Oshakati Circuit, Oshana Region.

This permission is subject to the following strict conditions; **(i)** There should be minimal or no interruption on normal working schedule **(ii)** Ethical issues of confidentiality and anonymity should be respected and retained throughout this activity i.e. Voluntary participation, and consent from participant.

Both Parties should understand that this permission could be revoked without explanation at any time.

Furthermore, we humbly request you to share with us your research findings with the Directorate of Education, Arts and Culture Oshana Region. You may contact Mrs. Hilma Nuunyango, the Acting Deputy Director; Programs and Quality Assurance (PQA) for the provision of summary of your research findings.

We wish you the best in conducting your study.

Yours sincerely,

OSHANA REGIONAL COUNCIL
DIRECTORATE OF EDUCATION, ARTS & CULTURE
05 MAY 2020
Private Bag 5518 OSHAKATI
REPUBLIC OF NAMIBIA

for HILENI M. AMUKANA
REGIONAL DIRECTOR

Cc: Inspector of Education, Oshakati Circuit
The Principal, Ondjodjo Combined School.

All Official Correspondence must be addressed to the Regional Director

Appendix B2: Principal letter of consent

Ministry of Education, Arts and Culture

[redacted]hakati Circuit

Oshana Education Region

Enq: [redacted] 30 April 2020
0812859381

To: Mr. Wilhelm Shilongo

PERMISSION TO CONDUCT THE EDUCATIONAL RESEARCH GRANTED

It is with sincere privilege that your request to conduct the educational research, **to explore with the Grade 8 learners and Life Science teacher the affordance and hindrances when using learners' home language to mediate Grade 8 Physical Science chemical bonding** is granted.

You are therefore reminded that your research should not interrupt the usual teaching and learning.

Wishing you all the best in conducting your research

Yours faithfully

J[redacted]
Principal

[redacted]

30 APR 2020

TEL [redacted]

Appendix C: Consent Letters

Appendix C1: Critical friend's consent letter

Rhodes University

Drosty Road

Grahamstown

6139

04 May 2020

Dear Research Participant

Re: Request for permission to be a critical friend in the educational research.

Thank you for agreeing to be a critical friend in my study. As per our discussion, my research focus is to explore on how the use of learners' home language impacts Grade 8 Physical Science learners' participation and sense making of the topic of chemical bonding, that will take about one week of June 2020 in the afternoon after school.

The study involves an intervention of teaching the topic of chemical bonding using learners' home language. Before the intervention, learners will be given the diagnostic test to evaluate their prior knowledge on the topic of chemical bonding. After the pre-test, an intervention will be done which is the teaching of the topic of chemical bonding using learners' home language, and you will assist me with observing (using behavior checklist) and video-recording all the three lessons, and we will also analyse the video together after the lesson presentations. Learners will be required to write reflections after every lesson which will form part of the data. A post-intervention test will be conducted to evaluate the learners' progress after the intervention. Six learners will be selected to take part in the focus group interview and stimulated recall interview.

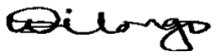
Your participation in this research study is completely voluntary and you have the right to withdraw at any time without prejudice. The data to be collected in this study will be published as a Rhodes University thesis. Your identity, views or contributions will be treated with a high degree of anonymity. There are no incentives and rewards for participating in the study.

This research has been approved by both the Rhodes University Ethical Standards Committee and the Education Department Higher Degrees Committee. During the research any concerns may be directed to Mr Siyanda Manqele, Ethics Coordinator, Research Office, Rhodes University +27 (0) 46 603 7727, s.manqele@ru.ac.za.

Please feel free to conduct me at 0813934377, willyshilongo@gmail.com or my supervisors Prof Kenneth Ngcoza K.Ngcoza@ru.ac.za and Ms Zukiswa Kuhlane z.kuhlane@ru.ac.za for further enquiries.

If you agree to participate in my research, please complete and sign the attached confidentiality agreement and consent declaration form.

Yours sincerely,



_____

Wilhelm N. Shilongo (17S8186)

CONFIDENTIALITY AGREEMENT FORM

(Please complete the declaration below)

I_____ (full name of the teacher), the Natural Science

teacher at _____(name of the school) hereby come to an agreement that I will treat all the data gathered from the research project to be conducted by Mr. Wilhelm N. Shilongo with confidentiality at all the times during the data collection process and data presentation process.

_____ _____

Teacher's Signature Date

CRITICAL FRIEND' CONSENT FORM

(Please complete the declaration below)

I_____ (full name of the teacher), the Natural Science

teacher at _____(name of the school) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project to be conducted by Mr. Wilhelm N. Shilongo. I understand that it is my liberty to withdraw from the project at any time.

_____ _____

Teacher's Signature Date

Appendix C2: Parents' consent letter (English)

Rhodes University

Drosty Road

Grahamstown

6139

04 May 2020

Dear Sir /Madam

Re: Request for permission to conduct educational research with your learner

My name is Wilhelm N. Shilongo a part-time Master student in Education with a student No: 17S8186, at Rhodes University. My research focus is to explore affordances and hindrances when learners' home language is used to mediate chemical bonding Grade 8 Physical Science learners' participation and sense making of the topic of chemical bonding. Therefore I am writing this letter with the purpose of providing important information regarding the study and formally request your consent for your learner to take part in the study that will take about one week of June 2020. I am also asking for your permission to reuse the data that will be gathered in this study, in another research study, that goes beyond the scope of this application.

The data collection process involves learners' participation and sense making of the topic of chemical bonding; therefore each learner will be required to write a diagnostic tests, a post-intervention test, journal reflections. Six learners will be selected to take part in the focus group interview and stimulated recall interview. The study will be conducted in the afternoon, after school in order not to interfere with normal running school activities. Furthermore, your learner will be expected to adhere to the rules for classroom interaction during this research that I have attached to this letter.

All the three lessons will be video-recorded by the critical friend who will also be carrying out an observation using a behaviour checklist. There are no foreseeable risks involved in participating in the study. The study will benefit your learner as he or she might understand the

concept of chemical bonding better. In addition, the study would also help science teachers to inform their own teaching practice.

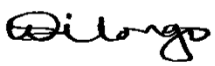
The participation of your learner in this study is strictly optional, and at own personal discretion. If you agree for your child to take part in this study, you still have the right to withdraw him or her from the study at any point without explanation. While every effort will be made to ensure that your child participation in the research is anonymous and the learner's identity is not revealed, this cannot be guaranteed. Please note: Learners who do not wish to take part in this research will not be disadvantaged, because after the study the topic of chemical bonding will be retaught in the formal curriculum. There are no incentives and rewards for participating in the study.

This research has been approved by both the Rhodes University Ethical Standards Committee and the Education Department Higher Degrees Committee. During the research any concerns may be directed to Mr Siyanda Manqele, Ethics Coordinator, Research Office, Rhodes University +27 (0) 46 603 7727, s.manqele@ru.ac.za.

Please feel free to conduct me at 0813934377, willyshilongo@gmail.com or my supervisors Prof Kenneth Ngcoza K.Ngcoza@ru.ac.za and Ms Zukiswa Kuhlane z.kuhlane@ru.ac.za for further enquiries.

After you have read and understood this letter, and you are willing to permit your child to take part in the research process, please complete and sign the attached informed consent declaration form.

Sincerely,



Wilhelm N. Shilongo

PARENT AND GUARDIAN'S INFORMED CONSENT

INFORMED CONSENT DECLARATION

(Parent or Guardian)

Project Title: Exploring affordances and hindrances when using learners' home language to mediate learning of chemical bonding in a Grade 8 Physical Science.

Wilhelm N. Shilongo from the Department of Education, Rhodes University has requested my permission to allow my child to participate in the above-mentioned research project.

The nature and the purpose of the research project and of this informed consent declaration have been explained to me in a language that I understand.

I am aware that:

1. The purpose of the research project is to explore affordances and hindrances when learners' home language is used to mediate chemical bonding Grade 8 Physical Science learners' participation and sense making of the topic of chemical bonding.
2. The Rhodes University has given ethical clearance to this research project and I have seen the clearance certificate.
3. By participating in this project my child might understand the concept of chemical bonding better and the findings of the study might also help science teachers to inform their own teaching practice.
4. My learner will participate in the project by writing a pre -tests, a post-test, journal reflections and an observation will also be carried throughout a series of three lessons. The three lessons will be video-recorded with your permission.
5. My learner will be expected to adhere to the rules for classroom interaction during this research.
6. The data that will be gathered in this study will be reused in another research study that goes beyond the scope of this application.

7. My learner's participation is entirely voluntary and if my learner is older than seven (7) years, s/he must also agree to participate.
8. Should I or my learner at any stage wish to withdraw my child from participating further, we may do so without any negative consequences.
9. My learner may be ask to withdraw from the research before it has finished if researcher or any other appropriate person feels it is in the child interests, or if my learner does not follow instructions.
10. Neither my learner nor I will be compensated for participating in the research.
11. There are no risks associated with my learner's participation in the project.
12. The researcher intends publishing the research results in the form of a full thesis. However, confidentiality and anonymity of records will be maintained and that my learner's name and identity will not be revealed to anyone who has not been in the conduct of the research.
13. I will not receive feedback regarding the results obtained during the study.
14. Any further questions that I might have concerning the research or my participation will be answered by Mr Siyanda Manqele, Ethics Coordinator, Research Office, Rhodes University +27 (0) 46 603 7727, s.manqele@ru.ac.za.
15. By signing this informed consent declaration I am not waving any legal claims, rights or remedies that I or my learner may have.
16. A copy of this informed consent declaration will be given to me, and the original will be kept on record.

