

**Understanding how teachers scaffold learners to make sense of biological
language and concepts when using English as a mediational tool:**

A case study

A thesis submitted in partial fulfillment of the requirements for the degree of

**MASTER OF EDUCATION
(SCIENCE EDUCATION)**

Of

RHODES UNIVERSITY

By

Elifas Nakale

December 2012

DECLARATION

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

Signature: Date:

ABSTRACT

For the past few years, Namibian grade 11-12 learners' achievement level in biology has not been very encouraging. Evidence to this effect is contained in recent examiners' reports which outline misunderstanding and various misconceptions.

The causes of these misunderstandings and misconceptions may be varied, but there is credible evidence that some of it is rooted in the language problem for learners. A classroom is a social unit where many social practices are acquired, including the use of English language. Equally, it is a place where errors in language are learnt and reinforced.

Triggered by these challenges facing biology learners, a qualitative case study was conducted at two secondary schools in Ohangwena Region, Namibia. Its purpose was to investigate how biology teachers scaffold learners to make sense of biological language and concepts when English is used as the mediational tool. Underpinned by an interpretivist paradigm, the study made use of document analysis, observation (lessons were also video-taped) and interviews to generate the data. Several data generating techniques were used for triangulation and validation. To further validate the data, transcripts of video-taped lessons and interviews were sent back to the research participants for member checking. The data gathering methods were also used in data presentation, analysis and interpretation to determine the extent of scaffold that teachers provide to their biology learners.

The main findings of my study are that, despite efforts by participant teachers to scaffold their learners in making sense of biological language and concepts, success rates in this regard remain disappointingly low due to their (teachers) limited pedagogical content knowledge. Teachers therefore require improved mentorship, monitoring and capacity building.

ACKNOWLEDGEMENTS

First and foremost, I would like to thank Almighty God who gave me strength and made everything possible for me to complete my study successfully.

I would also like to thank my wife, Martha, for her unwavering support she offered me throughout the duration of my study. The same goes to my children, Ndahafa, Ndangi, Etuna and Tsenaye for being patient with me when I kept a distance sometimes from them in order to concentrate on the study. My mother, Hileni Ezimbi kept me in her prayers always and this thesis is dedicated to her.

I would also like to thank my supervisors at the Directorate of Education in Ohangwena, Mr Isak Hamatwi and Mrs Sanet L. Steenkamp for being considerate and allowing me to take study leave now and then.

Special thanks go to my supervisor Dr Ken Ngcoza for his relentless effort and commitment in supporting me during my study. I remain indebted for his consistent support and words of wisdom. I would like also to thank my co-supervisors Ms Sarah Murray and Mr Charles Chikunda for their time and efforts in guiding me.

Many thanks to all the people who were involved in this study, including my two participant teachers. My fellow classmates have been team players and a source of inspiration and for that I thank you all.

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES.....	vii
LIST OF ABBREVIATIONS AND ACRONYMS	viii
LIST OF APPENDICES.....	ix
CHAPTER ONE	1
SITUATING THE STUDY	1
1.1 Introduction	1
1.2 Background to the study.....	1
1.3 Research goal and research objectives	3
1.4 The theoretical framework	4
1.5 Data generation techniques	5
1.6 Potential value of the study	5
1.7 Definition of concepts	6
1.8 Thesis outline	6
1.9 Concluding remarks	7
CHAPTER TWO	8
2.1 Introduction	8
2.2 Curriculum expectations	9
2.3 Language and concepts in Biology	10
2.3.1 Teaching learners how to talk science	10
2.3.2 Teaching biology to learners in a foreign language.....	14
2.4 Mediational tools other than language	16
2.4.1 Use of prior everyday knowledge.....	16
2.4.2 Code-switching	17
2.4.3 Use of graphs and charts	17
2.4.4 Practical activities	18
2.4.5 Use of analogies.....	19
2.4.6 Use of quality assessment techniques	19
2.5 Theoretical Framework	20
2.5.1 Socio-cultural perspective.....	20
2.5.2 Pedagogical Content Knowledge (PCK)	21
2.6 Concluding remarks	22

CHAPTER THREE	24
3.1 Introduction	24
3.2 Research design.....	24
3.3 Research approaches	25
3.3.1 Case study	26
3.4 Research site.....	27
3.5. The sample	28
3.6 Research goal and research question.....	29
3.7 Data generation	30
3.7.1 Document analysis	30
3.7.2 Observation	31
3.7.3 Interviews.....	32
3.8 Data analysis	34
3.9 Validity and Trustworthiness	34
3.10 Ethical considerations.....	35
3.11 Limitations.....	36
3.12 Concluding remarks.....	37
CHAPTER 4	38
4.1 Introduction	38
4.2 Teachers' Profiles.....	38
4.3 The selection of samples from each data set	39
4.4 Document Analysis	39
4.4.1 Textbook 1: GCSE Biology (3 rd edition).....	39
4.4.2 Textbook 2: Biology Module 1(2 nd), Grades 11-12.....	41
4.4.3 Lesson Plans.....	43
4.4.4 Learners' exercise/class activity books.....	45
4.4.5 Examiners' Reports.....	48
4.5 Lesson observation.....	49
4.5.1 School 1	50
4.5.2 School 2	53
4.6 Interviews	58
4.6.1 Interview (T1)	58
4.6.2 Interview (T2)	59

4.7	Concluding remarks	61
CHAPTER 5		63
5.1	Introduction	63
5.2	Analytical Statement 1:	64
5.2.1	Pre-planning	65
5.2.2	Elicitation of learners' prior everyday knowledge.....	66
5.2.3	Use of graphs and charts	69
5.2.4	Practical activities	70
5.2.5	Code-switching	72
5.2.6	Use of analogies	73
5.2.7	Use of quality assessment techniques	74
5.3	Analytical Statement 2:	75
5.4	Analytical statement 3:.....	79
5.5.	Analytical Statement 4:	81
5.6	Analytical Statement 5:	83
5.7	Concluding remarks	85
CHAPTER 6		86
6.1	Introduction	86
6.2	Summary of the findings	86
6.3	Recommendations	88
6.4	Limitations of the study.....	91
6.5	Areas for future research	92
6.6	My critical reflections	92
6.7	Conclusion.....	93
References.....		94
Appendices.....		99

LIST OF FIGURES AND TABLES

Figure 4.4.1(a)	Lock and Key Model
Figure 4.4.1 (b)	Practical work procedures
Figure 4.4.2	Example of glossary and hints
Table 4.6.1	Summary of factors/challenges faced by learners: T1's perceptions
Table 4.6.2A	Summary of factors/challenges faced by learners: T2's perceptions
Table 4.6.2B	Summary of T1 and T2 suggestions on possible methods to scaffold learners
Table 5.1	Analytical statements

LIST OF ABBREVIATIONS AND ACRONYMS

MoE-	Ministry of Education
PCK –	Pedagogical Content Knowledge
LTSM –	Learner-Teacher Support Materials
T1-	Teacher 1
T2-	Teacher 2
S1-	School 1
S2-	School 2
LP-	Lesson plan
Less1-	Lesson 1
Lnr1-	Learners from school 1
Lnr2-	Learners from school 2

LIST OF APPENDICES

- A- Permission request letter to the Regional Director
- B- Letters to the Principals
- C- Letters to the teachers
- D- Lesson plan
- E- Sample learner notes
- F- Sample learner activities for school 1
- G- Sample learner activities for school 2
- H- Interview Transcripts
- I- Video Taped lesson transcripts
- J- Document and Semi-structured interview schedules

CHAPTER ONE

SITUATING THE STUDY

Non- specialized academic words, crucial to success in understanding oral and written scientific discourse, are precisely the words English language learners are unlikely to know-they rarely occur in casual conversation, their meanings are complex, and they are less likely to be taught (Snow, 2008, p.73).

1.1 Introduction

This chapter introduces my study, the focus of which was on investigating how teachers scaffold learners to make sense of biological language and concepts when using English as a mediational tool.

The first section outlines the background, followed by the research goal and research objectives, the theoretical framework underpinning the study, data generation techniques used to generate data, the potential value of the study, definitions of concepts, and thesis outline. The chapter ends with concluding remarks.

1.2 Background to the study

My research study has been motivated both by personal experience in the teaching profession for about 12 years, and as a national marker for nine years. During that time I have observed many learners scoring low marks and eventually failing the examinations, mainly because of their inability to express their ideas properly on paper. It could also be assumed that this could be compounded by a mismatch or no alignment between the standard of teaching and the expectations of examiners.

Recent Namibian Life Science and Biology examiner reports attest to the fact that learners have a problem expressing themselves as far as biological language and concepts are concerned (2009-2010), as alluded to in the epigraph. The reports also point to misunderstandings and misconceptions about certain concepts.

In unpublished notes by the Chief examiner, Erni (2009) states that teachers of Biology must realise that not only do they have to teach content, but also the correct terminology, (the '*language of biology*'). She further indicates that Biology is a science and words have very definite meanings in all sciences. For instance, students write in the examinations that *respiration reaction produces energy* which is technically wrong, because energy is never produced, it is only *released* (Law of Conservation); or they write at a given point, *photosynthesis is fast*. It is not photosynthesis that is fast, but it is the *rate of photosynthesis which is faster*.

She further indicates that if words in a sentence are placed in the wrong order, they often convey a wrong meaning, although the candidate may have understood the concept. For example, '*more light will be bent*' has a different meaning from '*light will be bent more*'.

In addition, she observes that learners write: *Energy is changed to glucose/glucose is changed to energy*. In essence, energy cannot be changed to mass or mass to energy (under normal circumstances); learners do not understand the difference between matter and energy. Matter is made up of atoms and molecules (particles); energy is the ability to do work. This is science language learners have to master in addition to everyday language.

These language use and reasoning errors are why Kamini (2001), in his contribution, observes that "the differences in grammatical and reasoning patterns between everyday language and scientific language often act as barriers in students' construction of meanings" (p. 5). This is clearly evident in the above-cited examples.

I submit that it can be convincingly argued that language errors have different effects in different disciplines. Thus, grammatical or word sequencing errors in, say, an English literature class, even if systemic as some language errors often are for a particular group, do not usually have dramatic effects on understanding what the speaker intends to say. In fact, listeners often ignore these systemic language errors knowing what is intended. But in science, as illustrated by the few examples above, a seemingly minor misplacement of word order can dramatically change the very essence of meaning in an important and vital way.

The one-size-fits-all standard in curriculum instruction – viz., teach the science in a standard way regardless of the language circumstances of the students - is problematic and ignores the significant consequences for understanding the science that this produces in many students. This problem needs to be acknowledged in the Namibian context, where a significant number

of students are in the process of acquiring basic knowledge of a second language plus the language of the science discipline. Too often students are left to fend for themselves in the science classroom after they have acquired some minimum second language skills, yet many continue to experience academic difficulty that affects achievements in their subjects negatively (Gibbons, 2002).

This is why, in my view, the issue of how teachers help learners make sense of Biological language and concepts through the medium of English cannot go without being investigated. If such a situation is not addressed, it will serve as a continuing stumbling block to the realization of sufficient qualified citizens equipped in the sciences as envisaged in the knowledge-based society. Based on the Namibian Vision 2030 goals, the National Curriculum expects all biology students to become confident citizens in a technological world, to take or develop an informed interest in matters of scientific importance (Namibia, MoE, 2010). However, if learners are not proficient in the accurate use of scientific language in which the science subjects are taught in relation to content, this idea is doomed to fail.

Thus, since the level of achievement in biology nationally is not acceptable, and the languages issue might be part of the explanation, there is a need to better understand the nature of the effects of language competencies on the understanding of biology, and then to explore what might be the possible curriculum and pedagogic remedies.

It has been my intention to observe some biology lessons in two of the secondary schools in Ohangwena Education Directorate by pursuing the following goal and objectives:

1.3 Research goal and research objectives

The main goal of this research study was to investigate how teachers scaffold learners to make sense of biological language and concepts when using English as a mediational tool in grade 11.

To achieve this goal, the following objectives and questions guided the study. The question appears immediately after each objective:

- To establish how teachers scaffold learners to make sense of biological language and concepts when using English as a mediational tool; **Question:** How do teachers scaffold learners to make sense of biological language and concepts when using English as a mediational tool?

- To identify the language problems which lead to misconceptions through the use of English as a mediational tool in the biology classes concerned. **Question:** What are the language errors which lead to misconceptions through the use of English as a mediational tool in the concerned biology classes?
- To identify challenges experienced by teachers when mediating the learning of biological language and concepts in English. **Question:** What challenges do teachers experience when mediating the learning of biological language and concepts in English? and
- To establish how teachers could be supported on some of the challenges identified. **Question:** How can teachers be supported when mediating the learning of biological language and concepts?

Gray (2006) argues that learners were acquiring slightly different understanding of what it meant to be a science learner, as a result of the interplay between language, content, values and beliefs that varied somewhat in the classrooms he observed during his study. This argument resonates very well with the goal of my study as indicated earlier.

This is a baseline study in which I have identified and documented in context a reasonable sample of conceptions and misconceptions arising out of the English and unintended language errors made by biology teachers as they scaffold learners to make sense of biological language and concepts through using English as a mediational tool. These issues were also considered or noted on the side of the learners. I have attempted a preliminary categorization and analysis of the conceptions, misconceptions, errors and their effects on meaning making.

This study has perhaps laid some foundations for further work that should include developing appropriate long term interventions to help teachers correct these systemic language errors and misconceptions in their science classrooms, and thus provide a step forward in contributing towards the realisation of Vision 2030 and the more effective teaching and learning of biology.

1.4 The theoretical framework

A classroom is critical unit of socialization. It is a formal place new knowledge is constructed including effective use of English Language. It is also a place where a teacher exerts his or

her authority in terms of subject content and content representation based on the difficulties faced by the learners. Thus, the socio-cultural perspective or Vygotsky's (1978) theory and Pedagogical Content Knowledge (Shulman, 1987) were seen as appropriate analytical tools in this study.

1.5 Data generation techniques

The following data gathering techniques were used:

- Document analysis;
- Observation; and
- Interviews.

Various data generation techniques were used to enhance the validity of data. This is called triangulation of methods.

1.6 Potential value of the study

- It will potentially contribute to the role played by language in the learning of science, especially when students are learning in an additional language;
- It is of potential value to the Ministry of Education in Namibia regarding future policy formulation about the role of language in the learning of science;
- Probably more directly, it has the potential to help shape the training of future secondary school science teachers;
- Once the findings are reworked into appropriate training or resource material it may be useful to all practicing biology teachers;
- It may also be useful to upcoming researchers in the field of science and language, particularly the teaching of biology to English second language students; and

- As a short term intervention, it offers some support to teachers who participated in the research using the concrete experience gathered during the data gathering period.

1.7 Definition of concepts

The following are the key concepts often referred to in this study:

- 1.7.1 Scaffold-** Various forms of assistance given to learners as way of mediating the biology content by teachers.
- 1.7.2 Sense-making-** the ability of learners to relate biology language and concepts to their existing knowledge structures/life experiences.
- 1.7.3 Mediation -** A bridging process /method used by the teacher in scaffolding learners to access and make sense of subject content

1.8 Thesis outline

This thesis documents findings from two sites (schools 1 and 2) in Ohangwena Region. It consists of six chapters including the introduction.

In **Chapter 1** I present an overview of the context of the study, motivation for carrying out the study, research goal and research methodology, in which I shed light on the theoretical framework and methods used for data gathering during this winding journey of my case study, as well outlining other research protocols that were followed.

In **Chapter 2**, I review literature relevant to the study. The theoretical framework underpinning the work is provided in detail. In addition to the theoretical framework, the literature review chapter is sub-divided into six units to ensure that a sound background of the context in which the study was taking place was fairly covered.