I,_____ have read the above information/ confirm that the above information has been explained to me in a language that I understand and I am aware of this document's contents. I have asked all questions that I wished to ask and these have been answered to my satisfaction. I fully understand what I expected of my learner during the research.

I have not been pressurized in any way to let my learner take part. By signing below, I voluntarily agree that my learner_____, who is _____ year old, may participate in the above-mentioned research project.

_____ _____

_____

Parent/Guardian's signature Witness Date

Rules for classroom interaction during the research

1. Respect and listen to your classmates
2. Respect and listen to the teacher
3. Raise your hand to speak
4. Be quiet when the teacher is talking
5. Be quiet when classmates are talking
6. Be on time
7. Be respectful of classmates who are working, example on the chalkboard
8. Have a good attitude
9. Use positive language
10. Be well dressed in complete uniform
11. Stay in your seat
12. Contribute to discussions and ask questions when you things are not clear
13. Be respectful of others' views
14. Cooperate with your classmates
15. Do not physically or mentally injure others
16. We follow directions the first time.
17. No vandalism is allowed in the classroom
18. Don't ever distract the class during lessons
19. No sleeping in the classroom unless with permission

Appendix C3: Parents' consent letter (Oshiwambo translation)

Rhodes University

Drosty Road

Grahamstown

6139

04 May 2020

Omufimanekwa

Oshinima: Eindilo lepetikilo opo ndi ninge omapekapeko enasha nelongo nokaana koye

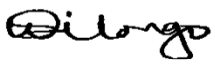
Aame Wilhelm N. Shilongo ndili omulihongi ko universiti ya Rhodes. Omapekopeko ange oenasha noku konaanakona nghene elaka loshiwambo tali dulu oku udifako ile oku ngabeka eudeko lovahongwa vomododo 8 meilongo loshipalanyole chemical bonding, mo shilongwa shounhongononi. Onghee nefimaneko linene ohandi ku indile opo upitike okaana koye opo kakufe ombinga moshinyangadalwa eshi. Oshinyadalwa otashi ka kwata oule weevile 5, oule woshivike shimwe momwedi June 2020.

Ina pa didilikwa oshiponga shinasha nekufombinga moshinyangadalwa eshi. Okanaana koye otaka ka mona omito yoku mbwalangadjeka eshivo lako shinasha no chemical bonding. Oshinyangadalwa otashika ningwa komatango opo shi haye moshipala eetundi dofikola.

Ekufombinga lokaana koye moshinyangadalwa eshi oleli kolelela pamaiyudo oye onga omudali wokaana. Ngeenge owapitike okaana koye kakufe ombinga ouna oufemba okuningulula etokolo loye. Ekufombinga lokaana koye otali kala oshiholekwa.

Komapulo shinasha noshinyangadalwa eshi kwatafana Mr. Siyanda Mangela kongodi: +27(0) 46 603 7727, noko email: s.mangele@ru.ac.za

Woye



_____

Wilhelm N. Shilongo

EPITIKILO LOMUDALI/OMUTEKULI WOMULONGO

Ame_____ onga omudali/omutekuli, ohandi yandje epitikilo opo okaana kange kedina _____kakufe ombinga moshinyangadalwa sha Wilhelm N. Shilongo omulihongi koshiputudilo shopombada sha Rhode. Ondi uditeko osho okaana kange kateelelwa okuninga no kena oufemba woku likufamo moshinima eshi.

_____ _____

_____

Eshaino lomudali/omutekuli Omukalelipo Efiku

Appendix C4: Learners' letters and assent forms

Rhodes University

Drosty Road

Grahamstown

6139

04 May 2020

Dear……(Learner Name)

Re: Participation in research on the affordances and hindrances when using learners' home language to teach chemical bonding in Grade 8 Physical Science class.

I am Wilhelm N. Shilongo, a part-time student doing master's in science education at Rhodes University, South Africa. I hereby humbly request your permission for me to conduct a research study with you as my research participant, during teaching and learning of the topic on chemical bonding at Ondjodjo Combined School. I plan to conduct the study for about one week of June 2020, in the afternoon after school. If you wish to participate in the study, you will be required to,(a) write a diagnostic and post-intervention test, (b) write a journal reflection after each lesson (c) be present in class and (d) interact with the researcher who will be presenting the topic on chemical bonding, while the critical friend will carry out observations and videotape all the three lessons with your permission. Six learners will be selected to take part in the focus group interview and stimulated recall interview. You will also be required to adhere to the rules for classroom interaction during the study that I have attached to this letter. Furthermore, I am also asking for your permission to reuse the data that will be gathered in this study, in another research study, that goes beyond the scope of this application.

The focus of this study is to explore affordances and challenges when using learners' home language to teach the topic on chemical bonding of Grade 8 Physical Science. Kindly be informed that participation in this study is voluntary. It is therefore your right to decide whether you wish to participate or not. Also, participants are free to withdraw any time they wish to do so. The identity and views of the participants will not be revealed, and I will maintain anonymity. The data that will be collected will not be used for other purposes apart from this study. Please note: If you do not wish to take part in this research you will not be disadvantaged, as the topic of chemical bonding will be retaught under normal in the formal curriculum. There are no incentives and rewards for participating in the study.

This research has been approved by both the Rhodes University Ethical Standards Committee and the Education Department Higher Degrees Committee. During the research any concerns may be directed to Mr Siyanda Manqele, Ethics Coordinator, Research Office, Rhodes University +27 (0) 46 603 7727, s.manqele@ru.ac.za.

Please feel free to conduct me at 0813934377, willyshilongo@gmail.com or my supervisors Prof Kenneth Ngcoza K.Ngcoza@ru.ac.za and Ms Zukiswa Kuhlane z.kuhlane@ru.ac.za for further enquiries.

Lastly, if you agree or do not agree to participate in this research, please complete the consent form below.

Yours Sincerely

_____

Wilhelm N. Shilongo

LEARNER PARTICIPANT'S ASSENT FORM

INFORMED CONSENT DECLARATION

Project Title: Exploring affordances and hindrances when using learners' home language to mediate learning of chemical bonding in a Grade 8 Physical Science.

Researcher's Name: Wilhelm N. Shilongo

Name of participant:……

Tick (√) in the box of your choice

1. Has the researcher explained what he will be doing and wants you to do?

YES	NO

2. Has the researcher explained why he wants you to take part?

YES	NO

3. Do you understand what the research wants to do?

YES	NO

4. Do you understand that the data that will be gathered in this study will be reused in another research study, that goes beyond the scope of this application.

YES	NO

5. Do you know if anything good or bad can happen to you during the research?

YES	NO

6. Do you know that your name and what you say will be kept secret from other people?

YES	NO

7. Did you ask the researcher any question about the research?

YES	NO

8. Has the researcher answer all your questions?

YES	NO

9. Do you understand that you can refuse to participate if you do not want to take part and that nothing will happen to you if you refuse?

YES	NO

10. Do you understand that you may pull out of the study at any time if you no longer want to continue?

YES	NO

11. Do you know who to talk to if you are worried or have any other questions to ask?

YES	NO

12. Has anyone forced or put pressure on you to take part in this research?

YES	NO

13. Do you understand the rules for classroom interaction during the study?

YES	NO

14. Are you willing to take part in the research?

YES	NO

_____

_____

Signature of Child Date

Rules for classroom interaction during the research

20. Respect and listen to your classmates
21. Respect and listen to the teacher
22. Raise your hand to speak
23. Be quiet when the teacher is talking
24. Be quiet when classmates are talking
25. Be on time
26. Be respectful of classmates who are working, example on the chalkboard
27. Have a good attitude
28. Use positive language
29. Be well dressed in complete uniform
30. Stay in your seat
31. Contribute to discussions and ask questions when you things are not clear
32. Be respectful of others' views
33. Cooperate with your classmates
34. Do not physically or mentally injure others
35. We follow directions the first time.
36. No vandalism is allowed in the classroom
37. Don't ever distract the class during lessons
38. No sleeping in the classroom unless with permission

Appendix D: Research Instrument

Appendix D1: Diagnostic test

Learner's code_____ **Date**_____

Physical Science test **Grade 8**

Topic: Chemical bonding **Marks: 20**

Instructions

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

Section A

Multiple choices

1. The reason elements take part in chemical bonding is for them to achieve: [1]

A. Noble gas configuration

B. Stable nucleus

C. More nucleus

D. Strong bonds

2. Which part of an atom take part in chemical bonding? [1]

A. Protons

B. Neutrons

C. Electrons

D. Shells

3. Choose the element that will not take part in chemical bonding [1]

A. Hydrogen

B. Argon

C. Nitrogen

D. Oxygen

4. Covalent bonding takes place between: [1]

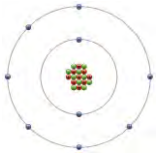
A. A metal and metal

B. A metal and non-metal

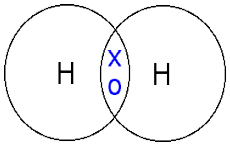
C. A non-metal and transitional metal

D. A non-metal and non-metal

5. Which diagram shows atoms covalently bonded? [1]

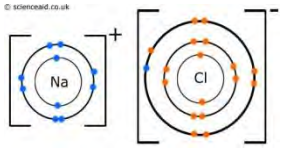


A



B

C



D

Section B

Structured questions

- Answer all the questions on the space provide.
- Legible handwriting is essential.

1. Shells' capacity of an atom tells us the number of electrons each shell can hold. Write down the shell's capacity of:

a) 1st shell…… [1]

b) 2nd shell…….. [1]

c) 3rd shell…… [1]

d) 4^{th} shell…… [1]

2. Draw the Bohr electronic structure of Oxygen ($_{16}O^{8}$) [3]

3. How do you understand covalent bonding? [1]

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

4. Explain in your own words, what "molecule" refers to? [1]

……
……
……

5. Rewrite the following sentence using your own words.

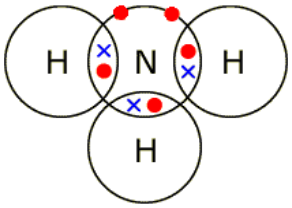
Some molecules are diatomic. [1]

……
…

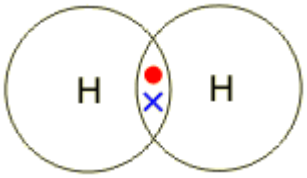
……
…

6. The Bohr electronic structure in the diagram below show different kind of covalent bonding.

A **B** **C**



D



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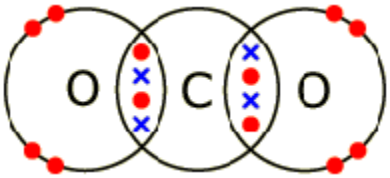
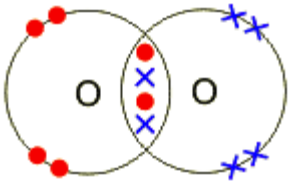
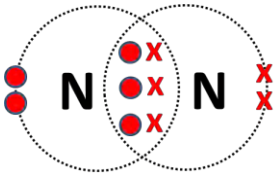






From the diagram above write down a letter that shows a:

a) Single bond…… [1]

b) Double bond……. [1]

c) Triple bond ……. [1]

d) Two double bond…… [1]

c) Three single bond…… [1]

End

Appendix D2: Observation schedule

Observation schedule

Name of school_____ Observation Date_____

Name of teacher_____

Grade_____

Subject_____ No of learners_____

Lesson topic_____

Observer_____

Language usage	Description
Teacher uses appropriate and clear language • Clarity of instructions	
The language teacher uses for instruction and asking questions • Clarity of questions asked	
The language that teacher uses to present the lesson content • Clarity of explanations	
Language used to express ideas in the classroom • Teacher-learner interaction	

• Learner-learner interaction	
This Part is adapted from Iyambo (2015, p. 91)	
Learners' sense making	Description
Signs which show learners making sense during lesson presentation • Learners' gesture (movement of hands and arms, adjustment of posture, touching of oneself and other fiddling movements)	
Signs which show learners are not making sense during lesson presentation • Learners' gesture (movement of hands and arms, adjustment of posture, touching of oneself and ther fiddling movements)	
Accuracy in learners' answers	
General comment	

This part is adapted from Silvanus (2017, p. xii)

Appendix D3: Learners' journal reflection

Journal Reflection: Adapted from Silvanus (2017, p. xix)

Journal Book (Reflection learning log)

Learner Code_____ Topic: Chemical bonding

Date_____ Code_____

How did I find the use of home language in the Science lesson?
Things that I do not understand well in the lesson
Things that I understand in the lesson
What I think teacher could have done to help me understand the topic
Use the space below to write anything you want to say about the lesson.

Appendix D4: Post-test

Learner's code_____ **Date**_____

Physical Science test **Grade 8**

Topic: Chemical bonding **Marks: 20**

Instructions

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

Section A

Multiple choices

1. What is the maximum number of electrons on a second shell in an atomic structure?

A. 2
B. 6
C. 8
D. 10

2. Which molecule is diatomic?

A. CO_2
B. H_2O
C. HCl
D. NH_3

3. Choose the element that will not take part in chemical bonding

A. Hydrogen

B. Nitrogen

C. Neon

D. Oxygen

4. A covalent bonding is…

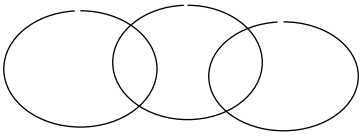
A. Bonding in which atoms share electrons.

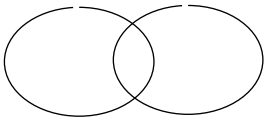
B. Bonding in which atoms contribute electrons.

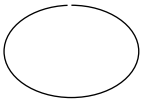
C. Bonding in which electrons are transferred.

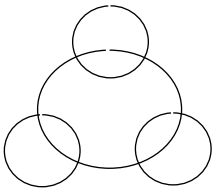
D. Bonding between metals and non-metals.

5. Which diagram shows the correct molecule of hydrogen gas?

A. 

B. 

C. 

D. 

Section B

Structured questions

- Answer all the questions on the space provide.
- Legible handwriting is essential.

1. From the list bellow chose all the substances that are made of molecules: [3]

Gas, Salt, Water, Metal, Concrete, oil

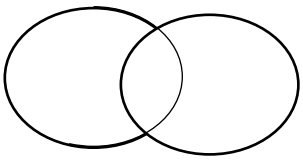
……..

2. Covalent bonding takes place between non-metals. Draw diagrams to show covalent bonding in the following atoms as molecules.

a) H_2O (Hydrogen is in Group 1 and Oxygen is in Group 6) [2]

b) Cl_2 (Chlorine is in Group 7) [2]

3. The diagram shows an incomplete structure of Oxygen.



a) Complete the structure above. [2]

b) Is the bond above a single bond or double bond? [1]

…….

4. State with a reason whether the statement below is true or false. [2]

Atoms in group 8 do not form chemical bonding.

……

……

5. Explain in your own words, what "molecule" refers to? [1]

……

……

6. Rewrite the following sentence using your own words.

Some molecules are diatomic. [1]

……

……

7. Describe the bond formation in CH_4? [1]

……

End

Appendix D5: Focus group interview's questions

Questions	Purpose
1. What do you think why you were chosen by your group members to be part of this focus group?	To put the participant to feel at ease.
2. What are your views about beingtaught science in English? Explain	To establish learners' views on the use of English when they are taught science.
3. What are your views about being taught science in Oshiwambo? Explain	To establish learners' views on the use of Oshiwambo when they are taught science.
4. How did you find learning chemical bonding through (Oshiwambo)?	To establish how learners' home language (Oshiwambo) enables and/or constrains learners' sense making of the concept of chemical bonding.
5. What were the challenges of learning chemical bonding through Oshiwambo?	To establish how learners, home language constrains learners' sense making of the concept of chemical bonding.
6. How did you find asking and answering questions in Oshiwambo during chemical bonding lessons?	To find out how learners' home language enables and/or constrains learners' participation in the science classroom.

Appendix D6: Stimulated recall interview

Diagnostic test

Interviewee(s)	**Test items reference**	**Questions**
Monica	3	Explain this statement: "I understand covalent bond better"
Filly	3	Explain this statement: "covalent bonding is a relationship between people"
Mossy	4	Elaborate more on this answer "is a substance that can undergo diatomic molecule"
Post-intervention test		
Interviewee(s)	**Test items reference**	**Questions**
Inge	1	Why did choose "salt" as one of the molecules?
Ndapewa	6	Why did you say "diatomic are molecules that are in period 2?
Mike	2.b	Why did you draw your diagram like the way you drew it?

Appendix E: Thematic Approach

Sub-themes and their colour codes

Teacher's language barrier:	Blue:	
Learners' participation:	Turquoise:	
Teachers' subject expertise:	Dark yellow:	
Learners' sense making:	Yellow:	
Use of many models:	Teal:	
More examples and activities:	Dark blue:	
Lack of vocabularies:	Red:	
Learners like Oshiwambo:	Pink:	
Learners like English:	Green:	
Exams and tests' language:	Gray:	
Language for instructions asking and lesson presentations:	Brighter green:	

THEMATIC APPROACH

Collated Observation schedule

Language usage	**Description**
Teacher uses appropriate and clear language • Clarity of instructions	**OSL1**: the teacher uses clear language (mixture of English and Oshikwanyama) to give instructions to learners. The instructions are mainly in oshikwanyama.

	OSL2: The teacher uses both English and Oshikwanyama for instructions. However the teacher tend to confuse learners when the instructions is mainly done in Oshikwanyama. **OSL3:** Instructions are clear to the learners and they are understood well English and Oshikwanyama is used. The most dominating language is Oshikwanyama. Learners are getting instructions well when they are being done in oshiwambo.
The language teacher uses for instruction asking questions • Clarity of questions asked	**OSL1:** The teacher uses English and Oshikwanyama, the lesson is mainly in oshikwanyama. The teacher is finding it difficult to ask questions and give instructions in Oshiwambo only. The teacher is struggling with some words in Oshikwanyama that sometimes lead to confusion of learners. **OSL2:** The teacher code-switch between English and Oshiwambo. The questions are asked mainly in Oshiwambo. The questions are well understood by the learners. **OSL3;** The questions are asked in English and Oshikwanyama, but mostly in Oshikwayama. Learners tend to understand questions well when asked in Oshikwanyama.
The language that teacher uses to present the lesson content • Clarity of explanations	**OSL1** The teacher uses both English and Oshikwanyama. Mostly Oshikwanyama is dominating the whole lesson presentation. Explanation are clear to the learners. **OSL2:** The lesson is presented using two languages (English and OShikwanyama) but oshikwanyama was dominating the whole lesson. The teacher is struggling to use Oshikwanyama in his lesson

	presentation at some points, but some words in English are not in Oshiwambo, however the lesson content is clear to learners. **OSL3** English and oshikwanyama, but oshikwanyama dominate English**.** The lesson `presentation is clear (the content is presented clearly). The teacher is finding it difficult to teach in oshiwambo, but learners understand the lesson content.
Language used to express ideas in the classroom • Teacher-learner interaction • Learner-learner interaction	**OSL1:** Teacher –learners interaction is a mixture of English and Oshikwanyama, but mostly oshikwanyama Learner-learner interaction is oshiwambo only **OSL2:** Teacher –learners interaction is a mixture of English and Oshiwambo. Learner-learner interaction is mostly in oshiwambo, only few learners communicate in English **OSL3:** Teacher –learners interaction is a mixture of English and Oshiwambo. Learner-learner interaction is oshiwambo only
Learners'sense making	**Description**
Signs which shows learners making sense during lesson presentation • Learners' gesture: (movement of heads (nodding) and facial expression (excitement and happiness)	**OSL1:** Some learners are nodding their heads continuously. Some are smiling to each other and to the teacher. Some are excited to participate during the lesson presentation. **OSL2:** Most of the learners shows that they understand the concept of chemical bonding by nodding their heads and showing excitement on their faces.