In **Chapter 3**, I present the methodology used. I first present the interpretive paradigm informing the work. I also used pedagogical content knowledge as an analytical tool to process the data. I further discuss various data generation techniques that were used, the

research site and participants, the ethical issues, validity and trustworthiness as well as limitation of the study.

In **Chapter 4**, I present a narrative account of the data generated. The presentation is mostly in the respondents' own words with a minimum comment from me as researcher.

In **Chapter 5**, data analysis and interpretation is presented in terms of analytical statements developed from the emerging themes regarding conceptions, unintended errors and misconceptions of both teachers and learners, which may have some influence on the performance and achievement of learners in Biology examinations. Such interpretation could not be meaningfully done without insights from the Literature Review Chapter.

Finally, in **Chapter 6** conclusions are drawn with respect to the:

- (a) Findings that support or do not support previous work;
- (b) Implications of the findings for learners, teachers, researchers and teacher educators;
- (c) Suggestions for the teachers in the light of these findings;
- (d) Limitations of the study, and the need for further research
- (e) Lessons learnt from the study;
- (f) Recommendations; and
- (g) Personal reflections of my whole winding research journey.

1.9 Concluding remarks

In this chapter I have outlined all the sign posts that were put up and that guided the whole of my research journey. This started with the problem statement of the study, the research design, and all other research protocols used that culminated in the development of this thesis document.

CHAPTER TWO

LITERATURE REVIEW

Classroom education, to a large degree, is talk: it is the social use of language to enact regular activity structures and to share systems of meaning amongst teachers and learners. They use language to develop, in monologue and dialogue, the meaning relations and special ways of speaking and writing of particular school subjects (Lemke, 1989, p. 1).

2.1 Introduction

This chapter reviews the literature related to language and the learning of science, and in particular biology, which is the focus of my study.

I explore various international perspectives regarding how teachers scaffold or should scaffold learners to make sense of biological language and concepts when English is used as a mediational tool. The idea was to identify best practices as well as challenges those teachers and learners were faced with.

I also further explore the relevant learning theories regarding learning science (which includes biology) through a second language in order to situate this study in the appropriate theoretical framework.

The presentation of this chapter therefore takes the following structure: I start by contextualizing the topic of my research in the Namibian curriculum expectations, explore further the issues of language and concepts in biology, also highlight further the studies that have already been done regarding language and science, listing and discussing some useful mediational tools teachers should explore to help learners make better sense of biological language and concepts. I conclude by identifying and discussing the relevant theoretical framework that guided my study.

2.2 Curriculum expectations

The National subject policy guide for Natural Sciences (Namibia Ministry of Education, 2009) does not make direct reference to how science teachers should scaffold learners to make sense of scientific language and concepts as such.

However, it indicates that:

it aims to strengthen the development of scientific literacy, understanding of scientific process through which learners will be able to apply scientific thinking and skills in real-life situations, as outlined in the Curriculum for Basic Education (p. 2).

That in itself could be achieved through various forms of mediation such as the appropriate use of language, inter-personal relations, learners' prior everyday knowledge and/or practical work in order for learners to express their ideas accurately.

The National Subject policy guide was developed in line with the Language Policy for Schools in Namibia, which was drafted immediately after independence and a countrywide consultation. The following were some of the criteria taken into consideration to develop the policy:

- The expectation that a language policy should facilitate the realisation of the substantive goals of education;
- 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 required; and
- The need for learners to be proficient enough in English, at the end of the seven-year primary school cycle, to gain access to further education as well as to a language of wider communication (Namibia, Ministry of Basic Education, Sport and Culture, 2003, p.1).

The Language Policy for Schools in Namibia (Namibia Ministry of Education, 2003) further emphasises that “in order to be literate, one should not only speak well, but also know the written language, as language is the system of human expression by means of words” (p. 1). In other words, the language policy recognises the critical role of language in facilitating the acquisition of new knowledge and experience, in particular in the context of this study.

In addition, it is widely believed that expression through the use of words should be supplemented with other equally valid means of communicating ideas. This requires flexible teachers in terms of their own ability to reflect on their teaching in their efforts to support learners.

These include amongst others: practical activities, analogies, prior everyday knowledge and pictures.

It should be noted that one of the aims of the National Basic Curriculum is to:

provide, through well designed studies of experimental and practical science, a worthwhile educational experience for all learners, whether or not they go on to study science beyond this level and, in particular, to enable them to acquire sufficient understanding and knowledge to become confident citizens (Namibia, Ministry of Education, 2010, p. 3)

This statement makes provision for teachers to explore a variety of ways of providing support and to effectively communicate the content knowledge to the learners.

2.3 Language and concepts in Biology

2.3.1 Teaching learners how to talk science

Lemke (1990, 1989) explores how language is used in secondary schools to communicate and construct meanings in science. He highlights the fact that learning science, which includes biology, involves learning how to talk science meaningfully. He suggests that to talk science means learning to use specialised conceptual language for reasoning and problem solving, which many teachers find challenging. In addition, he clarifies that learning science (biology) also means developing the capacity to communicate in the language of science and act as a member of the community of the people who do so. These issues, in the Namibian context, seem to be learners' main challenges, but equally they are teachers' challenges, because if a teacher becomes well experienced in handling them, learners might not have difficulties any more.

Content area instruction provides a meaningful context for English language and literacy development, while language processes serve as a vehicle for understanding academic content (Hart, 2003; Kocakulah, Ustunluoglu, & Kocakulah, 2005). According to Kocakulah, et al. (2005), students who study main courses in a foreign language have difficulty connecting new and old information meaningfully. They cannot store much in long term

memory and they lose information easily. This is assumed to be one of the main challenges facing the majority of the Namibian learners doing biology, especially at secondary level.

Because the concept definitions are written in English, it takes serious cognitive processes and relentless support to unpack them and make meaning out of them. For learners to develop appropriate concept meaning, appropriate mediation method and skills are further required. In agreement with Kocakulah, et al. (2005), I think science is and should be regarded as a discipline in which experiential and concrete examples should be presented as part of in-class processes in order to improve students' conceptual understanding and levels of attainment. Since the main mediation method for enhancing learners' conceptual development is English - a second language in this context - there is a need for learners to be conversant with it and/or to be supported using other forms of mediating the content.

Kamini (2001) writes that "the differences in grammatical and reasoning patterns between everyday language and scientific language often act as barriers in students' construction of meanings" (p. 5). It is important for biology teachers to understand this distinction to better support biology learners.

This line of thinking is also supported by Probyn (2004) who argues that learners should understand English language first before they can express themselves meaningfully. For example, it is one thing to know about the definition of the concept, but it is another for learners to demonstrate such understanding as well as to be able to apply the concept in real life situations.

To demonstrate such an understanding involves showing the relationships between terms and concepts (Kamini, 2001). The teacher's role is thus to assist learners and to show them how the concept works and how it should be articulated meaningfully. There are several ways of doing this.

Ali and Ismail (2006) observe that learners need to develop the necessary language proficiency for them to achieve success in school. They quote Cummins' (1986) distinction between two kinds of language proficiency: Basic Interpersonal Communication Skills (BICS) and Cognitive Academic Language Proficiency (CALP), to explain the kind of language necessary for academic achievement.

Further drawing from Cummins (1986), they explained that CALP is a kind of language which is cognitively demanding and disembedded from any context and it is usually abstract

in nature. He further argues that, unlike BICS, CALP takes longer to develop and can only happen when first language works interdependently with the second language which is being targeted. CALP is the type of language proficiency required to read textbooks, and to participate in dialogue and debate, and written responses.

Cummins' views resonate well with Nelson's argument (1996) that:

the unique contribution of human language is that it serves to communicate representations of state of affairs between individuals, transferring complex information from one mind to another, and structured in such a way that its transference maintains to an important degree the intended form and content of the original (p.121).

This indicates that a bidirectional function exists, with two interrelated roles: that of speaker/messenger and that of listener/interpreter. In other words, mental representation (MREP) of the speaker must be transformed into a language format that represents its intention. In the case of the listener, the external linguistic representation (LREP) must be internalised, interpreted, and transformed into an MPREP again that represents the intention of the speaker (Nelson, *ibid*). I believe this to be an essential frame of reference for realizing effective classroom dialogue when it comes to science language and concepts.

The challenge in the Namibian context appeared to be limited knowledge and skills on how to effectively engage the role of language during the presentation of lessons.

In view of the above argument, Noordin and Yong (2009) argue that some students who are English second language speakers do not have the necessary tools to construct advanced science concepts. As a result, learners encounter problems in understanding the instructions for activities, experiments and some of the questions given in the examination papers. In writing their answers they sometimes put words in the wrong sequence, which can result in a meaning different to what they intend. However, I argue, based on personal experience as an Advisory Teacher, that in many cases, the intentions of the teacher are also not communicated clearly, leading to misconceptions on the part of the learners.

To illuminate the picture painted above, the following are some examples of learners' responses taken from the examiner's reports: '*respiration reaction produces energy*' which is technically wrong, because energy is never produced; it is only *released* (Law of Conservation of Energy). In another example, a student had written that '*optimum temperature is the best temperature for the enzymes activities*', but in essence it is the

temperature where enzymes work best. The word best should describe the activities of enzymes and not the temperature.

It appears that some of the learners resort to rote learning for their tests and examinations, which is likely to have serious consequences when it comes to conceptual development and understanding. There should be ways of avoiding this by the teacher employing appropriate methods of mediating the students' learning.

I further assume that if science teachers do not have the required capacity to deliver quality support to learners, it is unlikely that those learners will be able to give out what they themselves did not receive. As a result, students have to imitate and internalise inappropriate information and strategies that may lead to misconceptions. Thus, it is teachers who should facilitate students' comprehension and better sense-making of biology content by providing students with concrete content experience that helps harmonize classroom biology with their life experiences.

Pea (1993), and Lantolf and Thorne (2007) also share this sentiment in their social perspective. Drawing on Vygotsky's work (1978), they observe that one comes to internalise the perspective externally first in social relations mediated by a more *knowledgeable other* (thus progressing from interpsychological to intrapsychological functioning; emphasis mine). Chaiklin (2003) concurs with the above conception. His view on the common conception of the zone of proximal development (ZPD) as adapted from Vygotsky (1978) is that it presupposes an interaction between a more competent person and a less competent one on a task, such that the less competent person becomes independently proficient at what was initially a jointly-accomplished task. I assume in this case, that teachers are considered to be the more knowledgeable others who ought to determine the level of learners' development and then determine their tasks accordingly.

Pea (1993), however, cautions that it should not be assumed that the process of internalisation is a simple one. He says "it cannot be simple as such, because the mind of the learner, in the midst of the cultural richness of social interaction, is not simply a sponge soaking up social process into mental life" (p. 267). This implies that there should be careful and deliberate efforts to support learners through various ways.

Apart from teachers' exposition that may not be learner friendly, Noordin and Yong (2009) also observe that the language used in the textbooks exceeds the normal experience of many learners for whom they are written.

It is generally assumed that textbooks are essential tools for teaching and learning, but it requires effective mediation on the part of the teacher. According to Van Heerden (2010), the responsibility of the author is to produce well-structured texts which should be supported by clear visuals. In agreement with Van Heerden, I think textbooks should contain a glossary for new and unfamiliar words or new meanings should be shown in brackets as a way of supporting learners to use the textbook effectively. It is for these reasons that Van Heerden refers to the textbook as a 'teacher helper' and I concur with her.

Carrier (2005) adds another dimension to this study. She suggests that teachers need to help learners develop scientific literacy by making use of Scientific Literacy Objectives (SLO). These objectives focus on the literacy skills that all students need to effectively participate in science learning. She cautions, however, that one of the common mistakes teachers tend to make when preparing science literacy objectives is to focus solely on vocabulary acquisition and not consider the structure in which the vocabulary is used. For example, in a cell inquiry lesson, students need to describe the shape of the cell they observe. In that, they need to know specific descriptive vocabulary, such as smooth, rough, square, rectangular, regular, irregular and patterned versus random appearance.

One more useful suggestion that Carrier (2005) makes, however, is that teachers could scaffold English Language Learning (ELL) to develop the ability to use science vocabulary in grammatically correct and fully formed sentences by providing sentence frames, also called sentence builders. As learners become proficient in the use of language and literacy skills, teachers can gradually withdraw some of the support so their students assume more responsibility for their science literacy. Herein rests Vygotsky's (1978) notion of scaffolding.

2.3.2 Teaching biology to learners in a foreign language

Kocakulah, et al. (2005) conducted a study in Turkey to look at the effect of teaching in native and foreign language on students' conceptual understanding in a science course. They used a causal-comparative research design to determine the differences between students who

took the science course in native and foreign language and the effect of language on conceptual understanding. Their results revealed that students who were taught a particular concept in a foreign language, namely English, had more misconceptions than those who were taught the same concept in their own mother tongue. The teacher's challenge (in the Namibian context as well) is therefore how to overcome misconceptions when mediating biology content through English to speakers of other languages. Learning new concepts in a foreign language takes up more space in the short term memory, making it difficult to connect new information to what is already known. As a result, learners cannot store much in the short term memory and lose information easily.

In a study conducted in schools in British Columbia, Kamini (2001) reported that teachers were unsure about how to teach English Second Language (ESL) students in mainstream classes due to the fact that learning academic content through ESL is quite a challenge. The above-mentioned examples of challenges were further highlighted by the discovery of a close relationship between language and conceptual understanding in science. Such a study was a comparative one done by Noordin and Yong (2009), who investigated students' achievement and problems they encountered by learning Biology in English in Public and Private schools in Britain. Their findings indicate that there was a positive correlation between their achievement in English and in Biology. Higher achievement in English also meant more achievement in Biology.

Kamini (2001) echoes similar sentiments. In his research paper, he observes that learners' success in science depends both on the acquisition of English language skills and academic content as their context dictates. The teachers' challenge is, according to Probyn (2009), to teach both the language and the content to learners.

The following quotation from Rosebery (2008) reminds teachers that the problems students encounter are not a result of poor academic ability:

Although students' language and cultural differences present teachers with instructional challenges, it is important to remember that these challenges are not the result of intellectual deficits in students. The diversity in the background and life experiences of students represents a source of considerable intellectual and pedagogical power for both teachers and students- rather than an obstacle that must be overcome (p.2).

When teachers recognize, understand and build on this diversity, it can be an asset in any classroom and the biology classroom is no exception.

2.4 Mediational tools other than language

2.4.1 Use of prior everyday knowledge

It is my opinion that for enhanced concept development and language sense- making to take place, teachers need to make use of different forms of mediation. Other than language explanations and descriptions, the use of prior and everyday knowledge can assist learners' progress better in conceptual development.

In support of the use of prior knowledge, Roschelle (1995) argues that new knowledge begins with the selection of ideas from everyday experience. In fact, he claims that new knowledge does not replace prior knowledge, rather new knowledge re-uses prior knowledge, and it is prior knowledge which is refined. He further argues that learning involves three different scales of changes whereby 1) learners assimilate additional experience to their current theories and practices, 2) an experience causes a small cognitive shock that leads the learner to put ideas together differently and 3) Though very rare, learners undertake major transformations of thoughts that affect their whole ontological view of the world. The above understanding could be very useful to all biology teachers for meaningful teaching and learning to take place.

In view of the foregoing, Kamini (2001) cautions that prior knowledge of concepts in the first language is not directly transferred to the second language. This is in line with the ideas expressed by Lemke (1990, p. 11) that “the assumption that English Second Language (ESL) students already understand what a concept means because they have learned the concept in their first language cannot be taken for granted”.

This point is critical for teachers to exercise caution in their approaches, but if properly explored, it may generate more insights regarding learners' conceptions and these insights could be used to develop an intervention to support teachers.

2.4.2 Code-switching

According to Lemke (1989), miscommunication is most dangerous when we convince ourselves that we are in fact communicating, but our partners in dialogue do not see it that way. Not just more dialogue, but different kinds of dialogues, and perhaps different styles, registers or contexts of social activity will be needed to improve the communication.

In view of this, Probyn (2009) explored other ways to overcome language barriers during teaching and learning of science in particular in the South African context. Her findings suggest that code-switching from English to the vernacular language may help with cognitive reasoning in response to learners' limited English proficiency. She acknowledges, however, that code-switching is in conflict with the language policy and those teachers sometimes had to 'smuggle' vernacular into the classroom. This only indicates that code-switching is covertly done to a large extent and not recognised as a legitimate strategy. Her findings therefore reveal that there is a gap between theory and practice when it comes to reality in a classroom, a situation which echoes well the Namibian context.

It was further noted that code-switching as learning and teaching resource has its own challenges (Hart, 2003). For example, the teacher may try to simplify a concept, but in the process may misrepresent it. Such views show that for effective code-switching to take place, there is a need for the teachers' capacity development in this regard.

2.4.3 Use of graphs and charts

Another meaningful way for learners to make sense of concepts is through graphs and charts to represent abstract concepts and processes, such as reactions and growth. Rosebery (2008) found out through her case study (Do plants grow every day?) that graphs are useful in science learning. She discovered that graphs help in making sense of the invisible concepts and in critical thinking. She further argued that learning to make, read, interpret, and use charts and graphs is key to acquiring a scientific perspective. It is for this reason that the Biology syllabus (Ordinary level) makes provision for data to be presented in various forms such as tables, graphs for example, Pie charts, Bar charts, Column Graphs as well as Histograms.

2.4.4 Practical activities

A supplementary method to empower English Second Language learners is by allowing them to engage with concepts by carrying out practical activities using the available resources. A worksheet could be prepared well in advance with the learners' inputs. The worksheet should make provision for learners to predict what would happen prior to the actual practical activity results. It has been my experience as well that practical activities may help learners make sense of concepts better, because they (learners) are making use of most or all their senses and that would increase the information retention as well as the retrieval rate.

Hart (2003) further argues that hands-on activities are less dependent on formal mastery of the language of instruction, and thus reduce the linguistic burden on English Language learners. This is an opportunity that teachers should surely explore.

Research findings by Maselwa and Ngcoza (2003) further say the following regarding learners' views on practical activities. Learners feel that practical activities minimise rote learning and are powerful in promoting conceptual development and understanding of science. These authors also found out that the majority of learners are in favour of doing practical activities themselves in order to experience science first hand. They warn, however, that science teachers should be careful not to equate activity with learning and they should thus be always mindful of the key scientific concepts they would like to develop during such practical activities.

In the context of the Namibian Curriculum, it is further articulated in the Biology syllabus that:

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

The curriculum is essentially suggesting that when a practical activity is to be done, learners should be involved from the beginning (planning stage) to the end to avoid it being prescriptive (Hodson, 1990) and therefore defeating the whole philosophy of using practical tasks in a lesson.

In motivating why science teachers need to be creative and innovative in their design of science teaching, Woolnough (1994) states that doing science, in school or at work, is a

holistic activity involving the will and the imagination as well as the mind and the hand. It should not be reduced to fragments of knowledge and skills.

Hodson's (1990) research further produced acceptable justifications for doing practical activities such as: to motivate (learners will find it worthwhile to learn science), by stimulating interest and enjoyment; to teach laboratory skills; enhance the learning of scientific knowledge and give insights into scientific method, and develop expertise in using it. In my opinion, these justifications would need to be translated into a well-structured intervention to be used to train science teachers so that the old adage 'I hear and I forget, I see and I remember, I do and I understand' becomes deeply ingrained in school science.

2.4.5 Use of analogies

Bean, Searles, Singer and Cowen (1990) propose that analogies, although difficult to construct by a novice teacher, may be used effectively by an author or teacher to guide students' concept learning. They further found that reasoning by analogy is one way that students may develop knowledge structures for unfamiliar concepts and these could be some of the possible solutions that our biology teachers may try. They therefore suggest supplementing text analogies to assist students' understanding of difficult concepts. Some teachers are already doing this unintentionally, and therefore have difficulty in assessing the effectiveness of the method.

2.4.6 Use of quality assessment techniques

Woolnough (1994) argues that student assessment in science is a necessary aspect of science teaching. In other words, assessment should be viewed as part and parcel of science teaching. Woolnough (ibid) claims that there is tension between reliability and validity of assessment, which represents one of the challenges faced by science teachers. This argument has exposed the danger posed by some assessment activities given to learners which are not of good quality. I therefore would like to further argue that there is a need for teachers' capacity development to address the above- mentioned tension, because each assessment task should be both valid and reliable. This will obviously have bearing on achievement level in biology examinations. Therefore, there is a need for teachers to thoroughly familiarize themselves with their assessment policies to ensure that they set standardized assessment tasks.

2.5 Theoretical Framework

2.5.1 Socio-cultural perspective

A classroom is a social unit where many social practices are acquired, including the use of English language. But equally is it a place where mistakes in language may be learnt and reinforced. Thus, the socio-cultural perspective or theory of Vygotsky (1978) seems to be one of the appropriate theories to underpin my study.

Boran (2004, p. 368) says the following about socio-cultural theory: “we must keep in mind that the learning conditions of the individual, the interactions of the individual with the teacher and other learners; the individual’s cultural background all affect the learners’ success in the learning of the target language”. This emphasizes the fact that there is need for a teacher to take into consideration these factors when planning a lesson for meaningful teaching and learning to take place.

In my view, English language being part of the cultural tools of a wider community, it should be used in an appropriate way to enhance the learning of the biological language (‘target language’) and concepts in the classroom. It is for this reason that in my research I would like to observe the dialogue between the teacher and learners. This will help me to understand how the teacher socializes learners into making sense of biological language and concepts and determines the challenges he/she is experiencing. This (teacher scaffolding learners) formed the basis of my data analysis, in addition to language errors and challenges facing teachers.

Lantolf and Thorne (2007) argue that the following are essential forms of mediation: regulation, symbolic artifacts and language. By regulation in this case, it is observed that children are firstly externally regulated before they reach the point of self-regulation in terms of their behaviour. Symbolic artifacts, which include language, are essential, because such a tool:

imbues humans with the capacity to free themselves from circumstances of their immediate environment and enables us talk and think about entities and events that are displaced in both time and space, including those events and entities that do not yet exist in the real world (e.g. building planned by the architect) (Lantolf & Thorne, 2007, p.202).

Regulation in this regard implies that teachers ought to support learners in an appropriate form of socialization until such time as those learners can reason independently. This is an essential component of the social-cultural perspective.

It is further worth noting Pea's (1993) idea regarding the acquisition of knowledge by learners through a mechanism of conceptual change. He puts forward a social framework proposing that crucial aspects of learning are mainly done through conversations among persons, involving the creation of communications and attempts to interpret communications.

He maintains that creation and interpretation are inverse processes of human conversational action through which the meaning of symbolic action is negotiated. He further observes that communication is thus not viewed in terms of one-way meaning transmission, but rather two-way transformative communications that lead to conceptual change. Such views underscore that teachers and learners involved in the study and beyond are expected to talk to one another in a clear and meaningful way.

Steers, Malcolm and Kowlas (2003) have the following views about mediation. They argue that although individuals can personally construct the knowledge, it has to be socially mediated as a result of cultural experiences and personal history. They further argue that "culture, as a contextual lens through which learners view and understand the world, has a direct influence on learners' cognitive processes and understanding of science" (p.31). In this case, the classroom culture is important.

2.5.2 Pedagogical Content Knowledge (PCK)

According to Shulman (1987), Pedagogical Content Knowledge (PCK) "represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organised, represented, and adapted to diverse interests and abilities of learners, and presented for instructions" (p. 1). In other words, Shulman is putting forward a strong argument that a teacher is someone who knows something not understood by others, in this case, probably learners. It is the teacher therefore who has to find better ways to unlock the content knowledge that learners do not understand through well-structured and contextualized teaching.

It is against this background that my study is further informed by the theory of PCK as crafted by Shulman (1986/1987). PCK is further defined by Van Driel, Verloop and de Vos

(1998) as teachers' knowledge developed through an integrated process rooted in classroom practice, which includes knowledge representation of subject matter and understanding of specific learning difficulties and student conceptions. They further argue that such a definition implies that prospective or beginning teachers may have little or no PCK at their disposal. This fits very well with the topic of my study.

The two participant teachers in my study have distinct experiences of teaching at grade 11 level. One has over five years' experience whereas the other is relatively new: this is his third year of teaching biology at grade 11. The different experiences of the two teachers are also likely to enrich the insights on the issue under study. It is acknowledged, however, that the fact that a teacher is experienced cannot necessarily translate to quality teaching.

PCK as a construct has helped me understand different repertoires being used by these teachers as they provide support to learners as they make sense of biological language and concepts.

Loughran, Mulhall and Berry (2004) talk about teachers' knowledge of practice often being tacit, making it influence both what teachers talk about and the manner in which they talk about their teaching. Engaging participant teachers has enabled me to see the extent to which they have developed the concept of PCK, although they may not be able to articulate it verbally. The concept of PCK is critical in teaching science beyond the teaching of facts to teaching for understanding. It has equally helped me to observe if there were any contradictions between what the teachers do in the classroom and what they say in the interview. The purpose of the interview was mainly for generating more insight into teachers' practice when it comes to how these two teachers negotiate meaning- making of biology concepts.

2.6. Concluding remarks

In this chapter, I have explored how teachers, in general, negotiate or are expected to negotiate meaning of biology language and concepts. This was considered by contextualising it within the Namibian Education Policy and Language in Education Policy as well as exploring international scholars' work in relation to the challenges faced by the teachers.

Critical issues that emerged include, amongst others, the need for learners to be properly socialized on how to talk science, appropriate subject representation and the need for teachers to be able to understand the students' learning difficulties. Inability to do so makes it difficult to communicate meaningfully. This work was explained in the context of socio-cultural theory as well as PCK theory.

CHAPTER THREE

RESEARCH METHODOLOGY

A qualitative design is emergent, the researcher usually does not know ahead of time every person that might be interviewed, all the questions that might be asked, or where to look next unless data are analysed as they are being collected...the process of data generation and analysis is recursive and dynamic (Merriam, 2009, p. 169).

3.1 Introduction

The main focus of my research study was to investigate how teachers scaffold learners in making sense of biological language and concepts when using English as a mediational tool. This chapter therefore gives details on how I explored the research topic and question. The chapter discusses the fine points of the research design and methods that I used to generate, analyse, discuss and interpret the data. I have carefully chosen the methodological design (as summarized in the epigraph) that was used in order to achieve the aim and objectives of the research study. I further explain in this chapter various techniques used to generate data in order to ensure that the recommendations and conclusion made from the data are comprehensively ethical, valid and trustworthy.

3.2 Research design

This study is premised on the assumption that learning science involves learning how to talk science meaningfully within a social context as proposed by Lemke (1990/2001). This implies that learning science means developing a learner's capacity to communicate accurately in the language of science and act as a member of the community of people who do so.

The study has therefore taken an interpretative approach to get a clear understanding of socio-cultural practices within the context of biology classrooms. According to Cohen, Manion and Morrison (2007, p. 36), "the aim of interpretive research is to provide a rich description of the phenomenon and, if possible, to develop some explanations". This approach has therefore

enabled me to understand the situation beyond the ‘obvious’ in the play of language in the teaching and learning of science, in particular, Biology, in the complexity of the lived experience of the classroom. It has further helped me develop my own skills in this regard to a high level through a concrete and context-dependent experience.

Henning, Van Rensburg and Smit (2004: 20) note that phenomena and events are understood through mental processes of interpretation which are influenced by and interact with social contexts. This is in agreement with the ideals of the socio-cultural theory underpinning my study (see Section 2.4.1).

It is essential therefore that data generated are well analysed, discussed and interpreted for better understanding, as eloquently expressed by Merriam (2009) in the epigraph at the beginning of the chapter. In addition, I decided to include a limited intervention as part of my study in order to offer support to teachers, hoping it would help them improve their practice. This was clarified during feedback sessions to the teachers concerned. Cohen, Manion and Morrison (2007) further emphasize that the data sets yielded should include the meanings and purposes of those people who are their source.

This study is a Namibian case study which focuses on two schools in order to come up with detailed and coherent information on which future researchers could build (case study is explained later in detail under 3.3.1).

3.3 Research approaches

According to Neshuku (2009), the research design should show how all the major parts of the research study work together to address the central research question, from planning of the inquiry to designing the strategy for data collection and analysis.

In this research study, different approaches and tactics have been used to generate data and analyse it in order to address the research question fully in a coherent and systematic way.

3.3.1 Case study

A case study refers to the study of the specific instance which provides a unique example of what is being studied in a real situation, enabling the researcher to have deeper understanding of the situation under study (Cohen, Manion & Morrison, 2007). Cohen, et al. (2007) further explain that a case study investigates complex, dynamic and unfolding interactions of events, human relations and other factors in a unique instance. In addition, sometimes researchers focus on a single case, perhaps because its unique or exceptional qualities can promote understanding or inform practice for similar situations (Leedy & Ormrod, 2010).

My project is a case study of two schools in Ohangwena region (see Section 3.4). Since I was trying to understand what real people do in their real situations, this further makes my case qualitative in terms of methodology. The data generated were analysed and interpreted within the context in which they were produced.

The study focused on the classroom interactions between teachers and learners. These interactions were video-taped (see Section 3.4.2.2). Since I was focusing on classroom interactions, socio-cultural theory provided an appropriate framework. Boran (2004, p. 368) states that “we must keep in mind that the learning conditions of the individual, the interactions of the individual with the teacher and other learners; the individual’s cultural background all affect the learners’ success in the learning of the target language”. In other words, the conceptions and/or misconceptions in biological language and concepts of a teacher could be reflected in learners’ understanding.

This study is further informed by the PCK (see Section 2.5.2). According to Shulman (1987), PCK

represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organised, represented, and adapted to diverse interests and abilities of learners, and presented for instructions (p. 1).

Thus Shulman is putting forward a strong argument that a teacher is someone who knows something not understood by others, in this case learners, and should find some meaningful way of representing it to be understood by them. It is against this background that I made use of PCK as an analytical tool.

3.4 Research site

The study was conducted at the two sites mentioned earlier. One site has been coded as School 1. It is a Senior Secondary School with Grade 11-12, about 60 km from Ondangwa. The second has been coded as School 2, a secondary school about 90 km from Ondangwa. Site 1 is a rural school while site 2 is in an urban area in Eenhana, northern Namibia. It has been my opinion that getting views from contrasting environments could be insightful, although the idea is not to compare the two schools. The learners' first languages at both sites are mainly Oshikwanyama. A handful speaks Oshindonga, but the language of teaching is English - a Second Language to both teachers and learners.

The majority of grade 11 learners in these schools take Biology as one of their six subjects; however, in many cases it is not supplemented with Physical Science, which serves as a basis for understanding the biochemistry part of biology. From my experience as a biology teacher, I have found that learners who are doing a combination of biology and physical science do better in biology than those who do not, probably because many concepts in Biology revolve around the chemistry part of Physical Science.

The two sites are in Ohangwena which is one of the 13 political regions of Namibia, and in the northern part of the country, forming borders with the southern part of Angola. According to the 15th school day Statistics of 2012, Ohangwena has 243 schools: 117 Primary schools, 107 combined schools, 7 Junior Secondary and 12 secondary schools.