	OSL3: Most of the learners shows that they understand the concept of chemical bonding by nodding their heads and showing excitement on their faces. Learners excited and happy to take part in answering and asking questions during the lesson.
Signs which shows learners are not making sense during lesson presentation • Learners' gesture: movement of heads (head shake and head scratching) and facial expression (confusion and anger)	**OSL1:** Two learners are in a state of confusion. Another two are just quite with angry faces. **OSL2:** Three learners are seem to be confused when the teacher is explaining how to draw covalent bonding diagrams. **SO3:** Two learners are seem not to be happy, they are seem to be in a state of confusion and they are rapidly scratching their heads. These two learners are just quite with angry faces.
Accuracy in learners' answers	**SOL1:** Most of the answers that learners gives are precisely correct. **SOL2:** Most of the answers are correct Three questions were answered wrongly while two questions are partial anwered. **SOL3:** The answers are accurate. Three learners seems to give precise answers when giving answers in English but when speaking oshikwanyama they give ambiguous answers.
General comment	**SOL1:** Learners have enjoyed the lesson because they were eager to participate during the lesson. Learners were asking a lot of questions using Oshikwanyama. It seems that Oshikwanyama afforded learners a great opportunity to engage more with the teacher during the lesson presentation.

	SOL2: The overall lesson presentation was enjoyable. Learners were in a mood of the lesson and this was proved by the way they were participating. Learners were engaging freely with the teacher in Oshikwanyama. More questions were asked by learners which makes the teacher to explain more and in details. **SOL3:** Learners enjoyed the lesson and this is evident by the way they were answering and asking many questions in their vernacular. Learners become more interested in the concept of chemical bonding and this was evident by the way they are participating in the lesson

Collated Journal Reflections: Lesson 1

How did I find the use of home language in the Science lesson?	
L1JR1M:	*Olesson ondi enjoya nawa you okwali in oshimwenyo oshikwanyama ondishi udite ko nawa lela*(The lesson was live and enjoyable, I understand oshikwanyama well)
L2JR1M:	*Oshikwanyama okweshi longifa nawa lela, okwali ta explain nawa ndi uditeko* (the teacher used oshikwanyama very well, I understood well when the teacher was explaining)
L3JR1F:	*Yes! Onda udako nawa neenghono because omulongi ota popi melaka lange eli lokeumbo* (Yes! I understand very well because the teachers was teaching in my home language)
L4JR1M:	Yes I got more education, *Shaashi* (because) Mr. Shilongo he know how teach well

L5JR1F:	I have been finding it very usefull and the teacher explain to us everything well and clear.
L6JR1M:	Use of Oshikwanyama I find it better and I understand this topic
L7JR1M:	I find it better because it make me to understand the topic, *ohaitu fatululile oitya ei katu uditeko melaka loshiingilisa* (we were able to understand the concepts that we do not understand in English)
L8JR1M:	Our teacher was more active when it come at the home language and I understand it very well.
L9JR1F:	Is a good way to teach us
L10JR1F:	*Onda udako nawa elaka eli handilongifa keumbo shaashi olalongifwa nawa moshilongwa sho Science eshi omuhongi tetufatululile apa atunyengwa mo English* (I understood very well the language that I use at home when the teacher was explain things that are difficult in Science subject)
L11JR1M:	I find it good and nice, because when the teacher is reading in English he explain in home language.
L12JR1M:	
L13JR1F:	The home language is not good. When the teacher talk in the home language sometimes I cannot understand well.
L14JR1F:	*Olesson oyali iwa shaashi okwali tamu longifwa elaka eli ndi udite nawa* (the lesson was good because the language that I understand well was used)
L15JR1M:	Some words cannot transfer in our language
L16JR1M:	The lesson was easy and simple
L17JR1M:	The lesson was enjable because I understand well what the teacher is explaining.
Things that I do not understand well in the lesson	

L1JR1M:	I did not understand how many electrons I should put on the first shell of atoms. I need more examples
L2JR1M:	I do not understand the structure of an atom and molecules well
L3JR1F:	*Opena ngoo apa inandi udako nawa ngaashi pokufaneka eebond.* (I did not understand well how to draw bonds)
L4JR1M:	All the things *onde yuudako* (I understand them) even if you ask a question I will answer it.
L5JR1F:	Things that I don't understand in the lessons are only small things like how to find number of atoms.
L6JR1M:	The five building bock
L7JR1M:	How to calculate number of protons and neutrons, and the number of elements in a compound.
L8JR1M:	The electronic structure of the first 20 element
L9JR1F:	Compound number of elements
L10JR1F:	I did not understand well how to find numbers of atoms when the teacher give for example $Al_2(SO_4)$.
L11JR1M:	The definition of a molecule
L12JR1M:	Building blocks of matter
L13JR1F:	I don't understand how to find the number of atoms in a molecule.

L14JR1F:	
L15JR1M:	
L16JR1M:	*Ame kandi udite aike* (I do not understand) how to calculate the number of atoms and elements in compounds
L17JR1M:	The number of atoms in the molecule
Things that I understand in the lesson	
L1JR1M:	Drawing atoms
L2JR1M:	I understand number of elements, compound, number of atom, how to draw atoms
L3JR1F	*Oinima ihapu onde yuudako nawa lela kapena oundjuu, kakele koku faneka eebond* (I understood everything except drawing of bonds)
L4JR1M:	I understand everything
L5JR1F:	Buliding blocks of matter like how to define atoms, elements, compound, molecule and mixtures.
L6JR1M:	I understand how to draw atoms
L7JR1M:	How to draw the bohr structure
L8JR1M:	Structure of an atom, how to draw the bohr structure of an atom
L9JR1F:	A structure of an atom
L10JR1F:	Everything (Structure of an atom, building block of matter, how to draw an atomic structure)

L11JR1M:	Structure of an atom, number of elements and atoms in a compound
L12JR1M:	Structure of an atom
L13JR1F:	I understand how to draw the structure of atoms
L14JR1F:	How to draw an atomic structure
L15JR1M:	*Iinima ihapu ondei yuudako nawa ngaashi elements, compound, molecule and mixture* (I understood many things such as elements, compound, molecule and mixture)
L16JR1M:	I understand everything but not how to calculate the number of atoms and elements in a molecule
L17JR1M:	Almost everything apart from number of atoms in the molecule.
What I think teacher could have done to help me understand the topic	
L1JR1M:	*Inandi udako nawa shaashi otopika oina iinima ihapu yoo oina eemango nomafano mahapu* (I did not understand well the topic because it has many things and many rules as well as many pictures)
L2JR1M:	*Omulongi napopye teende kashona shaashi ngeenge ta endelele ohakokoma unene* (they should speak slowly because he is speaking fast he start to stammer)
L3JR1F:	*Omulongi nakale hapopi mokule ngeenge talongo moshikwanyama, ohapopi unene pedu ngeenge tapopi moshikwanyama* (the teacher should start to speak louder when teaching in Oshikwanyama, he speaks softly when speaking Oshikwanyama).
L4JR1M:	Aalongwa vamwe okwali tava shouting omanyakulo (some learners were shouting answers) we need to rise hands.
L5JR1F:	The teacher must give me more examples on the chalkboard.
L6JR1M:	He was supposed to give every learners a piece of paper to define it.