A NAMIBIAN MAP SHOWING THE 13 POLITICAL REGIONS



- | | |
|----------------------------------|------------------------------|
| 1. Caprivi | 6. Khomas |
| 2. Erongo | 7. Kunene |
| 3. Hardap | 8. Ohangwena |
| 4. Karas | 9. Omaheke |
| 5. Okavango | 10. Omusati |
| 12. Oshikoto | 11. Oshana |
| 13. Otjozondjupa | |

Source: http://en.wikipedia.org/wiki/Regions_of_Namibia: Retrieved on 07 August 2011

3.5. The sample

Convenience sampling was used in this study. Cohen, Manion and Morrison (2007) note that in convenience sampling, researchers simply choose the sample from those to whom they have easy access. Bryman (2001) echoes similar sentiments to Cohen, Manion and Morrison on convenience sampling. He views it as the sample that is simply available to the researcher by virtue of its accessibility.

From the 12 secondary schools in the region, I chose two that I could easily access, especially in terms of distance, given the vastness of the region. Also, I am acquainted with the Biology teachers at these schools. These teachers were the respondents and their lesson presentations were my unit of analysis. I was aware that my position could be a validity threat to the data gathered, since I was their former Advisory Teacher. As result, I tried in my communications with the teachers to ensure that we were on equal footing throughout my research.

I also felt that the two teachers could be free to tell me their honest opinions, as they usually did when I was their Advisory Teacher for Biology. In this study, I mainly worked with one of the grade 11 classes at each of the two sites. These classes were chosen by the teachers at their own discretion.

3.6 Research goal and research question

The main goal was to investigate how teachers scaffold learners in making sense of biological language and concepts when using English as a mediational tool.

To achieve this goal, the following questions guided the study:

- 1) How do teachers scaffold learners to make sense of biological language and concepts when using English as a mediational tool?
 - To answer this question, I analysed documents such as learners' exercise and note books, lesson plans, the biology syllabus (ordinary) Grade11-12, the national policy guide on natural science and examiners' reports.
- 2) What are the language errors leading to misconceptions through the use of English as a mediational tool in the concerned biology classes?
 - To answer this question, I observed lessons which were videotaped, analysed learners' exercise and notes books, as well as their textbooks.
- 3) What challenges do teachers experience when mediating the learning of biological language and concepts in English?
 - To answer this question, I observed lessons, analysed lesson plans, examiners' reports and interviewed the teachers.

- 4) How can teachers be supported when mediating the learning of biological language and concepts?
- To answer this question, I observed lessons and I discussed them with the teacher through the use of a Stimulated Recall Interview (SRI).

3.7 Data generation

The following data- gathering techniques were used:

- Document analysis;
- Observation; and
- Interviews.

Several data generation techniques were used, with the intention of enhancing the validity of data through triangulation of methods.

3.7.1 Document analysis

Document analysis refers to the technique of making inferences by objectively and systematically identifying specified characteristics of messages in documents (Bryman, 2001). According to Cohen, Manion and Morrison (2007, p.201), “Document analysis has several attractions. It provides a platform for the researcher to reach out to even inaccessible subjects as in the case of historical research”. One of the advantages of document analysis is their unobtrusive nature and therefore non-reactive to the researcher such that one can infer on issues with minimum human reaction (Merriam, 2009).

In my case, document analysis offered me a potential platform to gather relevant and rich data. Through document analysis, I could track teachers’ lesson plans, for example, in order to understand how they had been going about supporting learners in making sense of biological language and concepts before I came to their school.

Other documents included textbooks used by the teachers, learners’ homework and test books, the National Subject Policy Guide, the Biology syllabus as well as the examiner’s

reports. I expected these documents to reveal types of support teachers had given to their learners and challenges they (the teachers) were facing. The Biology syllabus and the National Subject Guide on Natural Science provided the curriculum expectations in terms of what teachers should teach and how. Possible indicators were, for example, how written work was marked and whether there was any evidence of teachers helping learners rephrase sentences, make comments, corrections done by learners and so forth.

3.7.2 Observation

Observation is one of the techniques I used to generate data, which offered the opportunity to gather 'live' data occurring in a social situation (Cohen, et al., 2007). According to Cohen, et al. (2007) with observation, the researcher has an opportunity to look directly at what is taking place *in situ* (primary) rather than relying on second-hand information. In my view, in addition to what the above authors' indicated, observation also has the potential to generate first-hand data. For example, I observed that I was able to pick up information that I did not think of when I was planning my research.

I further agree with Cohen, et al. (2007) when they say that what people do differs from what they say. Observation offers a reality check. This shows that observation can afford a researcher an opportunity to look at what would otherwise have gone unnoticed.

I also believe that I was likely to uncover respondents' 'windows' that they themselves were not aware of (for example, I observed that teacher 1 was doing unreasonably more of the talking than learners, but did not realize it).

During my observations, teachers were expected to conduct normal lessons and learners were expected to participate in the lessons as per the instructions of the teachers. Four lessons for each teacher teaching the topic on Enzymes were observed in order to get more insight into the phenomenon under study.

I was aware, however, that an open-ended observation approach requires much more reliance on the observer's memory, and this increases the possibility of bias.

To minimize such bias, the learners' and teachers' conceptions, challenges, language errors and misconceptions were noted, while my critical friend videotaped the lesson. The use of video in this case was seen as appropriate because non-vocal activities such as facial expressions, gaze direction, and gestural displays serve - along with vocal activities - as

communicative interpretive resources for participants in interaction (Clayman & Gill, 2004). As a result, insights were generated regarding teachers' ability to support learners in making sense of the biological language and concepts when English is used as a mediational tool. I further looked at whether the teachers were using other mediation methods to scaffold learners in making sense of biological language and concepts as a supplement to explanations.

In a similar vein, while observation has the potential to contribute to the richness of the research findings, in this case it may have contributed as well to the professional growth of the individual teachers involved in my study as explained below.

3.7.3 Interviews

Semi-structured interviews

A semi-structured interview is flexible, allowing new questions to be brought up during the interview as a result of what the interviewee says. It is eminently suited to exploring views, experiences and attitudes of participants. It is about searching for meaning and understanding (van der Mescht, 2011).

All my interviews were conducted after the lessons and this was done with all the teachers in the sample in order to get more insights from them regarding their experiences and also providing an opportunity for them to reflect on their teaching with special attention to the support they had given to the learners (on biology concepts' sense making), methods used to offer such support and challenges thereof.

Stimulated Recall interviews (SRI)

At some points during my stay at the two sites, I managed to watch the videos on the lessons together with the teachers, during which I could pause so that I could probe further in order to get more clarity regarding what had happened in the classroom. According to Lyle (2003), stimulated recall (SRI) "is an introspection procedure in which (normally) videotaped passages of behaviour are replayed to individuals to stimulate recall of their concurrent cognitive activity" (p.861). It is seen as a good approach for one to understand a phenomenon under study holistically. However, Lyle warns that narratives produced from SR may not

represent the conscious or unconscious cognitions taking place at the time of the videotaped episode.

The stimulated recall in my situation, however, served as a useful basis for me to discuss with the teacher what the best practices were, as well as the challenges and misconceptions that emerged from the video, and how such misconceptions and unintended errors could be rectified. It also served as a validation process (see Section 3.9).

In support of this process, Gass (2000) observes that to understand adequately the choices teachers make in classrooms, the grounds for their decisions and judgement about pupils, and the cognitive processes through which they select and sequence actions they have learned while teaching, we must study their thought processes before, during and after teaching.

In addition, member checking is seen as a strategy to increase validity whereby the participants are asked if they thought the researcher's recording or interpretation were correct representations of their views.

Initially, the idea of stimulated recall in this study was only to capture the reflections of the participant teachers on their lessons and come up with baseline data. However, after having observed some misconceptions both teachers and learners were making, and the challenges this represented, I decided to offer some support and guidance to these teachers where I could. I wanted my study in the end to benefit both my participant teachers and learners even if it was on a small scale. The support I offered to these teachers was not a structured one, but was rather a response to challenges of language errors, and misconceptions that were observed. The teachers were requested to rectify such identified problems in subsequent lessons in any way they saw fit. My interventions were based on the following, eloquently expressed idea of Schram (2006):

Experiences do not speak for themselves as worth of your attention. As a qualitative field worker, you cannot view your task simply as matter of gathering or generating 'facts' about 'what happened'. Rather, you engage in an active process of interpretation: noting some things as significant, noting but ignoring others as not significant, and missing other potentially significant things altogether (p.9).

My observation and interpretation that the participant teachers were in need of support was of significance to me, hence the support given.

3.8 Data analysis

According to Henning, Van Rensburg and Smit (2004), data analysis literally means to break down data into bits and pieces or to break down data by categorising it. This is also in most cases informed by the theory (socio- cultural theory and PCK in the context of my study) in which the research study is located and directed by the research questions for this particular study (Lankshear & Knobel, 2004).

Data analysis includes identification of themes that were inductively derived from the data, and such themes were translated into analytical statements which are discussed and interpreted in Chapter 5.

During the data analysis and interpretation, I used PCK (see Section 2.5.2) as an interpretive approach, in an effort to explain and understand the type of support teachers gave their learners, their innovativeness or lack of it in terms of content representation (mediation), best practices that were observed, misconceptions held by learners, unintended language errors they made, challenges they faced as well as the teachers' contextual understanding of their learners (Abell, 2008 ; Loughram, Mulhall & Berry, 2004).

The above-indicated analytical approaches allowed the analysed data to speak for themselves, but in alignment with the research questions.

3.9 Validity and Trustworthiness

As mentioned earlier, I made use of triangulation to enhance the validity and trustworthiness of my data. According to Cohen, Manion and Morrison (2007),

Triangulation techniques in the social sciences attempt to map out, or explain more fully, the richness and complexity of human behaviour by studying it from more than one standpoint...Triangulation is a powerful way of demonstrating concurrent validity, particularly in qualitative research (p. 141).

Triangulation thus helps one to detect errors made in the analysis of the data gathered. Cohen, Manion and Morrison (2007) further suggest that exclusive reliance on one method is likely to bias or distort the researcher's picture of the particular slice of reality being investigated.

For example, if I concentrated only on the learners' side of the story as picked up during the analysis of their tests and exercise books regarding the challenges they were facing as far as the expression of Biological concepts were concerned, then I might miss out on the reality that was happening in the classroom. For this reason, triangulation is very useful in any research undertaking.

Although there are different kinds of triangulation methods, I made use of the observation (of lesson presentation), interviews and document analysis. Watching the video-taped lessons with the teachers was also a form of validation of what happened in the class. In addition, after interviews were transcribed, transcripts were given back to the teachers in order for them to validate what was in the interview transcripts. This is called member checking (Leedy & Ormrod, 2010). In this case, however, when transcripts were sent back to teachers, T1 made few changes which had to do with language/grammar correction which could in a way serve as a validity threat.

3.10 Ethical considerations

I have followed the normal procedure in this kind of research with regard to ethical considerations. According to Collaham and Hobbs (1998:1), the primary concern of a researcher should be the safety of the research participants. Privacy and confidentiality issues should also be approached with utmost care. They cannot be ignored in that they relate directly to the integrity of a piece of research and of the disciplines that are involved (Bryman, 2001).

To address this, I wrote to the Regional Director of Education of Ohangwena Region to obtain permission to carry out my research in the schools in the region (see Appendix A). I also asked permission from the two school principals and individual teachers in formal letters (see Appendices B & C). I further requested teachers to ask permission from the parents for learners who took part in the research.

I informed the participant teachers of the purpose of the research and told them that all the information would be treated confidentially. I made it emphatically clear that participants were free to withdraw from the research at any point if they wished to do so.

On arrival at the first school, coded as School 1, I was given an office from which to operate. This served as a sign of confidence that the school had in me. At the second school, coded as School 2, I operated from the Library, but that was due to lack of space. At the end of my visit, both teachers indicated that they would continue consulting with me whenever they experienced problems with their lessons. In my view this shows that a good rapport had been established with the teachers.

3.11 Limitations

Being based on two schools in Namibia, the results of this study cannot be generalised. However, the study provided insights into how biology teachers in these specific schools scaffolded learners to make sense of Biological concepts, and the challenges that confronted them. I recognise that the teachers' understanding of the learners' challenges, and that of their own, was quite limited as observed. This further limited the insights they could provide during the interview discussions. I also understand that my position as a senior official at the Regional Directorate of Education in the region could serve as a perceived threat to the participant teachers.

The following methodological dilemmas were experienced:

School 1

- Four days of research were reduced to two, due to a death on the side of the participating teacher. On day one, the teacher made an arrangement with another teacher to use her lesson period. This implies that two lessons were observed in each of the two days.

School 2

- I had fears that the teacher might withdraw because as the time drew closer to my trip to his school, it took him longer to respond to my short text messages as to whether he was ready for the next morning;
- Some days, we struggled to get a camera man;

- The interview at school 2 was poorly recorded and it appeared the voice recorder was malfunctioning; this had a bearing on how the transcribing was done; and
- One teacher asked me to confirm or clarify an issue when he was not sure during the observation of one of the lessons. Since it was a matter of yes or no, I asserted that the learner's answer was right, but made no further elaborations.

3.12 Concluding remarks

In this chapter I have described the research design used to generate insights that illuminated my study. I have also focused on the data- generating techniques used to answer my research questions. Analysis of documents, interviews and observation were the main tools for generating data. I took into consideration the ethics, triangulation methods and limitations of the study, and explained the method of data analysis and how data were interpreted to draw conclusions regarding the findings.

CHAPTER 4

DATA PRESENTATION AND ANALYSIS

Analysis is a breaking up, separating, or disassembling of research materials into pieces, parts, elements, or units. With facts broken down into manageable pieces, the researcher sorts and sifts them, searching for types, classes, sequences, processes, patterns or wholes. The aim of this process is to assemble or reconstruct the data in a meaningful or comprehensible fashion (Jorgensen, 1989, p. 107).

4.1 Introduction

In this chapter, I present the findings from the data gathering techniques used for this study, namely, document analysis, observation and semi-structured interviews which were reinforced with stimulated recall interviews

In Chapter 3, I indicated that this research study was motivated by my personal experience in the teaching profession for about 12 years, and as a national marker for nine years where I have observed many learners scoring low marks and eventually failing the examinations. My assumption is that this could be due to the inability of learners to express their ideas properly on paper as a result of English being the medium of instruction, and a second language to them. To a certain extent, such experience has served as baseline data for this study. Data from document analysis, observation and semi-structured interviews formed the main material for this study.

This chapter commences by outlining the teachers' profile information, which I consider crucial, so that the data presented is properly contextualized. I then describe how the examples of each situation or each data set were chosen. Thereafter, findings from each technique are presented as per the given situation generated from different data-gathering techniques used.

4.2 Teachers' Profiles

Two participant teachers were involved in this study.

Teacher 1 (T1), at School 1, teaches Biology and Geography in grades 11 and 12. She has a BEd Degree from the University of Namibia and has specialized in Biology and Geography. She has been teaching these subjects for over 6 years.

Teacher 2 (T2) teaches at School 2 and has a Basic Education Teacher Diploma (BETD) and Mathematics and Science Teachers' Extension Programme (MASTEP) from the University of Namibia, specializing in Biology. He has been teaching Biology for over three years, but his total teaching experience is nearly eight years. Before he started teaching Biology, three years ago, he was a Life Science teacher.

4.3 The selection of samples from each data set

Samples of data sets presented in this chapter were chosen according to the following categories, and in line with the research questions:

- Overall scaffolding given to learners by teachers;
- Frequency and quality of assessment tasks given;
- Best practices observed;
- Unintended language errors that lead to misconceptions;
- Challenges faced by the teachers; and
- Missed opportunities.

4.4 Document Analysis

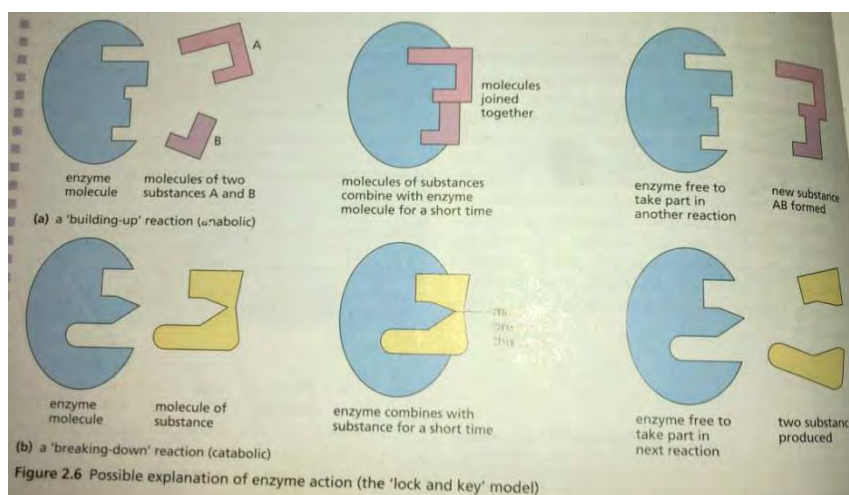
Two text books have been analysed, namely; GCSE Biology (3rd edition) and Biology Module 1(2nd). They were chosen, because the participant teachers indicated that these are the ones that they mainly use.

4.4.1 Textbook 1: GCSE Biology (3rd edition)

This textbook includes the topic of enzymes. Based on my analysis of the textbook, the language and pictures used are appropriate for senior secondary level, which includes grade 11. However, the absence of a glossary at the beginning of each chapter to explain key concepts for the chapter, at times, makes the presentation of information in the textbook more clinical, meaning that concepts are not easily understood because they are not contextualized (Van Heerden, 2010).

It is encouraging, however, to find that the illustrations and suggested experiments/practical activities used are reasonable enough and duly explained at every step or stage (see the example that follows).

Figure 4.4.1 (a) shows well explained illustrations of enzyme action ('LOCK AND KEY') MODEL)



The example of enzyme - controlled chemical reactions mentioned such as photosynthesis, respiration and digestion were not contextualized enough, probably because this textbook was designed for all countries that were using the Cambridge system. While some examples may be familiar to many learners, there is room to add more familiar examples such as fermentation reaction that are more contextualized to learners' experiences. For example, what learners see at their homes as their parents prepare different homebrews as well as other local examples.

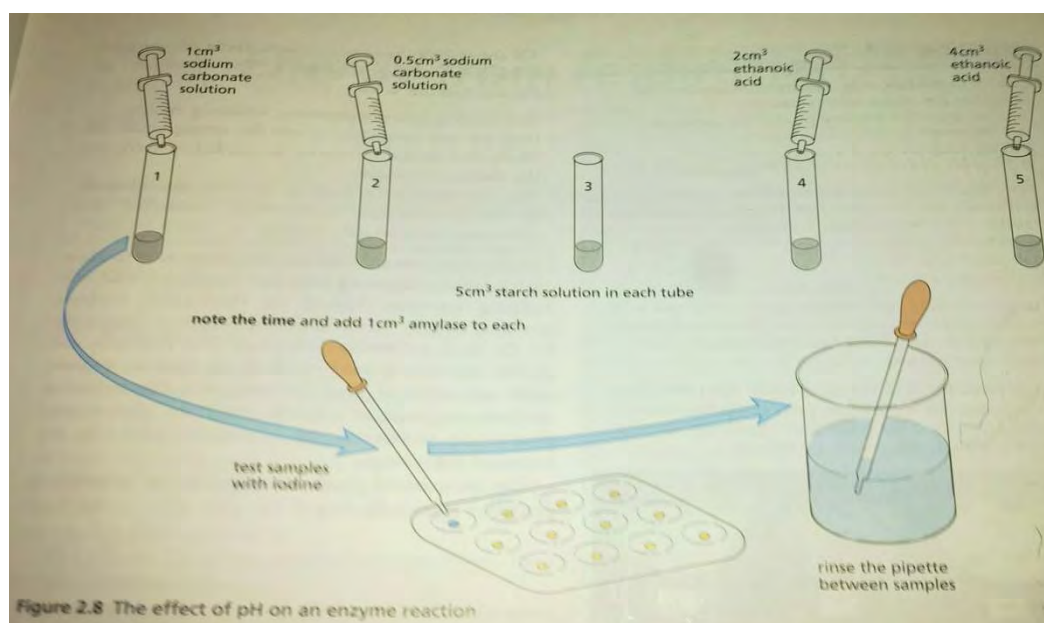


Figure 4.4.1 (b) shows well explained practical work procedures and it is given a title

The textbook has also adopted user-friendly procedures for carrying out practical work. This has potentially provided a ‘hands on’ approach to mediating learning. It could therefore be concluded that this textbook is intended to promote interaction, involvement and effective dialogue between learners and their teachers during the Biology lessons. An example is shown below:

The content for learning about enzymes in this textbook is structured as follows:

- Enzymes;
- Enzymes and temperature;
- Enzymes and pH;
- Enzymes are specific;
- Rates of enzyme reactions;
- Intra- and extra-cellular enzymes;
- Practical work with three different practical activities clearly illustrated, and
- Enzymes in industry.

4.4.2 Textbook 2: Biology Module 1(2nd), Grades 11-12

This module textbook is one of the biology modules (1-4) written for the Namibian biology syllabus and to a certain extent contextualized by the Namibia College of Open Learning (NAMCOL). The typical examples given appeared to have come as a result of long experience of marking and setting examinations at National level. I have observed that the Namibian author and the Reviewer of these modules were marker and Chief Marker of the National Biology Examination respectively.

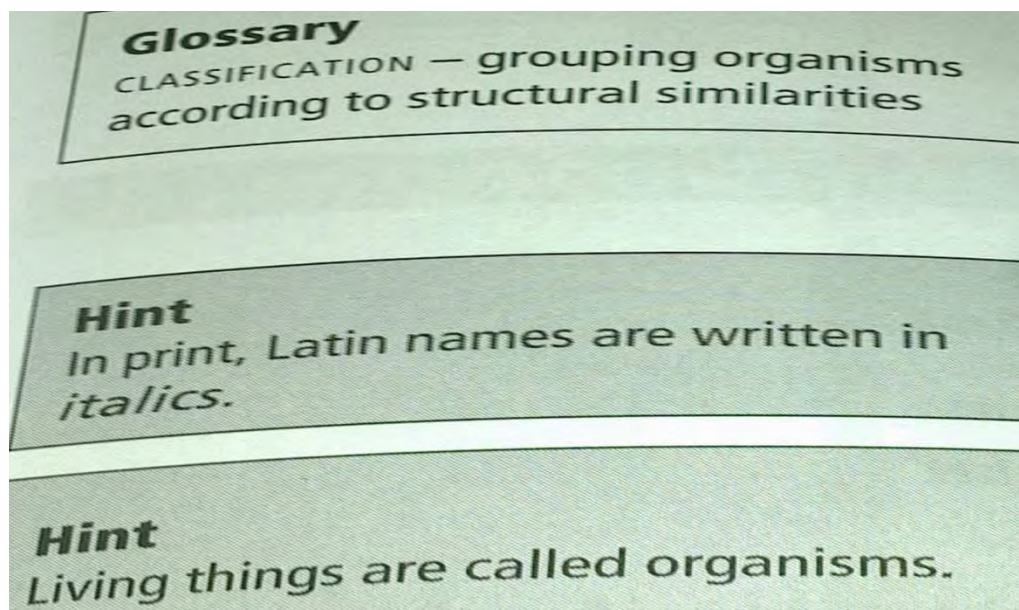


Figure 4.4.2: Shows how supportive the textbook module is

As it can be seen from the picture above, for each subtopic, there is a provision for glossary and 'hints'/explanation for new concepts. The textbook further contains model examination questions that can be very useful especially to novice teachers in terms of setting assessment tasks for learners.

There are, however, fewer mistakes than in the GCSE Biology (3rd edition) and clarity is not always given to all issues.

For example, the textbook only indicates that starch is digested to maltose which is soluble, but it does not clarify that all sugars are very soluble in water because of their many [hydroxyl groups](#). It is for this reason that learners need to be cautiously guided in the use of these modules' content by a competent teacher, for them to stand a good chance of having their performance improved in the subject. The limitation with this textbook, however, is that the content is structured strictly according to the basic competencies of the syllabus, which might make learners' learning scope narrower. For instance, the content in this Module1 textbook is structured as follows:

- Enzymes;
- Properties of enzymes;

- Metabolic reactions;
- Classification of enzymes;
- Experiments and Control;
- Substrates and products;
- Enzymes and proteins;
- Active sites and enzyme specificity;
- Lock and key mechanism;
- Effect of temperature and pH on enzyme activity; and
- Enzymes in everyday life.

As indicated earlier, the content and sequence of information is based on the basic competences in the syllabus and are systematically arranged to allow for smooth progression from simpler to complex ones.

4.4.3 Lesson Plans

In Namibia, a lesson plan is usually a structured tool developed to guide teachers as they prepare and present lessons. All teachers are obliged to have a lesson plan for every lesson. As per the requirements of the National Standards and Performance Indicators for Schools in Namibia, a lesson plan should have specific component details and focus. Such template is always made available to each teacher at every school and each teacher is expected to add details to it, depending on the topic of the day (as an example, see Appendix D). In my opinion, if the template is correctly completed, this would enable teachers to follow it easily and teach with understanding. I now discuss each of the teacher's lesson plans.

Teacher 1 (T1):

The lesson plans for T1 have not met the above-mentioned criteria. Apart from well- outlined objectives, the details of the lesson development are lacking. On the lesson plan for 14 February 2012 for example, I observed an interesting case where she wrote:

“Based on the learners answers about enzymes, teacher present feedback by the help of a poster, teacher present information more about enzymes through presentation and questioning methods. Teacher also asks learners to explain how they understand the word enzymes, temperature, pH and properties. We also summarize the main points” (see Appendix D S1: LP1)

The above information does not reveal what particular issues would be discussed or the exact questions that the teacher would ask learners in the lesson and if taught for the second time under similar conditions, it is likely that information provided would show discrepancies. From my own experience, in the absence of a well-structured lesson plan, the lesson presentation is likely to lose focus. So, the dialogue in the class would not be purposeful.

In addition, assessment activities or homework given are not always well structured. In one of the lesson plans, T1 wrote the following in the homework space “*oral questions, classwork Activity 2 and 3*”. It was not a good idea for the teacher to give homework orally and it was not clear which particular questions the teacher would pose to the learners.

As per the prescription of National Standards and Performance indicators, the teacher had indicated on the lesson plan how she planned to develop learners’ reading and writing skills. She wrote “*Teacher asks at least one learners (sic) to read loud correct mispronunciations; Teacher mark’s learners work and correct misspelled terms*” (See Appendix D S1:LP1).

While the initiative of the teacher is commendable in this regard, sometimes one wonders about the level of concentration and commitment the teacher puts into the preparation of lesson, given the unclear tasks she developed. As a result, the effectiveness of the scaffolding given to the learners could leave much to be desired.

Teacher 2:

In addition to the objectives, in lesson 2, T2 was somewhat specific and added some details, albeit limited. He wrote:

“Ask learners to define enzymes and comment on learner definition. Ask learners to mention the properties of enzymes. Jot them down on the chalkboard and explain each of them. Learners may ask questions or give comments. Use diagram for more clarity if learner got difficulty” (Appendix D S2: LP1).

In his lesson plan 3, he was even more specific. He said he would give the definition of pH (which stands for proportion of hydrogen/potential hydrogen and measures the acidity and alkalinity of a solution). He indicated that this explains the degree of acidity or alkalinity of a solution. He also explained the effect of pH on enzymes with reference to amylase, pepsin and lipase. Although such good examples existed in lesson 3, this was not the case with lesson 4. It was therefore clear that there was no consistency in terms of putting up of sign

posts and making deliberate efforts to support learners in making sense of biological language and concepts. Yet, progression is very important during lesson presentations.

The homework given in the lesson plan was also not well structured. It read, “*Find out about the effect of temperature and pH*” (Lesson plan dated 13.03.2012). It was not clear what the effect of temperature and pH was the question asking and what learners should do after they found out.

In some cases, learners were not given any homework at all and the teacher wrote on the homework part that “*no homework*” and the spaces for developing learners’ reading and writing skills were often left blank as well. In some cases, instead of giving homework, the teacher wrote classwork which might limit the learners’ development to work independently. One expected that learners would often be given activities to do at home in an effort to increase their individual contact with the content and develop tips and techniques of answering questions as per the prescription of the National Standards and Performance Indicators.

4.4.4 Learners’ exercise/class activity books

At the time of collecting the data, learners were just starting the topic of enzymes. As such, there was nothing in their exercise books regarding enzymes, especially at school 1. At school 2, at least one activity was conducted on the topic. I, however, managed to look at the activities done in other topics for both teachers. I found out that activities given were mainly assessing the assessment objectives of knowledge with understanding, because questions posed were mainly requiring learners to remember facts and their understanding and/or explanations of such facts.

The other two assessment objectives that should as well be assessed are: Handling information, application and solving problems; and practical skills and abilities. These received very little attention. The following are the explanations of the three assessment objectives as per the Biology (Ordinary) syllabus 2010:

- Assessment Objective A: Knowledge with Understanding (assesses learning content that learners need to recall and explain);

- Assessment Objective B: Handling information, Application and Problem Solving (requires learners to use principles and concepts that are within the syllabus and apply them in a logical, deductive manner to a novel situation); and
- Assessment Objective C: Practical Investigation and Experimental Skills (assesses learners' practical skills).

Table 4.4.4: Shows the analysis of assessment items given to learners in terms of how much they cover all the required assessment objectives as mentioned above

School code and Date	Type of activity	No. of questions	Assessment objectives covered	Objective frequency
1(08 Feb 2012)	Class activity	1(with five sub-questions)	A	A= x5 B= x0
1 (30 Jan 2012)	Homework	2	A & B	A= x1 B= x1 C= x0
1 (14 Feb 2012)	Class activity	3	A	A= x3 B= x0 C= x0
2 (14 March 2012)	Class activity	6	A & B	A= x2 B= x4 C= x0
2 (23 Feb 2012)	Homework	5	A	A= x5 B= x0 C= x0

From the analysis in Table 4.4.4.1 above, it could be concluded that teachers do not do much to support learners regarding their exposure to high- order thinking questions that are likely to help them to better make sense of biological language and concepts and become critical thinkers. The syllabus explanations of these objectives imply that much of the critical thinking is learned through assessment objectives B and C. As such, it could be argued too

that even teachers' critical thinking would be limited because the type of answers they are getting from learners would be straightforward and less challenging.

School 1

In limited cases, activities with questions addressing all the above-indicated assessment objectives were observed, as can be seen in the Table above. It was encouraging, however, to observe that with most activities given, learners had a chance to make corrections which had been monitored by the teacher, who signed next to it to indicate that she made sure those learners copied answers correctly.

However, apart from writing excellent or very good, there were no guiding or suggesting comments in learners' books. It is possible that learners might not have any idea why a particular answer (s) was said to be correct (justification of the answer).

Contradictory notes from the teacher had been observed in the learners' note books as shown in the examples below (E1-E2 from S1:N1-3):

E1: *"Amylase breaks down large carbohydrate molecules, such as starch into simple sugars" (glucose) and in the next paragraph "Amylase hydrolyses the glycosidic (sic) of polysaccharides, such as starch which is changed to maltose"* (maltose is double sugar and not a simple sugar).