L7JR1M:	
L8JR1M:	He was support to give us many activities on the building blocks of matter and the electronic structure of the first 20 element of a topic task.
L9JR1F:	The teacher need to learner Oshikwanyama well
L10JR1F:	*Omulongi okwa pumbwa oku kwafelange okweendulula nghene ndina okuvalula opo ndimone onumber of atom, tahongo nge ngeno moshiwambo slowly by slowly* (the teacher need to repeat with me on how to calculate the number of atoms in a compound, in oshikwanyama slowly by slowly)
L11JR1M:	He could repeat the topic as a revision. *Omuhongi okwa pumbwa oku tupa iiholelwa ihapu ye molecule* (the need to give many example of molecules)la
L12JR1M:	He must make more examples. He is too fast.
L13JR1F:	*Okwa pumbwa alonge kashona nakashona, shaashi ngeeng ta endelele oha kokoma* (the teacher need to teach slow by slow, because when he is fast he stammer)
L14JR1F:	*Omulongi okwa pumbwa oku popya slowly by slowly* (the teacher need to speak slowly by slowly)
L15JR1M:	The teacher must teach in one language only, two languages confuse me a little. The teacher must speak English only.
L16JR1M:	He need to improve his Oshikwanyama so that I can understand well
L17JR1M:	
Use the space below to write anything you want to say about the lesson	
L1JR1M:	*Olesson oya enda nawa shili, otwa longwa nawa moshiwambo. Sir okwetupa nee activity twa shanga twa pita nawa* (the lesson was good, we were taught well in Oshiwambo, I passed well the activity that we were given)

L2JR1M:	This is good because anything the teacher told us for now, I know it clearly. Things are very simple. *Omuhongi nakale hetupe iihopaenenwa ihapu opo tu udeko nawa* (the teacher need to give more examples on how to draw atoms on the chalkboard, so that I will undersatand better)
L3JR1F:	*Omuhongi natwikile okulonga moshikwanyama, oshiwa unene* (the teacher must continue to teach in oshikwanyama, is a good thing) Olesson oyali iwa (the lesson was good) because everything Mr. Shilongo said I just understood.
L4JR1M:	The lesson was very good, I understand almost everything. *Onda hala aike ndikale handi longwa moshikwanyma* (I want to be taught in oshikwanyama only)
L5JR1F:	
L6JR1M:	The lesson was good and there was no noise I hear what the teacher was teaching.
L7JR1M:	I just want us to say this lesson make us to understand well this topic.
L8JR1M:	This lesson was not boring at all, and we were given confidence by the teacher on our home language. The teacher also active, thank you Sir.
L9JR1F:	Mr Willhem you teach so nice bonding is a thing that is easy, I don't think there is anyone whole will fail this. Thank you oshikwanyama
L10JR1F:	I want to say how protons and neutrons are found in the nucleus.
L11JR1M:	The lesson was so good and classmates participated a lot. We did not make noise.
L12JR1M:	

L13JR1F:	The lesson is good because the teacher know physical science.
L14JR1F:	The lesson it was very very enjoyaful because I understand every in the lesson of this topic
L15JR1M:	
L16JR1M:	*Ondahala oku longwa oPhysical Science moshikwnyama alushe* (I want to be taught Physical Science in Oshikwanyama always.
L17JR1M:	*Oshikwanyama okwali ndishi udite nawa ashike omulongi in pyokoka nawa melaka loshikwanyama* (I understood well when the teacher was teaching, but the teacher is not fluent the language of Oshikwanyama.

Collated Journal Reflection: Lesson 2

How did I find the use of home language in the Science lesson?	
L1JR2M:	*Olesson oya enda nawa lela* (the lesson went well)
L2JR2M:	It help me to understand well
L3JR2F:	*Yes otundi oyali iwa lela neenghono* (yes the lesson very good)
L4JR2M:	*Ohandi uduko nawa* (I use to understand well) because is my mother language
L5JR2F:	I have been finding it better because the teacher was explaining to me very clear.
L6JR2M:	Good language has used in this lesson and I understand good
L7JR2M:	*Olesson okwali ipu neenghono shaashi elaka eli kwali tali dominatinga okwali ndili udite nawa inalifa oshiingilisha* (the lesson was easy because the language that was dominating the lesson I understand it well, unlike English
L8JR2M:	Science lesson with home language was good, but our teacher is somehow not good in this home language
L9JR2F	*Omukalo muwa shaashi oinima aishe ondi yuudite in Inglish and Oshiwambo* (is a good way because I understand everything in English and Oshiwambo)

L10JR2F	*Onda udako elaka eli handilongifa keumbo shaashi omuhongi okweli longifa nawa opo tu udeko otopic* (I understand the language that use at home because the teacher used it well so that we can understand the topic)
L11JR2M:	I find it good because the teacher explain the topic well
L12JR2M	I found it well clear and enjoyable. I understand well
L13JR2F	I find it better than English, because I understand oshikwanyama more better
L14JR2F	The home language is not good for use by the teacher who did not learn that language as their subject. The teacher struggle too much
L15JR2M	*Olessona oyali iwa lela, ondali ndi uduteko nawa* (the lesson was good, I understood well)
L16JR2M	I like it, I understand well
L17JR2M	
Things that I do not understand well in the lesson	
L1JR2M:	*Oku valula uu atom ava veli mo compound* (how to calculate the number of atoms in the compound)
L2JR2M:	Reactants and products
L3JR2F:	*Opena iinima imwe inandi yuudako ngaashi molecule* (There are some of the things that I did not understand well, like molecule)
L4JR2M:	I understand all things, even *otapula epulo andi dulu ku nyamukula mondjila* (even if he ask a question I can answer it correctly)
L5JR2F:	Things that I don't understand in the lesson are just small and they are as follow:
L6JR2M:	I don't understand well the structure of CO_2
L7JR2M:	The structure of Carbon dioxide
L8JR2M:	I don't understand some covalent bond structures *ngaashi* (like) CO_2
L9JR2F	Nothing I do not understand
L10JR2F	Nothing
L11JR2M:	Electron structure

L12JR2M	I do not understand the structure of carbon dioxide well
L13JR2F	
L14JR2F	I do not understand chemical reactions
L15JR2M	
L16JR2M	All the things I understand
L17JR2M	
Things that I understand in the lesson	
L1JR2M:	Everything is clear
L2JR2M:	All unless reactants and products
L3JR2F:	*Okufaneka eebonding* (drawing of bonding)
L4JR2M:	*Iinima aishe onde yuudako unene ngoo ocovalent* bonding (I understand everything more especially covalent bonding)
L5JR2F:	Things that I understand well in the lesson are; drawing of covalent bonding
L6JR2M:	
L7JR2M:	Most of the things
L8JR2M:	*Iinima aishe ondi yuudite nawa* (I understand everything well)
L9JR2F	*Iinima aishe ondi yuudite* (I understand everything)
L10JR2F	Everything I understand
L11JR2M:	Covalent bonding are easy
L12JR2M	I understand many covalent bond structures but not CO_2
L13JR2F	
L14JR2F	I understand the bonding well
L15JR2M	

L16JR2M	
L17JR2M	
What I think teacher could have done to help me understand the topic	
L1JR2M:	*Omulongi okwa pumbwa okwiilonga oku longa moshiwambo shaashi keshishi nawa* (the teacher need to learn how to teach in oshiwambo because he does not know it well)
L2JR2M:	Give more examples on drawings of atoms
L3JR2F:	*Omulongi okwapumbwa okukala hapopi mokule ngeenge tapopi oshikwanyama* (the teacher need to speak louder when he is speaking oshiwambo)
L4JR2M:	
L5JR2F:	The teacher must explain to me better and asking me question and give me lots of examples so that I may understand well.
L6JR2M:	Give us more examples on drawing covalent bonding
L7JR2M:	The teacher need to give use many many examples on the chalkboard *nghene eebonding handi fanekwa* (on how to draw bondings)
L8JR2M:	He need to repeat CO_2 and give more examples on the draw of bonding
L9JR2F	The teacher need to speak good Oshikwanyama so that he can make me understand very good.
L10JR2F	*Omuhongi ina pumbwa oku pukululange molwaashi this topic kaidjuu ye okwei longa audifangeko* (the does not need to help me with anything because this topic is not difficult and he taught it well)
L11JR2M:	He could have given more examples to me and
L12JR2M	To do more examples. He must be slowly when explain in oshikwanyama, *oha kokoma ngeenge tappopi oshikwanyama* (he stammers when speaking oshikwanyama.)
L13JR2F	I thout he could just revise the how to draw some bonding of some molecules, just alittle beat.

L14JR2F	*Okwa pumbwa akale talongo nakashona shaashi ohakokoma ngeenge talongo moshikwanyama* (he need to teach slowly, because he start to stammer when teaching in oshiwambo)
L15JR2M	Many examples
L16JR2M	Teacher must just Oshikwanyama to teach *opo aike andi uduko nawa* (so that I understand well)
L17JR2M	
Use the space below to write anything you want to say about the lesson	
L1JR2M:	*Olesson oya enda nawa, Sir okwali otalongo iitulamo* (the lesson went well, the teacher put more effort on the lesson)
L2JR2M:	*Otundi kakwali yasuwaka okwali yiwa yoo oyalongange shihapu kombinga yotopic* (The lesson was not boring, it was very good and it taught me many things about the topic). I want the teacher to repeat that good thing of teaching us in Oshikwanyama every lesson.
L3JR2F:	*Ame kandinaposha* (I have nothing to say) I just want to say Wilhelm condinue with your study
L4JR2M:	The lesson is good to me because Mr. Shilongo he know how to teach.
L5JR2F:	The lesson was very good because I learn lots of thing
L6JR2M:	The whole lesson was good, *ondi hole okulongwa moshikwanyama mboli* (I like to be taught in oshikwanyama)
L7JR2M:	*Otundi oyali iwa lela shaashi okwali tu uditeko nawa* (the lesson was good because we understood very well)
L8JR2M:	This lesson was more boring
L9JR2F	*Omulongi natwikile okulonga moshikwanyama keshe efimbo* (The teacher must continue to teach in Oshikwanyama all the time)
L10JR2F	*Ondahala ashike okutya oshiwa oku longifa elaka loshikwanyama motundi shaashi oletu kwafa tu udeko nawa* (I just want to say it is good to use Oshikwanyama in the lesson because it helped us to understand well)
L11JR2M:	We feel happy of the lesson. I like it
L12JR2M	The lesson was good Sir, keep it up