E2: *"Pepsin breaks down large molecules of protein into small amino acid molecules"* and in the next paragraph she wrote: *"pepsin digests the protein by breaking it down into polypeptides"*

As can be seen, the end product of digestion (of proteins) by the same enzyme differs which is not possible). It could be concluded that should a learner write any of those above-mentioned examples, their teacher would be inclined to mark the learner correct. But the reality is that amylase never breaks down starch into simple sugars and pepsin never breaks down protein into amino acids, different enzymes are responsible for that (Maltase and Trypsin respectively). The average activities marks ranged between 4-9, which further limited the probability of learners being assessed in all assessment objectives and chances for learners to be assessed in the work covered.

School 2

Question items set in assessment activities given to learners which required them to evaluate, predict, and analyse issues were limited and where they were included, learners often missed them. It seems that learners' exposure to such types of questions is quite limited. From the activities done in exercise books, only one activity indicated that learners were required to do corrections. The few corrections given to learners were also not always correct.

In one case, a learner made the following correction "*At a temperature of 40°C, the proteins in the enzyme may break down and the enzyme will no longer be able to perform its job in the body*"(see Appendix F: S1 CA1). This clearly indicates that the learner was not able to see that the enzymes are proteins and that they are not two different things. In another activity, one learner wrote "*the reaction increase*", and the learner was marked correct. Yet, the reaction would not increase under any circumstances, but rather the rate of a reaction would. In other words, the time component in the process would be missing should the term 'rate' be left out.

Although learners missed some of these questions, T2 had not written any comments or guidance as to what was expected from them. It is most likely that learners would miss the same question should it appear in the final examination. It could also be concluded that platforms for learners to develop better sense- making of concepts were limited because of the type of questions their teachers usually ask.

It was also not clear when the teacher allocates a mark, for what exactly the mark was given, and what should be in the answer for it to warrant a mark. In other words, there were no clear marking points.

Regarding activity 4, given on the 14 March 2012, a mark was given despite the fact that the sentence did not make any biological sense. It read, "*The temperature is not at normal rate of reaction, they slowly destroyed*" (see Appendix G: S2: A1). This was another interesting case from the side of the teacher's commitment and /or understanding of the subject content.

4.4.5 Examiners' Reports

Examiners' reports for 2009-2011 were analysed. Key issues noted were that it appears that teachers use everyday language to teach and explain difficult concepts, to make them easier

for learners to understand, although such an approach is not acceptable for sciences such as biology (concepts can easily its essence). It was further reported that learners experience problems when comparing processes. The reports emphasized that when comparing two processes, comparative words must be used, for example ‘higher and lower’; ‘larger and smaller’; less/fewer and more’.

The reports further gave hints on plotting of graphs. Explanation was given of when to draw a Histogram, line graph and a bar graph. It is further emphasized that the curve must occupy more than 50% of the graph paper provided, because it was often observed in the examination that many learners usually use inappropriate scales resulting in smaller graphs. In addition, the reports revealed misconceptions learners have when it comes to physical quantities. It appeared that learners were often very vague when describing physical quantities, for example they would say ‘amount’ when they should refer to *volume, mass or number*.

4.5 Lesson observation

Observation was one of the data- gathering techniques used in this study. It offered me an opportunity to gather ‘live’ data occurring in a social situation, which in this case was a classroom (see Section 3.7.2). It enabled me to see how the two participant teachers were able to support their learners in making sense of biological language and concepts, which was the focus of this study.

I was able to observe misconceptions on both sides, unintended errors made, and challenges facing both teachers and learners. Although this was not a structured observation, I wanted to see if the teachers could also foresee the challenges faced by the learners with regard to English and therefore use various methods to support learners as lessons progressed. After every lesson or two lessons observed, each teacher was given an opportunity to reflect on their own lesson (see Appendix J), and only afterwards was feedback given to them in anticipation that this would assist in improving subsequent lessons.

Four lessons were observed for each teacher. Each lesson lasted about 40 minutes. On one occasion, a double period lesson of about 80 minutes at School 1 was observed for the reason explained in Chapter 3, Section 3.11. The data presented here are from my field notes as well as the videotaped lessons.

4.5.1 School 1

Lesson 1 (40 min)

The lesson started with the teacher introducing me (the researcher) to the class and reminding the class of the purpose of the visit. I noticed a genuine interest from learners and this was confirmed with a round of applause. There was great enthusiasm among learners and the majority wanted to show what they were capable of.

She then started with the actual lesson, by reading out to the learners the objectives of the lesson. She said “*the general objective for this topic in the syllabus is that learners should realize the importance and application of enzymes*”. The idea was to tell learners what was expected of them as far as the syllabus expectations were concerned in this particular topic of enzymes.

Learners were then introduced to the definition of enzymes, and the teacher asked them to identify key concepts from the definition. Key words were *catalyst* and *biological*, and learners managed to get them right. The teacher tried to explain what each of the identified concepts entailed. For example, she said “*Catalyst means to speed up*”. In my opinion, this was a good strategy to unpack the new concepts to learners and to build a foundation for future reference regarding enzymes.

When explaining the meaning of a catalyst, the teacher tried to contextualize it by asking them to wonder what happened to the breakfast that they had eaten that morning. This enabled her to tell them that the food is digested by the digestive enzymes. The teacher told the class that the digestive enzyme Lipase is only responsible for breaking up fats, and no other food substances. She explained that enzymes work like ‘a key and lock’. It could thus be concluded that the teacher thought of trying other teaching methods such as use of prior knowledge (see Section 2.4.1) as well as the use of analogies that might enable learners to make sense of biological concepts better.

Lesson 2 (40 min)

The teacher started the lesson by building on the previous lesson. In other words, she wanted to lead learners from what they knew to what they did not yet know (elicitation of prior knowledge). She further continued to engage in the dialogue with learners in order to build up

knowledge and understanding. It became clear that some learners were confused about certain concepts. One learner explained what a product was as follows “A *product* is *substrate* is a substance which the substrate is turned into” and the other one responded “is the substrate the product is turned into”.

This showed some confusion on the side of the learners and the teacher tried to give practical examples to clear up any misconceptions among learners. She said:

“I am giving you an example, which enzyme again which is breaking down starch food? Learner: Amylase. T1: Amylase is breaking down starch in maltose, isn’t? Which one is the substrate there?” (See Observation video transcript S1: Lesson 2)

This was good probing skill on the teacher’s part that could support learners in making sense of the discussions. To engage learners with the content, an activity from the biology on page 106 of their textbook was given to learners to carry out individually. The teacher moved around to monitor and provide support to individual learners when required, as well as marking their work. This enabled the teacher to give immediate feedback to individual learners. Towards the end, learners were asked to share answers in order to learn from one another. In other words, learners had an opportunity to socially construct meaning (see Section 2.5.1).

Lesson 3 (40 min)

This lesson was mainly on the properties of enzymes and role of enzymes in germination of seeds. This lesson was once more started with the elicitation of prior knowledge. By this time, the teacher had been given feedback on lessons 1 and 2. During the feedback, the attention of the teacher was drawn to specific challenges noted on the side of both the teacher and learners. Observed misconceptions were also noted and shared.

As a result, the teacher appeared to have gained some knowledge from the feedback session we had observed during the teaching of lesson 3. The teacher managed to correct mistakes she had made in the previous lessons in order to avoid further misconceptions. For example, she previously informed learners that optimum temperature for enzymes is between 37°C-38°C, while in actual fact, some enzymes work best even up to the temperature 40°C. This was later corrected. This made the teacher become a reflective practitioner.

Lesson 4 (40min)

The teacher used an activity to support learners' understanding of enzymes and their properties. A learner was asked to read the activity aloud in order to help develop their reading skills. She said:

“It means these kinds of questions are trying to test your understanding of enzymes and temperature. It also tries to test whether you are able to read and interpret the correctly ee..?”(ee.. is for emphasis) (See Observation, Video Transcript S1: Less 4)

This means that the teacher tried to use the activity to give examination tips to learners, as well as supporting them when it came to correct reading of graphs. This is one of the main challenge facing learners nowadays. The teacher also used the activity to correct the mistakes she made in the previous lesson, thus identifying herself as a reflective practitioner.

Best practices from lessons 1-4

The teacher managed to relate some of her presentations to learners' everyday knowledge by making reference to, for example, the reason why parents at home sow different seeds in different types of soil.

She started each lesson by reading out the lesson objectives and basic competencies to the learners so that they were aware of what was expected of them.

For example, she reminded the learners what the syllabus requirements were regarding the uses of enzymes in biological washing powders, as well as in the food industry. She tried to give an explanation of how biological washing powders are manufactured and what they are made of, to facilitate a better conceptual understanding.

She gave some examination tips based on her experience. Where the teacher made a mistake, she would always find a better way to convey the correct information.

Unintended errors that lead to misconceptions from all four lessons

During the presentations, T2 made some obvious mistakes which would have created misconceptions on some issues in learners. One of the mistakes was when she indicated to learners that *“Enzymes only work if a seed was buried in the soil and water gets in it in order to activate the enzymes to start working. Soil is not a requirement for the seed germination”* (See Observation transcript: S1, Lesson 3).

However, soil is never a requirement for the germination of seeds, because seeds can germinate in the absence of soil. She further indicated that “*starch is digested by amylase into maltose or glucose*”. In fact, amylase is only able to digest starch to maltose and not glucose or simple sugar. Another enzyme called maltase is responsible for digesting maltose to glucose as indicated earlier.

It was further observed that the teacher was pronouncing some of the terms incorrectly. This would have bearings on how learners would pronounce and even spell those concepts in future.

Missed opportunities

In all the lessons observed, visualization by learners was limited, as was the use of practical work: the situation which has undermined the power of practical work. However, as shown under Section 4.4.4, the syllabus requires learners to develop practical skills and abilities, but it appeared that the teacher was yet to discover such opportunity.

4.5.2 School 2

Lesson 1

This lesson started with a short story about a person who usually incites other persons to fight, but is himself never hurt in the process. This was an analogy to introduce learners to the topic of enzymes and how they operate (meaning that enzymes catalyse reactions, but themselves never get used up in the process or changed in any way). The classroom interaction was mainly a dialogue between the teacher and learners. The teacher posed well-sequenced questions to convey the content to the learners. Clarity was sought by posing follow-up questions.

Some explanations by the teacher were, however, subject to misinterpretation by the learners and /or they were confusing. For example, he said the following regarding the effects of temperature on enzymes: “*The difference or the change in the temperature affects the enzymes activity, if the temperature is high, they are affected in one way and when it is low, they are affected in one way*”. Personally, I could sense what the teacher was trying to say, but I wondered if learners had any idea.

Where the teacher wanted to emphasize the point, he would code-switch. When he explained what a catalyst was, he said the person in the story at the beginning of the lesson was a

catalyst *Oku hongaiifa omukushi ndishi?* (Freely translated “Do you know what provocation is?”).

The teacher drew a sketch of the pH scale on the board to explain what pH was, and also referred to what learners learnt in Physical Science. She said “*We know the pH, isn’t? We learnt about pH scale in Physical Science which runs from 1-14 nee?*” This is an indication that learners should see the link between different subjects. Having a sketch further enabled the teacher to explain different pH conditions where different enzymes worked in a human body. The pH scale runs from 0 to 14.

It was observed that being a teacher, one does not necessarily know everything. The teacher had to learn from a learner that there are foodstuffs that are acidic and this was new to the teacher. He asked me to confirm it. Since the confirmation was simply a matter of yes or no, I responded by saying that the learners’ observation was true, without elaboration.

Lesson 2 (40min)

This lesson was on the effects of temperature on the activity of enzymes. The syllabus requires learners to realize the importance and applications of enzymes. To explain this, the teacher drew a graph on the board, and asked learners to come up and interpret the graph to the whole class. In my opinion, it was a good opportunity for the teacher to see learners’ understanding and/ or misunderstanding of the concepts so that he could correct them. The model explanation should be that: as the temperature increases, the rate of the reaction also increases until at a point where an enzyme starts to be denatured by high temperatures.

The teacher’s question or instruction was: “*How does temperature affect the work of enzymes? Use the graph to explain on the table to explain the effect of temperature on enzymes*”.

The following are some of the explanations given (see observation transcript, S2, Less2):

L1 “*According to my understanding, the enzymes work best in optimum temperature. If the temperature is low, the enzyme is not working well or higher than the optimum temperature*”

L2 “*I think that this side is where the low temperatures are and that side is where the high temperatures are, here is where the optimum temperature and it is showing where the average temperature of a human is.*

L3 “*As you can see on the graph, the more the temperature increase, the more the reaction is increasing as you can see on the graph*”

Having observed various approaches and interpretations of the graph, the teacher realized that it appeared that learners had difficulties reading the graph to see which variable was influencing the other. He then started supporting the learners by showing them on the board the correct way of reading the graph, as well what could be concluded from it.

Lesson 3 (40min)

This lesson was about the effects of pH on enzyme activity, and role of enzymes in the germination of seeds. My intention was still to see how the teacher was supporting his students regarding making sense of this lesson. The teacher started by establishing what the learners already knew about pH (prior knowledge), by asking them what pH stands for. The following were some of the learners' responses:

L1 "Phosphorus"

L2 "Per hydrogen"

L3 "Potential hydrogen"

As in the case of the temperature, the teacher drew the pH scale on the board to help learners understand how pH works. The explanation was done systematically from low numbers to high numbers, but notes were written on the board. Prior everyday knowledge was sought by learners if they were familiar with pH at different stations in the alimentary canal of the human body. This enabled the teacher to explain why it was only some enzymes that work in certain parts of the alimentary canal.

Lesson 4

The lesson was about the role of enzymes in biological washing powders as well as in food industries. The teacher started the lesson by asking if learners knew what kind of washing powders contain enzymes. However, none of the learners knew or remembered right away. To bring the situation closer to the learners, the teacher made use of sentence frames, namely, incomplete sentences to be completed by learners. The following are some examples:

Ex.1. Powders that can wash biological.....?

Ex.2. Bio means what.....?

Although learners initially struggled, with the effort of the teacher, they were able to make the following suggestions in relation to the first statement:

L1: “stains”

L2: “stains like blood”

L3: “those that were difficult to remove”

In the second part of the lesson, the teacher tried to relate the content to the learners’ life experiences. For example, on the role of renin, which is responsible for making milk clot (coagulate), he said: “*traditionally, we also make milk clot, but we use some plant roots*” which the learners were able to identify correctly.

He then smuggled the vernacular (see Section 2.4.2) into the lesson so that he could explain in detail why fresh milk was always used traditionally to flush out poison from a human body.

“Nomolwaasho owu wete kutya omashini ohaadulu oku longifwa piinima ihapu ngeenge wanwa nande uudiyo wonhumba ohodulu oku nwefwa omashini mahapu, oku dja opo ototondoka wu uka kokatoileta ile tokungu ndee oudiyo tau dimo, osheshi kutya medimo kamuna oenzyme oyo tayi dulu okudigestinga omashini oo”. (Translation: This is the reason why milk is used in many instances such as when you have consumed poisonous food. They let you drink a lot of milk after which one runs to the toilet or vomit so that poison is discharged, mainly because in the stomach renin enzyme is absent) (See observation transcript, S2, Less4).

Best practices observed

Some of the best practices that were observed were the use of peer teaching method. This method always inspires learners to update their content in preparation for the presentation. It also enables the teacher to pick up any misconceptions through observation. The teacher also tried to make use of analogy as a way of introducing enzymes as catalysts. Although analogies are not easy to construct, they are likely to be useful tools to represent unfamiliar concepts.

The use of code-switching in my opinion was good, because it enabled students to express themselves fully. The use of examples related to learners’ everyday experiences also came out strongly and helped create deeper understanding of new concepts.

Missed opportunities

The teacher had an opportunity to bring in different types of washing powders for learners to differentiate between normal detergent washing powder and a biological washing powder. I also thought that one could have brought in examples of differently staining cloths. A

demonstration with such cloths could have supplemented the explanations for deeper understanding.