L13JR2F	The lesson was nice, we participate well
L14JR2F	The lesson was so very good because the teacher was teaching good. I am understand
L15JR2M	
L16JR2M	I just want to say I did enjoy this lesson
L17JR2M	The lesson was very good

Collated Journal Reflection: Lesson 3

How did I find the use of home language in the Science lesson?	
L1JR3M:	*Olesson ondei enjoya unene shaasho okwali ndi uditeko nawa eshi omulongi talongo moshikwanyama* (I enjoyed the lesson because I understood well when the teacher was teaching)
L2JR3M:	I need to be taught in Oshikwanyama always because it make me to understand all the things the teacher is saying.
L3JR3F:	Lesson in home language is good, *shaashi omunhu oho kala aike wamanguluka oku ponya nokupula omapulo* (because you are free to speak and to ask questions)
L4JR3M:	*Elongifo loshiwambo motundi yo Physical Science oshiima shiwa lela shaashi omunhu okwali ashike wu uditeko nawa* (the use of Oshiwambo in Physical Science lesson is a good thing because I understood well)
L5JR3F:	*Teacher fimbo limwe ohe tu ngwangwa neke ngeenge tapopi oshikwanyama* (the teacher confuse us sometimes when he is speaking Oshikwanyama)
L6JR3M:	It is better than English
L7JR3M:	*Olesson okwali ipu neenghono shaashi elal eli kwali tali dominatinga okwali ndili udite nawa inalifa oshiingilisha* (the lesson was easy because the language that was dominating the lesson I understand it well, unlike English
L8JR3M:	*Ohandili mono lipu kelaka loshiingilisha shaashi ohali fatulala oinima ei katu udite* (I find it easy compared to English because it explains things that we not understand)
L9JR3F	I hear good everything

L10JR3F	*Omulongi okwa longifa elaka nawa yee okushi oPhysical Science nawa opo shituningile shipu oku udako melaka letu eli hatupopi noshoyo melakapambelewa* (The teacher used the language well and he knows Physical Science well and this made it easier for us to understand)
L11JR3M:	The home language in science is very easily.
L12JR3M	Very well and clearly
L13JR3F	I find it easy, because it makes me to be free and proud by communicating to the teacher, because that is my home language
L14JR3F	The home language is not need to be used by teacher who do not teaching that language, they do not know how to speak it well.
L15JR3M	It was nice and I understand it very well home language
L16JR3M	I understand better in my home language, *olesson oyali iwa unene* (the lesson was very good)
L17JR3M	*Good, shaashi okwali ndi uditeko nawa iinima aishe ngaashi omalombwelo aeshe ndee naashi omulongi kwali talongo, iinima aishe okwali yayela nawa* (Good, because during the lesson I understood everything for instance the instructions and lesson presentation, everything was very clear.)
Things that I do not understand well in the lesson	
L1JR3M:	I am a bit confuse on describing the bond formation in methane
L2JR3M:	I don't have a problem with anything
L3JR3F:	*Iinima aishe ondi yuudite nande otest andi ipiti aike* (I understand everything, I will even past a test)
L4JR3M:	I do not understand some properties of covalent compounds
L5JR3F:	
L6JR3M:	*Ounima ashike vashona inandi udako nawa ngaashi the bond formation in methane ashike ikwao onda udako* (only few things I did not understand like the bond formation in methane, the rest I understood them)
L7JR3M	Nothing I do not understand, I just want to write a test
L8JR3M:	*Kandina eshi kandi udite* (I have nothing that I don't understand)
L9JR3F	Nothing I don't understand because is easy and I like its

L10JR3F	All thing I understand well
L11JR3M:	Properties of covalent compounds
L12JR3M	Covalent bond of oxygen
L13JR3F	As I am looking at things, I understand all about this topic
L14JR3F	I do not understand how to describe bond formation of methane and I don't know how to draw it
L15JR3M	*Aishe ondei yuudako nawa* (I understand everything)
L16JR3M	*Kapena nande oshimwe inandi udako* (I understand everything)
L17JR3M	I do not understand how to draw some of the bonds
Things that I understand in the lesson	
L1JR3M:	The lesson was fine I understand everything
L2JR3M:	I understand all the things
L3JR3F:	I understand how to draw bonding, it is easy
L4JR3M:	I understand covalent bond drawings
L5JR3F:	*Iinima aishe* (everything)
L6JR3M:	*Oinima aishe twalongwa nena ondei yuudako* (all the things we were taught today I understand them) but not bond formation in methane
L7JR3M	All the things
L8JR3M:	To describe the bond formation in carbon dioxide. How to draw covalent bonding. Property of covalent compound.
L9JR3F	*Aishe onde yuuda nawa ngaashi* (I underatsnd everything) covalent bonding, properties of covalent bond and to describe the bond formation.
L10JR3F	How to draw covalent bond, properties of covalent bond and how to describe the bond formation in covalent bond.
L11JR3M:	Covalent bond, describing the bond formation in carbon dioxide, methane and many more
L12JR3M	Covalent bond and properties of covalent compound and formation of bonds

L13JR3F	All about this topic I understand it very well
L14JR3F	I understand everything but nit methane
L15JR3M	How to draw a covalent bond, properties of covalent bond, how to explain bond formation
L16JR3M	I have understand more things like all things
L17JR3M	I understand some bonding but only some
What I think teacher could have done to help me understand the topic	
L1JR3M:	I want a revision slowly and slowly in oshikwanyama
L2JR3M:	No problem I understand all the things, I don't need help
L3JR3F:	
L4JR3M:	Only many examples
L5JR3F:	Nothing
L6JR3M:	*Teacher okwali a pumbwa oku tupa oihopaenenwa ihapu* (the teacher was supposed to give us many examples)
L7JR3M	
L8JR3M:	I need a homework
L9JR3F	*Kandina apa ndapumbwa evatelo komuhongi shaashi* (I don't need any help because) everything that he teach I understand it already.
L10JR3F	I don't need help
L11JR3M:	He could explain more
L12JR3M	Make more examples on chalkboard. He must be slowly when he is teaching
L13JR3F	My teacher need to give me many tasks
L14JR3F	He need to teach slow by slowly
L15JR3M	*Ngeno ota longo kashona nakashona, shaashi ohapukifa ngeeenge talongo moshikwanyama* (He need to teach slow by slow, because he makes mistakes when teaching in Oshikwanyma)
L16JR3M	nothing

L17JR3M	I don't think he need to do anything
Use the space below to write anything you want to say about the lesson	
L1JR3M:	The lesson was really good *ashike* (but) the teacher is struggle to teach in oshiwambo. *Iitya imwe yomoshiinglisha kaimo moshikwanyama* (some words in English are not in Oshikwanyama)
L2JR3M:	The lesson was live, I like it and continue with your study Sir
L3JR3F:	I like many examples the teacher give us, *nghene tuna okufaneka eebonding* (on how to draw bonding)
L4JR3M:	The lesson was good but
L5JR3F:	The lesson was enjoyaful, but teacher have to learn to teach in oshikwanyama nicely
L6JR3M:	Thank you for making us understand Sir
L7JR3M	The teacher is fine but *keshi nawa okulonga moshikwanyama* (he does not know how teach in Oshikwanyama)
L8JR3M:	The lesson is good because we are free to speak in any language
L9JR3F	I am understand well *nghina ashike ashi inandi uda* (I have nothing that I did not understand) Physical Science is my subject that I like it.
L10JR3F	*Olesson oyeenda nawa lela* (the lesson went well)
L11JR3M:	The lesson was good. The lesson was live
L12JR3M	
L13JR3F	The lesson was making sense to the topic of bonding. I am just saying thanks to my teacher who did so.
L14JR3F	I don't have anything to say because the teacher was teaching good
L15JR3M	The lesson was endjoyaful
L16JR3M	The lesson was very very good well done Sir!!!!!!
L17JR3M	I think I need more lessons like this one, *onda udako nawa shili* (I really understood well)

Focus Group Interview

T: **Good afternoon once again?**

Learners: Good afternoon sir?

T: **Welcome to our focus group interview session, which language would you prefer?**

Learners (5): To be interviewed in English or Oshiwambo?

Learner (1): I prefer English

T: **Okay, we are going to use Oshiwambo and English. You are free to use a language of your choice. Our first question is…**

1. **T:** ***Omolwashike mbela wahoololwa kuvakeni*** **(What do you think why you were chosen?)**

FGIL1: *shaashi kashiimba ovalongwa vekwetu ove wete kuty ohandi dulu oku nyamula omapulo* (because maybe my fellow learners think that I can answer questions well)

FGIL2: *osheshi ondiinekelwa kovahongwa vakwetu kutya ngeenge ndapulwa epulo ohandi dulu okulinyamula* (because my fellow learners trust that if a question posed to me, I can be able to answer questions)

FGIL3: *shaashi ohandi popi unene moclass noghee ovalongwa vakwetu ovewete kutya andidulu oku nyamukala omapulo* (because I talk too much in the class, therefore my fellow learners think that I can be able to answer question)

FGIL4: because I am one of the active learners that can be able to answer the questions

FGIL5: *shaashi oveshishi kutya onda manguluka oku nyamukala omapulo* (because they know that I am free to answer the questions)

FGIL6: I am not shy

2. **T:** ***Oushi uditile ngahelipi oku longwa oPhysical Science moshiinglisha?*** **(What are your views about being taught science in English?)**

FGIL1: *Ihandi kala ndiuditeko nawa eshi omulongi tati, shaashi iitya imwe ohai kala ipe kwaame, ohaikala yapumbwa oku fatululwa moshiwambo, shoo osho ashike*

hashi eta ndi dope omafimbo amwe shaashi oinima kandi yuudite (I normally do not understand what the teacher is saying, because some words used to be new to me that sometimes make me to fail as a result of misunderstanding what teacher said)

FGIL2: *fimbo limwe ihandi kala ndiu diteko nawa kutya omulongi otati, nande efimbo limwe oshiima eshi tamu longwa oshipu ashike, ndee molwaashi kandi uditeko nawa oshiinglisha ohashikala ashike shidjuu* (sometimes I do not understand what the teacher is saying, even though what the teacher is teaching is easy, but because I do not understand English things turn out to be difficult).