In addition, on page 16 of GCSE Biology and Module 1 there are provisions for the teachers to do practical work with the learners on this topic. Page 7 of the syllabus reads “*carry out and /or design experiments to investigate the effects of temperature and /or pH on the rate of enzyme activity*”. Equally, in the National Policy Guide for Natural Sciences under Section 2.2, provision is made for Natural Sciences teachers to be creative and innovative to produce their own teaching and learning materials linked to practice.

It was unfortunate, however, that in all the lessons observed, the learners were not accorded an opportunity to engage with the content fully and use most of their senses through hands-on approach (practical work). This opportunity could have developed learners’ understanding of how temperature and pH might affect the activities of enzymes.

Misconceptions and unintended errors in the lessons observed

The teacher asked the learners to identify the ‘normal’ body temperature of a human as if there was a fixed figure. The use of the key concepts, average body temperature is critical, because not all humans have body temperatures of 37°C.

On the learners’ side, the relationship between the temperature and enzyme activity was misunderstood and/or there was an inability to express themselves clearly.

The teacher also talked about hydrochloric acid being produced in the wall of the stomach, instead of saying that it is secreted from cells in the lining of the stomach. In this lesson, the teacher also revealed misunderstanding of what optimum temperature and pH were. He said “*optimum temperature is best temperature and optimum pH is the best pH*”. Learners were further unable to distinguish between the two concepts, namely; *sunlight and temperature* and some of them used them interchangeably. Examples were as follows:

L1 “*sunlight is part of the temperature*”

L2 “*Plants need sunlight, but not temperature*”

4.6 Interviews

4.6.1 Interview (T1)

This interview started with the teacher being asked to reflect on her lessons. She indicated that in her opinion, the lessons went very well in terms of the presentations. She did however identify challenges that learners faced during those lessons, such as wrong pronunciation of concepts. This was attributed to English being a second language to both the teacher and learners. The teacher indicated that she was going to work on such weaknesses.

In her own words: *“I think with regards to the aims and objectives of the syllabus, I think I have attained that very well”* On challenges, she said *“On the side of the learners sometimes is just shyness of them to say something in class, because the learner did not try to participate in class in class, they also not learn how to pronounce the words”*. Pronunciation was singled out as the main challenge, although some others are given in the Table below. Based on the teacher’s analysis, it could be assumed that she had limited understanding of her learners’ needs.

After watching the video with the teacher, she was asked to identify challenges that emerged from the video (see Section 3.7.3). She identified some, as given in Table 4.6.1, below.

Table 4.6.1: Summary of factors/challenges faced by learners in making sense of biological language and concepts as identified by teacher 1 during interview

Identified challenges	Effects	Who is affected	
		Teacher	learner
Wrong words/terms pronunciation	Wrong spelling of terms (spelled as pronounced)		x
Lack of motivation	Limited expression in class- poor classroom interactions		x
Poor information	Bad ways of explaining a term	X	x

Limited resources	Limited access to information e.g. two or three learners sharing a textbook	x	x
-------------------	---	---	---

4.6.2 Interview (T2)

This interview also started off with some reflections on the lessons taught. The highlight of the reflections from teacher T2 was the identification of learners' inability to differentiate two terms, namely substance and substrate. This, the teacher indicated, that he anticipated, and had carefully included it in his preparations. Despite the preparations, learners still had difficulty in telling the difference. Regarding the holistic support that learners needed to understand the topic of enzymes, the teacher indicated that there was a need to contextualize the content. In his own words:

“It has to do with digestion, you see and when this topic will be discussed, you have to refer to food that learners have eaten, they will be able to get to notice how this food have been used in our bodies and how enzymes play a role in making it possible for the food to be utilized in the body of the living organisms”(see Appendix H, S2:I).

Table 4.6.2A: Summary of challenges faced by learners in making sense of biological language and concepts as identified by teacher 2 during interview

Identified challenges	Effects	Who is affected	
		Teacher	learner
Incorrect use of words and terms	Meaning lost and obviously the marks	x	x
Misconceptions	Misleading information	x	x
English as Second Language	Inability to find proper words/terms to express themselves clearly	x	x
Language errors	Results in misunderstanding as a teacher tries to simplify concepts, but diluted explanations end up being carried over to learners.	x	x

Limited resources	One may be limited to just a few textbooks that may not give all the required information	x	x
Errors in textbooks, especially the modules	If the teacher has not noticed them, they may be carried over to learners	x	x

After each teacher had identified the challenges they noticed, they were asked to suggest better ways/methods to scaffold learners in making sense of biological concepts, as indicated in the following Table.

Table 4.6.2B: Suggested ways/methods to scaffold learners in making sense of biological concepts

Participant teachers	Suggested way/methods	Purpose
Teacher 1	Use video	For model pronunciation
	Use of poster with key terminologies in a particular topic	Familiarize learners with key concepts
	Use of real life examples	For learners to relate to
	Use of practical work for seed germination and starch	For learners to see that they are normally dry, when they are soaked in water, they become soft so that the chemical reaction inside will take place. For starch- one can make use of saliva, containing salivary amylase, which digests starch to a double sugar, maltose.
	Reflection on one's lesson	See what has been omitted or needs to be rectified
Teacher 2	Being a critical presenter	To avoid using words that are non- biological for learners to get used to biological language
	External teacher evaluation	It is usually not easy to identify

		one's own mistakes
	Studying of examiner's report	They (examiner's report) point out errors made in previous examinations that can be used to guide teaching
	Making use of videos on enzymes activities	Learners will be able to see simulations of reactions between enzymes and their substrates and therefore develop better understanding.

What emerged from the Tables above is that teachers' understanding of their own challenges regarding how they should scaffold to make sense of biological language and concepts is to some extent limited. T1 especially emphasized bad pronunciation of terms as the main challenge, but T2 showed some encouraging insights about what the real challenges are. However, the suggestions they made regarding scaffolding learners to make sense of biological language and concepts could be more useful if explored further. This leads to another implication: that the reason they did not try to implement some of the strategies they suggested during the study is perhaps that they do not plan and prepare adequately.

4.7 Concluding remarks

In this chapter I have presented and analysed data generated at the two research sites as they were described in Chapter 3. In document analysis, I looked at learners' written work, textbooks; teachers' lesson plans and examiners' reports. Analysis of such documents revealed that learners' ability to express biological language and concepts clearly on paper is quite limited. This appeared to have a negative influence on their achievement level in biology, and probably in other subjects.

I also used observation, which revealed that although the participant teachers had fair subject knowledge, they made several mistakes and had difficulties in presenting what they knew well to their learners. I further made use of interviews, during which teachers managed to indicate some of the challenges they were facing, and they also made suggestions for improvement.

The data were described and presented to assist the reader to visualize my research journey and what transpired in the two situations. The data reveal the types and quality of scaffolding that was happening at the two sites in the concerned subject. The picture that emerged enabled me to suggest possible suggestions for the change agenda.

In the next chapter I interpret and discuss the findings in order to make sense of them.

CHAPTER 5

INTERPRETATION AND DISCUSSION OF FINDINGS

Attaching meaning and significance to the analysis (Renner, 2003, p. 5)

5.1 Introduction

In this chapter I analyse, interpret and discuss findings on how teachers scaffold learners in making sense of biological language and concepts when English is used as mediational tool. The discussion is supported with key messages and practices captured using three data-gathering techniques as presented in Chapter 4, namely document analysis, observation and interviews. The discussion is further underpinned with literature and personal view points. In discussing the findings I develop analytical statements that are aligned to the research questions that informed my study, as outlined in Chapter 3.

As a reminder to the reader, the following are the research questions that guided this study:

- 1) How do teachers scaffold learners to make sense of biological language and concepts when using English as a mediational tool?
- 2) What are the errors of language and meaning made in using English as a mediational tool in these science classes?
- 3) What challenges do teachers experience when mediating the learning of biological language and concepts in English?
- 4) How can teachers be supported when mediating the learning of biological language and concepts?

In view of my research questions above, five analytical statements were drafted for analysis as shown in Table 5.1, interpretation and discussions, and were mainly informed by the data generated. These analytical statements were mainly inductively developed in anticipation that they would give concise answers to my research questions. Out of them I made my concluding remarks and recommendations regarding how teachers scaffold learners in making sense of biological language and concepts when English is used as a mediational tool.

Table 5.1: Major points/analytical statements that are later discussed in detail and research question (s) to which each statement is responding

Data source	Theme	Analytic statement	Research question(s) addressed
Document analysis and Observation	Supporting strategies	1.Teaching Pedagogy: Strategies used by teachers to scaffold learners in making sense of biological language and concepts	1
Document analysis, Observation and Semi-structured interview	Learning approaches	2.Teachers' familiarity with the learning styles of their learners	1 & 3
Document analysis, Observation and Semi-structured interview	Everyday language versus science language	3.Language errors that lead to misconceptions	2
Document analysis, Observation and Semi-structured interview	Biology mediation challenges	4.Challenges faced by teachers when mediating the learning of biological language and concepts	1 & 3
Stimulated Recall Interview	Feedback discussions	Reflections of teachers on feedback given to them during the stimulated recall interview	4

5.2 Analytical Statement 1:

Teaching Pedagogy: Strategies used by teachers to scaffold learners in making sense of biological language and concepts

In Chapter 2, I argued, using Carrier's (2005) suggestion, that teachers should scaffold English Language Learners (ELL) to develop the ability to use science vocabulary in grammatically correct and fully formed sentences by providing and adopting various teaching strategies. As learners become proficient in the use of language and literacy skills, teachers can gradually withdraw some of the support so that their learners could assume more

responsibility for their science literacy. In addition, using the Pedagogical Content Knowledge (PCK) theory (see Section 2.5.2), I argued that the strategies a teacher uses to convey a particular content are influenced by the teacher's understanding of the content and the learning challenges of the learners. Based on that, several teaching strategies were observed being employed by the participant teachers in their daily work as biology teachers. This echoes well with Shulman's (*ibid*) views on teachers' pedagogical content knowledge. He argues that teachers' pedagogical content knowledge determines the choice of methods for presenting particular topics, problems, or how issues are organised, represented, and adapted to diverse interests and abilities of learners.

The presentation in this section has seven sub- sections: Pre-planning, Elicitation of learners' prior everyday knowledge, Use of graphs and charts, Practical activities, Code-switching, Use of analogies, and Use of quality assessment techniques.

5.2.1 Pre-planning

Although the participant teachers were in possession of the lesson plans, analysis of these documents revealed that deliberate and systematic efforts in terms of scaffolding learners were disappointingly less than expected. The lesson plans that were analysed were often not well articulated/structured to maximize the outputs of a lesson presentation. Based on what was found in the lesson plans, it was therefore concluded in Chapter Four (Section 4.3.5) that there was no consistency in terms of putting up sign posts and making deliberate and systematic efforts to scaffold learners in making sense of biological language and concepts from the side of the teachers. Evidence has also shown that teachers had different understanding and approaches in presenting the same content (topic of enzymes), and at times such understanding was contradictory in terms of factual information.

Although I have presented my data in Chapter 4, I will repeat some few examples to cement the findings regarding the two teachers' pre-planning and other strategies employed. The following are some of the unclear guiding strategies noted in their lesson plans:

E1: T1 *"Based on the learners' answers about enzymes, teacher present feedback by the help of a poster, teacher present information more about enzymes through presentation and questioning methods. Teacher also asks learners to explain how they understand the word enzymes, temperature, pH and properties. We also summarize the main points"*

E2: T2 *“Ask learners to define enzymes and comment on learner definition. Ask learners to mention the properties of enzymes. Jot them down on the chalkboard and explain each of them. Learners may ask questions or give comments. Use diagram for more clarity if learner got difficulty”.*

E3: T2 Planned homework reads *“Find out about the effect of temperature and pH”*

It is clear from the above excerpts that T1’s teaching strategy was intended to treat things as they unfold during the lesson development and had no vision of what to achieve at the end of the lesson and how to achieve it. With such planning and preparations, a teacher is prone to making mistakes of all kinds, because the skeleton of her lesson lacked coherence and the necessary details.

In Chapter 2 (Section 3), I further argued that if some of the science teachers do not have the required capacity to deliver the required quality support to the learners; it is unlikely that those learners would be able to give out what they could not get. It is against this background that a properly planned lesson plan is critical in systematic presentation of factual information and for the development of critical process skills in learners. Furthermore, the plan is intended to indicate the type of teaching aids to be used, details of the subject content to be covered and role of the teacher and that of the learners as well as details of a well-structured homework. Such planning is required so that unnecessary mistakes and unintended language errors can be avoided.

Colgrove (2012), in his research conducted in the USA, attributes some of the above- noted weaknesses to capacity- building programmes for teachers which do not include opportunities for teachers to participate in experiences that are essential to bring about the kind of changes that will be significant in terms of content knowledge or teaching practices. I assume this situation may be applicable to my own research context in addition to inadequate monitoring and evaluation, because none of the teachers’ work analysed at the two schools had any sign of being checked by management as required in the Namibian context.

5.2.2 Elicitation of learners’ prior everyday knowledge

Neglect of prior knowledge can result in the audience learning something opposed to the educators intentions, no matter how well those intensions are executed in an exhibit, book or lecture (Roschelle, 1995, p.1).

The above epigraph shows how important prior knowledge is during teaching and learning, because it influences learning, and learners construct concepts from it. To help learners make the most of a new experience, educators need to understand how prior knowledge affects learning (Roschelle, *ibid*).

Both participant teachers in this study, through their practice, appeared to be well aware of the elicitation of learners' prior everyday knowledge as a teaching strategy and this was noted during the observation of their lessons. However, the way in which they implemented the strategy differed slightly from one teacher to the other, probably as a result of different contexts, creativity and own exposure. This shows that teaching is idiosyncratic. There is no recipe for being a good teacher.

For example, T1 asked the learners to wonder what happened to the breakfast they had eaten that morning as part of the introduction of the lesson. Surely, something was going through the minds of the learners. There must have been a lot of questions in their minds as to what happens to the food in the stomach so that it is used by the body. Such questions would have provided a solid foundation for the learners to build on their understanding and development of the new concept of enzymes.

In contrast, if the teacher had gone straight to the topic, there was going to be a mismatch/tension between the new knowledge and learners' own experiences. Drawing from the work of Piaget, Roschelle (*ibid*) explains the issue of tension by suggesting that designers create tasks that engage learners and create tensions between assimilation and accommodation. It is engagement in physical aspects of a challenging task that could lead to reformulation of the intellectual aspects of the task. This is what could have happened in the above example.

Roschelle's view resonates with what Ogunniyi (n.d.) said when he was trying to understand the issue of border crossing. From his work, he concluded that when two or more distinct world views come together in the mind, they either 'attract or repel' each other depending on the context. It is therefore possible for an individual to hold two diametrically opposed world views without experiencing any apparent cognitive conflict which is called 'harmonious dualism' (Ogunniyi, *ibid*). In my opinion, that explains well what happens in the learners' brains as far as prior and new knowledge are concerned.

In Chapter 2 (Section, 2.5.1), I stated that the Social-Cultural theory underpins my study. This theory talks about the need to consider individual's cultural background as it affects the learners' success in learning. Perhaps that is where elicitation of learners' prior everyday knowledge becomes critical. Stears, Malcolm and Kowlas (2003) support this method of mediating learning. They argue that although individuals can personally construct the knowledge, it has to be socially mediated as a result of cultural experiences and personal history.

Although this strategy (elicitation of prior knowledge) can be very useful, based on how it is implemented, a teacher needs to be creative and experienced as well in case the initial plan does not work out as it can be seen in the following example.

On the topic of 'role of enzymes in biological washing powders' the teacher started the lesson as follows:

T2: What kind of washing powders are these?

Lnr2: None of the learners answered.

T2: Powders that can wash biological.....?