FGIL3: *ngeenge haandi longwa moshiingilisha ohandi kala ngoo ndiu diteko, ashike ngeenge omulongi afatulula moshiwambo ohandi kala ndiuditeko nawa unene shaashi oitya aishe ondi yuuditeko nawa* (when I am being taught in English I use to understand a little bit, but when the teacher explain in Oshikwanyama, I use to understand everything because I understand all the words)

FGIL4: *Ihandi kala naana ndiu diteko nawa shaashi oshiingilisha oshiingilisha aike*…(I do not really understand because English is just English…)

T: *oshiinglisha oshiingilisha aike, ngaho owahala okutya ngaipi?* (English is just English, what do you mean by that?)

FGIL4: *oshiinglisha osha piyaana oshina iitya indjuu* (English is complicated, it has difficult words)

FGIL5: English makes me to understand Physical Science well *shaashi omulongi wetu okushi oku longa nawa moshiingilisha shidulife ngeenge ta longo moshikwanyama* (because our teacher knows to teacher in English than in Oshikwanyama)

FGIL6: English is not easy because i*itya imwe moshiingilisha ihandi kala ndi yuudiko kutya otaiti ngaipi* (I do not understand the meaning of some words in English)

3. **T: *Oushi uditile ngaipi oku longwa oPhysical Science melaka loshikwanyama*? (What are your views about being taught physical science in Oshikwanyama?)**

FGIL1: *Ngeenge handi longwa oPhysical Science mOshikwanyama ohandi kala ndiuditeko nawa shaashi elaka olo olo handi popi keumbo mos. Keshe eshi omuhongi tati ohandi kala ndishi udite nawa* (when I am being taught Physical

Science in Oshikwanyama I understand well because is the language that I speak at home)

FGIL2: *oPhysical Science yomoshikwanyama okwali ndi uditeko nawa eshi kwali andilongwa moshiwambo shaashi osha kwafelange opo ndi udeko nawa iitya oyo hainyengenge moshiingilisha opo ndi yuudeko nawa* (I understand Physical Science in Oshikwanyama well, because it helped me to understand words that I find difficult it English)

FGIL3: *okwali ndamanguluka oku nyamukula omapulo melaka loshikwanyama nokupula* (I was free to ask and answer questions in Oshikwanyama)

FGIL4: *ngeenge ndalongwa moshikwanyama ihapakala opart yimwe yo lesson inandi yuudako shaashi itya aishe ondi yuuditeko.* (when I am taught in Oshikanyama there no part of the lesson that I do not understand, because I understand all the words). *Okwali handi pula nawa omapulo ange nda manguluka moshikwanyama* (I was asking my questions freely in Oshikwanyama) compared to when the lesson is in English alone.

FGIL5: *Ame kakwali naana ndi uditeko nawa shaashi ondi hole unene oshiingilisha* (I did not understand well because I like English very much). *Omulongi okwali takokoma unene shaashi iitya imwe yomoshiingilisha keishi nawa moshiwambo* (the teacher was stammering too much because he does not know some Oshikwanyama words in English)

FGIL6: *Okutya aike okulongwa oPhysical Sceince moshikwanyama oshiima shiwa lela shaashi okwali ndamanguluka oku pula noku nyamukula omapulo moshiwambo kaapena ou tayolonge ngeenge ndateya* (is a good thing to be taught Physical Science in Oshikwamya because I ask and answer questions freely without anyone laughing at me for breaking English). *Ohashikala shiindjuu okupula omapulo moshiinglisha kwaame shaashi kandi shishi* (I find it difficult to answer ask questions in English because I do not know it well).

4. **T. (*Ochemical bonding owei udako ngahelipi eshi wei longwa moshikwanyama?)* How did you understand chemical bonding when you were taught in Oshikwanyama?**

FGIL1: *ochemical bonding onde yuudako nawa* (I understand chemical bonding very well).

T: ommh…. why?

FGIL1: Because e*laka eli lalongifwa ondilishi nawa* (because I know the language that was used well).

FGIL2: *ame onde yuudako nawa shaashi otopic kai ndjuu* (I understand it well because the topic is not difficult).

FGIL3: *ame onde yuudako nawa shaashi oyalongwa melaka olo handi udu nawa loo no ondi lihole* (I understand it well because it was taught in the language that I understand and I like it). The teacher know to teach and he know physical sciencewell.

GFIL4: *okwali ndi uditeko nawa eshi omulongi talongo, ashike peembinga dimwe okwali handi hale oku ngwangwana shaashi omulongi okwali tanyengwa koshikwanyama* (I understand it well when the teacher was teaching, but at some point I almost confused because the teacher was struggling with oshikwanyama)

GFIL5: I understand it well but I sometimes oshikwanyama confused me

T: confused how? Can you please elaborate more?

GFIL5: because the teacher is not an expert in Oshikwanyama, he is forcing it.

FGIL6: *Otopic ondei udako nawa, oipu mboli* (I understand the topic well, it is easy).

5. **T: *Omashongo ashike wamona mokwiilonga ochemical bonding moshikwanyama?* (What were the challenges of learning chemical bonding through oshikwanyama?)**

FGIL1: *Omulongi wetu keli active moku popya oshiwambo yee nog ngeenge tapopi moshiwambo ohapopi unene pendu* (our teacher is not active when it comes to speaking Oshikwanyama, he speaks very low).

FGIL2: *oh…* *omulongi okwali tanyengwa oku fatulula iinya imwe moshikwanyama* (oh… the teacher was not able to put some words in Oshikwanyama).

FGIL3: *iitya imwe ili moshiinglisha kaina efatulolo moshiwambo* (some words in English are not in Oshikwanyama)

FGIL4: *ongaashi ashike vakwetu veshi popya nale, iitya imwe yomo shiingilisha kaina eemeaninga moshiwambo naashi okwali nee sha eta omulongi wetu akale talongo nuundjuu mo lesson* yee okwali takokoma unene ngeenge talongo

moshikwanyama (just like it was mentioned earlier by my colleagues, some words in English have no meanings in Oshikwanyama, and this made our teacher to really struggle in the lesson and he was stuttering too much)

T: ***opena vali ou ahala okuwedapo sha?*** **(is there anyone who wants to add anything?)**

FGIL5: *uupyakadi umwe ulipo oyou kutya iitya imwe yomoshiinglisha oina omeaning imwe moshikwanyama* (the problem is that some words in English have one meaning in Oshikwanyama)

T: ***ngaashi…*** **(like….?)**

FGIL5: *ngaashi toti* carbon dioxide gas, *moshikwanyama omhepo* yo carbon dioxide *ashik*e. gas, air no wind *aishe moshiwambo omhepo ashike.* (for example carbon dioxide gas in oshikwanyama gas is *omhepo*, so gas, air and wind their all *omhepo* in oshikwanyama)

T: ***okay… natuyeni kepulo laxuninwa*** **(okay… let us move the last question)**

6. **T:** ***Ouwete shili ngahelipi oku pula noku nyamukula omapulo poshikwanyama?*** **(How did you find asking and answering questions in oshikwanyama during chemical bonding lessons?)**

FGIL1: *F*

FGIL2: *Kwaamee… Okwali shidjuu unene kwaame, shaashi oshikwanyama ohandi mono shidjuu unene oku faafanifa noshiingilisha* (to mee… it was very difficult to me, because Oshikwanyama is difficult comparing to English).

FGIL3: *mhh… oshali shiwa unene oku pula noku nyamuka moshikwanyama, ashike uudjuu ouli aike apa ngeenge tokapulwa omapulo mo test ile mekonaakono oto mono ashike eshi tonyamukula omapulo moshikwanyama. Ito kiihaluka ashike wadopa shaashi inolongifa elaka lopambelewa.* (mhh… it was a very good thing to ask and answer questions in Oshikwanyama, however the problem is when you will be asked questions in a test or examination, you may end up answering in oshikwanyama. This will make you fail because you did not use the official language)

FGIL4: *oshiima oshili ngaha kutya, ohashike kala shipu okupula nokunyakula melaka eli hopopi, omunhu oho kala aike wamanguluka iho worry nasha* (the thing is, it is easy to ask and answer in the language that you speak, you are free and you do not worry about anything)

FGIL5: *okupula noku nyamukula moshikwanyama oshipu shaashi ngeenge to pula moshiinglisha oho kala vali to kondjifa oku tula iitya kumwe*. (to ask and answer questions in Oshikwanyama is easy you, because when ask questions in English you have to struggle to put words together)

FGIL6: *Naame ohandi tu kumwe na Maria* (pseudonym) *shaashi ame kandi wete naana shiwa, shaashi otashi tuningi tuvandede ndee hatukala aike tuhole oku pula nokunyamukala moshikwanyama, omanga omapulo meetestnomekonaakono hama pulwa moshiingilisha* (I am also agreeing with Maria (pseudonym) because I do not thing is a good thing, because it is making us lazy that we will only want to ask and to answer questions in Oshikwanyama, while questions in tests and examinations are asked in English.

T: ookay… this is the end of our group interview, thank you very much for answering the questions.

Appendix F: Stimulated Recall Interview

Appendix F1: Diagnostic test

Interview with Monica

Interviewer (Int): Good afternoon Monica

Monica (Mnk): Good afternoon Sir

Int: My question is a very short one…

Mnk: Okay Sir

Int: *Mo testa yoye yotete owa holola kutya ou uditeko nawa kutya ocovalent bonding oshike, hasho?* (In your diagnostic test you indicated that you understood the concept of covalent bonding better, is it so?)

Mnk: *Oshoshili Sir* (it is true Sir)

Int: *Okwali wushi uditeko ngahelipi?* (How did you understand it?)

Mnk: *Otashiti oku kanyatela kumwe* (it means to stick together)

Int: *Okwiikanyatela ngahelipi? Penge utale oshi holelwa.* (To stick together how? Can you give me an example?)

Mnk: *Ngaashi ngeno tolongifa oka glue kenya hakutiwa oka quick bond ngeenge totula kumwe oshiima shateka* (For instance when you are using a glue called a quick bond to put broken things together.)

Int: Using a glue?

Mnk: Yes Sir

Int: oh… I understand what you mean, thank you for this clarity.

(The interviewer gives the correct explanation of the concept of covalent bonding the learner)

Interview with Filly (Fly)

Int: Filly (pseudonym), when I was marking your diagnostic test (your first test) you indicated that covalent bonding is the relationship between people. neh?

Fly: Yes Sir

Int: What did you really mean by this?

Fly: Oh! Is…..

Int: *Manguluka oto dulu explain moshiwambo* (Feel free to express yourself in Oshiwambo.)

Fly: *Okwali nda hala okutyaa… eshi ndi uditeko bonding okutya ekwatafano liwa pokati komunhu nomunhu ngaashi ngaashi ngeno ekwatafano liwa eli lilikala pokati kameme wange name.* (I wanted to say, the way I understand bonding is like a good relationship between a person and a person, for instance the bond between my mother and I)

Int: How did you understand the word covalent?

Fly: *Aaye kakwali ndi shiudite kutya otashiti ngaipi kaya* (No I did not understand the meaning of covalent)

Int: *Kuudite ashike kutya otashiti ngaipi nande nande?* (You did not understand it at all?)

Fly: uuh aaye… mbela ….

Int: But after the lessons on chemical bonding, do you now understand what covalent bonding is? *Oto dulu okushi fatululila nge?* (Will you be able to explain it to me?)

Fly: Yes Sir

Int: *Shi fatululile nge utale*. (Can you please explain it to me)

Fly: Ommh… Covalent bonding…is… the sharing of electrons between atoms of non-metals to have full outershells.

Int: wow! This is wonderful, thank you so much for your time.

Fly: Welcome Sir

Interview with Mossy (Msy)

Int: Good afternoon Mossy (Pseudonym), how are you?

Msy: I am fine Sir.

Int: The question I am going to ask you is based on the diagnostic test. I am going to ask you about your answer you provided in question 4. In Question 4 you were asked to explain in your own words, what "molecule" refers to. Your answer was "*is a substances that can undergo diatomic molecules".* Why did you answer the question in this way?

Msy: (Look in the ceiling and scratched his head)

Int: *Oto dimbuluka nghee twalongifa oshiwambo meelesson detu?* (Can you still remember how we used oshiwambo during our lessons?

Msy: Eeno Sir (yes sir)

Int: *Okay natango oto dulu okulongifa oshiwambo wu lombwelenge eshi todilaadila* (Okay, you can still speak Oshiwambo to tell me what you are thinking about.)

Msy: Okay Sir

Int: *Okwali wahala okutya ngaipi* (what did you mean)

Msy: *Okwali ndahala okutya eemolecule dimwe ohadi ufanwa eediatomic molecule* (I wanted to say some molecules are call are called diatomic molecules)

Int: *Oo… oto dulu oku pange o example yo diatomic molecule?* (Oo… are you able to give me an example of a diatomic molecule?)

Msy: Example MgO

Int: So MgO is a diatomic molecule? Why?

Msy: *Shaashi oya ningwapo keelement mbali* (because is made up of two elements)

Int: *Owahala okutya shama o compound yaningwapo keelemente mbali ngaho o diatomic molecule?* (So you mean as long as a compound is made up of two element is a diatomic molecule?)

Msy: Yes Sir

(The interviewer explains to the learner what a molecule and diatomic molecule is)

Appendix F2: Post-intervention test

Interview with Inge (Ing)

Interviewer (Int): Good afternoon Inge and how are you?

Inge (Ing): I am fine Sir

Int: I have a very short question for you which is based on the answer you gave in the Post-intervention test.

Ing: Okay Sir

Int: *Omolwashike mopulo lotete komapulo male wa hoolola salt onga molecule?* (In the first question of the structured questions, why did choose salt as one the molecules?)

Ing: *Shaashi owati eemolecule odedi daningwapo kee non-metal da ninga ocovalent bonding* (Because you said molecules are those that are made of non-metals covalently bonded together)

Int: *Ashike omongwa ohau ningwapo ngeenge ometal no non-metal da bonding.* (But salt is usually made of a non-metal and a metal bonded together ionically)

Ing: *Oo… osho kwali shapukifnge osho* (Oo… that is what confused me)

Int: Oshike wafiilapo "oil"?

Ing: *Uhh…. Opo aike andi dimbuluka paife kutya moclass owati eeliquid andishe eemolecule*. (Uhh… I am just remembering now that in the lesson you said all the liquids are molecules

Int: *Ondati omolwashike eliquids hakutiwa eemolecules tuu?* (What did I say about why liquid are molecules?)

Ing: *Shaashi odangwapo kee non-metals* (Because they are made up of non-metala)

Int: *Keenon-metals daninga shike?* (By non-metals how)

Ing: Covalent bonding

Int: That is wonderful Inge, we come to the end of our interview, thank you so much for responding to the questions. Have a good day.

Ing: Okay Sir

Inteview with Ndapewa (Npw)

Int: Ndapewa I have a very short question for you.

Npw: Okay Sir

Int: Epulo 6 okwali talipula wu shangulule etumbulo miitya yoye mwene owashanga toti: "diatomic are molecules that are in period 2". Omolwashike watila ngaha?

Npw: *kakwali ndeluudako nawa kaya Aaye epulo* (I did not understand the question well)

Int: *Paife ou li udite nee?* (Do you understand the question now?)

Npw: *Yes, diamolecule eemolecule edi daningwapo kuu aatom vavali vaninga obonding yo covalent* (yes diamolecules are those that are made up two atoms bonded together covalently)

Int: Oh good!!! You are correct. Thank you for you for clarifying thing and have a nice day.

Npw: Oky Sir have nice day too Sir.

Interview with Mike (Mik)

Int: *Mike tangi eshi wanyamukula keshiivo lange. Ondiku na epulo lixupi lela shinasha no katest ko post-intervention*. (Mike thank you for responding to my invitation. I have a short question for regarding you post-intervention test.)

Mik: *Eewah Sir* (Okay Sir)

Int: *Epulo la 2. b) okwali talipila ufaneke efano tali ulike o covalent bonding mo Chlorine, omolwashike wafaneka ngaha?* (Question 2. b) was asking you to draw a diagram to show covalent bonding in Chlorine (Cl2), why did you draw like this?)

Mik: Mhh… *Ngaipi* Sir? (Mhh… like how Sir)

Int: *Tala aike efano olo nawa* (Just look at that diagram very careful)

Mik: (After looking at his diagram) *kandi wete pena epuko ame apa* Sir (I do not see any mistake here sir)

Int: *Keeshell doye daxuuninwa owa tulako uuelectron va* 10 (On the outer shells of Chlorine you put 10 electrons after bonding)

Mik: No Sir, I put 8 Sir…

Int: *Ahawe Mike, owatula uuelectron vavali kukeshe oshipambu shoshell oyo yaforminga po obond, ngaho otashiti meni lo bond owa tulamo uuelectrons vanhe. Ngeenge owa tula kumwe uulectrons aveshe oto mono uulectrons va 10 kukeshe oka atom* (No Mike, because you put two electrons on each part of the shell that have formed the bond, that means you put four electrons in the bond. If you count them together with those outside the bonds it will give you 10 electrons on each atom.)

Mik: Ohoo…

Int: *Ouwete kutya onda hala okutya ngaipi?* (Are getting what I want to say?)

Mik: Yes Sir, *mboli inandi ku uda nawa eshi kwali to explain*. (Yes Sir, it seems like I did not understand you well when you were explaining)

Int: *Ondati ngaipi hano mo class?* (What did I say in the class?)

Mik: *Owati oshell yalast ohai yada kuu electrons veli 8 kekale kwaai yotete… maar okwali ndishi ondili mondjila shaashi keshe ko shell onda tula ko uulectrons vavali…..maar mboli avashe ovelilepo eeshell adishe*. (you said the last shell is full when it holds 8 electrons except for the first on that holds two electrons only… but I thought I was correct because I put two electrons on each shell… but now realized that all the electron inside the bond are for all atoms.)

Int: *Okay, paife ouwete kutya epuko olili peni?* (do you now see where the problem is)

Mik: Yes Sir

Int: Paife oto dulu oku faneka ostructure yo Cl_2? (n

Mik: Yes sir