Lnr2: Stains

It appeared that learners initially had no idea about biological washing powders, and the teacher realized it, hence he used sentence frames (see Section 2.3) instead. It was surprising to notice the learners not responding, because both the two textbooks that were in their possession, such information is there. However, using the sentence frame helped the teacher to get the lesson going without having to spoon-feed.

It appeared that the teacher initially wanted learners to indicate the type of stains that could be washed off using biological washing powders. However, this was not the impression created with the first question she posed. It could therefore be concluded that, to successfully scaffold learners using this strategy requires good planning, properly structured questions and flexibility on the part of teacher. Precisely, because unclear questions posed are subject to misinterpretations which lead to misconceptions.

5.2.3 Use of graphs and charts

Of the three data- gathering techniques used, only through observation of lessons I noted that the two participant teachers did make use of graphs and charts as a strategy to enhance learners' ability to make sense of biological language and concepts. Roseberry (2008) noted through her case study that graphs help in making sense of the invisible concepts and in critical thinking. She further argued that learning to make, read, interpret, and use charts and graphs are key to acquiring scientific perspectives.

According to the Biology Ordinary syllabus, teachers are required to teach learners how to plot and interpret various graphs such as Pie charts, Bar charts, Column Graphs and Histograms. That means questions in examinations, in all likelihood, would contain item (s) presented in one of those forms, and unless learners are taught how to use and interpret them, they are likely to experience a lot of challenges that affect their achievement level negatively.

Useful insights could be tapped from the following example, during the presentation of the second lesson on the effects of temperature on the activities of enzymes; T2 had the following to say:

“Good, I have a graph on the table, which will help us explain the effect of temperature on enzymes” (see Observation video transcript: Lesson 2)

T1 also asked her learners to do activity 2 and 3 individually from the textbook and she asked one learner to read it aloud. These activities had a graph on enzymes and temperature as well as enzymes and pH. More examples were shown in Chapter 4, and that underscores the fact that both teachers had realized that one of the best ways to convey a clear message to learners is often through the use of graphs.

Using graphs, teachers were able to explain the relationship between the two variables which were otherwise going to be difficult for learners to make sense of. The graphs also helped teachers to pick up misunderstandings on the side of the learners. Now, imagine if the following learner's explanation was in the written form during a final phase examination.

This was said when the learner was called in front to interpret the graph by T2:

“I think that this side is where the low temperatures are, and that side is where the high temperatures are, here is where the optimum temperature is” (see Observation video transcript: Lesson 2).

The first impression one might get with the above example is that the learner had limited exposure to graph interpretation, and as such, the learner was not able to quote figures from the graph and answer graph- related questions accordingly. It is clear that such a learner would be disadvantaged when it comes to national examinations, because the probability of graph- related questions in such examination is very high.

Although there is evidence that the participant teachers did make use of graphs, this was noted only once for each teacher. Other data sources such as analysis of lesson plans and exercise books of learners have not shown anything to this effect, an indication that this important strategy is being neglected and where it is done, it is done haphazardly. Apart from the curriculum expectations, the preparations for the knowledge- based society of Namibia require that all citizens should be able to read graphs successfully in their everyday life.

According to Erni (2009), interpreting graphs is always the most difficult of the graph questions, because learners do not know how to answer such questions. She suggests that the best way is to start with the X-axis (mentioning the variable) and then go on to say how the Y-axis responds. The Namibian Ministry of Education and Culture (1993) underscores the importance of using various teaching methods, which include the use of practical activities as shown below:

Currently, teaching methods in our schools tend to foster memorisation and rote repetition. But to address the problems we face and to lay the foundation for a self-reliant and prosperous Namibia we need our young people to go beyond relying on what they have read or been told. Indeed, learning is more than memorising and repeating. Our children need to learn to think independently and critically. They must master strategies for identifying, analysing, and solving problems (MEC, 1993, p.119).

It is therefore my opinion that including regular use of graphs as part of lesson presentations will help realize the dream of Namibian Policy Makers.

5.2.4 Practical activities

Recognizing the challenge that science learners have when learning through foreign language, Woolnough (1994) states that doing science, in school or at work, is a holistic activity involving the will and the imagination as well as the mind and the hand. It should therefore not be reduced to fragments of knowledge and skills.

Such views are in line with the findings of the study by Maselwa and Ngcoza (2003) who found that learners participating in their study felt that practical activities minimised rote learning and were powerful in promoting science conceptual development and understanding.

Based on the above argument, and on the provisions in the syllabus, the National Policy Guidelines as well as the textbooks, one expects that teachers would make use of this approach more often because it creates a platform for dialogue and meaning-making through social interaction (Pea, 1993; Stears, Malcolm & Kowlas, 2003). Hodson's (1990) research further produced acceptable justifications for doing practical activities: to motivate (learners will find it worthy to learn science), by stimulating interest and enjoyment; to teach laboratory skills; enhance the acquisition of scientific knowledge and give insight into scientific method, and develop expertise in using it.

On one occasion when T1 in this study presented a lesson on seed germination, she indicated that there was a need for her to bring in the seeds for the learners to see that they are normally dry and when you soak them in water, they became soft as chemical reactions start to take place in them. In other words, the teacher was aware that a practical activity could bring reality to the fore and it was one of the best ways to explain a concept and a biological process when language becomes a barrier.

Despite such knowledge, none of the participant teachers made use of this method during the whole duration of the study neither was there evidence in the lesson plans, nor in the learners' exercise and note books. On asking the reason, T1 asserted that '*we did not do any practical activity, I just given them example of how humans are digesting those food*'. Through my interaction with her, she indicated that some of the practical such as using saliva to prove that amylase digests starch to maltose might not be healthy (using saliva could be unhygienic). However, there are so many other practical activities they could have done, even in the previous topics and such excuses if allowed to continue would deny learners the crucial opportunity to conceptualize science concepts in an enjoyable and rewarding manner. Learners should be given opportunities to learn in all possible interesting ways provided that appropriate precautions are observed.

These are some of the issues that are always pointed out in the examiners' reports. Issues such as non-familiarity of learners with practical procedures are noted, but similar mistakes recur every year. Biology is a practical subject and it is essential that teachers recognize the power of learning it through practical activities.

5.2.5 Code-switching

In view of excerpts on language errors from teachers and learners given as examples in Chapter 4, the probability exists that the intention of the teacher could not be properly interpreted by learners and *vice versa* (Nelson, 1996). In other words, the argument is that mental representation (MREP) of the speaker must be transformed into a language format that represents its intention. In the case of the listener, the external linguistic representation (LREP) must be internalised, interpreted, and transformed into an MPREP again that represents the intention of the speaker (Nelson, *ibid*).

To avoid such a situation from happening, code-switching from English Second Language to vernacular may help with cognitive reasoning in response to learners' limited English proficiency (Probyn, 2009). However, in the Namibian context, code-switching is not allowed as per the prescription of the language policy in the country. This is the main reason given by participant teachers as to why not much code-switching was observed during the presentation of lessons. Isolated cases of 'smuggling the vernacular' into the classroom (Probyn, *ibid*) were observed, however, especially by T2 when a concept seemed to be too abstract and difficult to articulate. What came out during such discussions in vernacular were more insights and enthusiasm, especially from the learners. These were experiences that learners could relate to and could build on to develop their scientific and conceptual understanding.

The challenge with this supportive strategy is that no attempts were made by the concerned teacher to ensure that learners were able to transform such experiences into biological language without losing original intention (Nelson, *ibid*). Discussions just happened and the teacher moved on to the next phase of the lesson without the necessary consolidation. This dark cloud had also been noted by Hart (2003), who argues that code-switching as a learning and teaching resource poses challenges to both teachers and learners.

Despite such limitation, code-switching in my opinion is a potentially rich and powerful strategy for creating effective dialogue in classrooms if explored further in terms of reviewing the language policy (Language Policy review is due sometime this year (2012) or early next year).

5.2.6 Use of analogies

During observation, T2 told a story of a man who was a fight instigator among other school-going children during his school years as a means of introducing the topic of enzymes, while T1 talked about 'lock and key'. The first example was an analogy of what a catalyst (enzyme) could do to speed up a reaction, and the second one was a better way of explaining the relationship between the enzyme and its substrate. Although the first analogy in my view was technically wrong, because the teacher used an analogy of a physical process for a chemical process, learners were able to have somewhere to build on and visualize what it was like to catalyse a reaction. The story also stimulated interest in learners and focused their attention on the lesson.

In a study conducted by Bean, Searles, Singer and Cowen (1990), it was found that reasoning by analogy is one way that students might develop knowledge structures for unfamiliar concepts. These could be some of the possible solutions that our biology teachers might try more where possible and experiment with what works for them. Bean, et al. (1990) therefore suggest that supplementing text analogies would further assist students' understanding of difficult concepts. The data generated revealed little evidence on the use of this approach, with T1 using it only once while T2 used it twice.

The limitation to this approach, however, is that it requires creativity and enough experience in terms of design in order to achieve the planned objectives (Bean, et al., 1990). This could be the contributing factor to its limited use in the observed lessons. It is unfortunate that I could not ask these teachers' views with regard to the benefits and challenges of using analogies.

5.2.7 Use of quality assessment techniques

In Chapter 4 I indicated that the National Curriculum expects teachers to design quality and valid assessment activities that address all the assessment objectives. In other words, there should be good alignment between teaching and assessment. Assessment should be ‘for learning’ and not ‘of learning’.

Despite such expectations, evidence from analysing learners’ exercise books showed that the quality of activities given to them left much to be desired. Table 4.3.4.1 in Chapter 4 has shown the analysis of the quality of activities given. On average, most questions in the class activities and homework were mainly assessing the assessment objective A, and few on B. None of the activities given had assessed the assessment objective C, which prepares learners to develop practical and experimental skills. Biology is a practical subject, and failing to prepare learners in this area would fail the holistic approach to learner development.

Based on what has been observed, it could perhaps be argued that the standard of teachers’ scaffolding for learners in making sense of biological language and concepts was not solid. Scaffolding is intended to provide contextual supports for meaning through the use of simplified language, teacher modelling, visuals and graphics, cooperative learning and hands-on learning (Bradley & Bradley, 2004). In my view, assessment support lacked quality; for example activities were too short (limited number of questions), had no clear marking criteria, assessed only a few assessment objectives and therefore did not meet the curriculum expectations. Learners needed to be engaged with quality questions that stimulated and made them think critically. The envisaged knowledge-based society requires highly skilled and critical scientists (ETSIP, 2008). To validate the above argument, Goos (2004) argues that a teacher ought to present learners with a significant problem designed to engage them with new concepts, eliciting their initial conjectures and justifying their thinking to others.

It has also been noted with concern that the corrections made by the learners were not always ‘correct’. There were instances, as cited in Chapter 4, in which a learner had made a correction, but the correction was still not making sense. At another point, a learner’s statement in the activity was marked correct, yet it was in fact wrong. By implication, this means two things:

- 1) limited content knowledge of the teacher, or
- 2) an oversight as a result of inadequate concentration. It was most likely that if similar questions came in the examination, the learner would write what he/she had learned from the work of the year. Therefore, there is a need for teachers to be extra cautious on the type of information they give learners. Giving wrong information may have serious consequences on learners' future performance.

In his views on teaching, Shulman (1987) argues that the teacher has special responsibilities in relation to content knowledge, serving as the primary source of student understanding of subject matter. It is for this reason that the two participant teachers need to develop better strategies to manage the content ideas they give to learners as per the requirement of the syllabus.

5.3 Analytical Statement 2:

Teachers' familiarity with the learning styles of their learners

In Chapter 2 I explained, based on Shulman (1987)'s Pedagogical Content Knowledge (PCK) theory, that teachers' PCK is about blending content and pedagogy into an understanding of how particular topics, problems, or issues are organised, represented, and adapted to diverse interests and abilities of learners, and presented for instructions. This includes teachers' contextualised understanding of how best their learners learn and therefore treating them as such. With such views in mind, it could be argued that effective teaching and learning would take place only when teachers understand and are familiar with the learning styles of the learners and teaching methods are guided by such understanding. It goes without saying that learners are unique individuals and their abilities in terms of how best they learn are quite diverse.

Some learners are visual learners while others are artistic, *etcetera*. In order to effectively tap learners' potentials, then, there is a need for the teachers to make deliberate efforts and understand their learners' situation; their needs; their learning difficulties and how they best learn.

My findings in this study showed that the two participant teachers understood their learners, but that such understanding was limited. As such, the discussions for this sub-topic will be presented in two parts: 1) Strengths that were observed and 2) Areas that need improvements.

1) Strengths observed

It has been noted from the generated data that participant teachers were aware that one of the best ways learners could engage the content and learners was through doing assessment tasks. Evidence in this regard was obtained from learners' exercise books. It appeared that these activities were often done individually. An assessment task could be given as a test, class activity or homework. It was good to note that both teachers had given at least some kind of activities, although such activities might not have been enough in terms of the requirements of the National Standards and Performance Indicators for Schools in Namibia (NSPI). The NSPI is a policy document that is used as a yardstick to measure the operation of a whole school. It requires that learners be given homework/assignments every day.

Although teachers had given learners some activities, and marked them, none of the teachers mentioned, during the interview, the issue of giving more written work as the best way learners could learn. There is no doubt that it is easier to understand when one does tasks and engage the activity.

The two teachers, however, suggested that there was a need to use the audio-visual materials to make learning more enjoyable and rewarding. They felt that many learners enjoyed watching videos and other audio-visual materials. The question is, however, if they knew about the benefits of using audio-visual aids, why did they not try them in any of the lessons observed?

It was also observed that both teachers made use of analogies (see Section 5.16), albeit to a small extent, because some learners found interest in storytelling and therefore would remember such information better in the long run. T1 also suggested that there was a need for a teacher to be critical when teaching, and ensure that learners were always guided on how to use the biological language. She further suggested that learners learn better when they are able to relate to something they are familiar with. As such, she felt that teachers should be able to refer to real life examples. That is, they observed that meaning was constructed by the individual as new information interacts with extant knowledge.

Her views echo those of Stears, Malcom and Kowlas (2003) and Oloruntegbe and Ikpe (2011). These scholars' studies produced evidence that the use of everyday knowledge in the science classroom increases the levels of engagement of learners, and that learners enjoy making links between their different experiences when curriculum is designed to facilitate such links.

During presentation of the lessons, some good examples to this effect were observed. For example, T2 introduced a lesson by narrating a story as way of contextualizing the topic of Enzymes as catalysts. In the same vein, Rennie (2011) also shares similar sentiments. Through her work, she observes that:

if students are to operate as informed citizens in a world that is becoming increasingly global, then the science curriculum they experience at school must be sufficiently meaningful and relevant for them to perceive links with what they experience outside the school doors (p.15).

Another best practice observed, which indicated that the participant teachers were aware of some of the learners' learning styles, was the use of peer teaching. For example, T1 asked learners to do an activity individually, and at the end of the lesson asked a number of learners to share their answers with the whole class in order to create a support network or a community of practice (Lave & Wenger, 1990).

On the other hand, T2 asked learners to go upfront and interpret the graph to the whole class. Such understanding created a platform for sharing of learners' divergent views and approaches to a question and provided opportunities for teachers to identify misconceptions as they arose. It also enhanced learner talk, as proposed by Lemke (2001).

2) Areas for improvement

As one might observe under the sub-section of strengths, only limited examples were identified as best practices of how much teachers were familiar with the learning styles of their learners. With such a picture painted, there is a need for teachers to understand and know more about the learning styles of their learners, so that they can assist them more in an efficient and meaningful way, including developing compensatory teaching programmes for their learners.

The issue of giving more quality assessment tasks is one area that needs to be developed. The more activities the learners engage in, the better they learn. During the semi-structured interviews, teachers were asked to suggest ways on how they supported their learners in

making sense of biological language and concepts. T1 suggested that there was a need to teach learners pronunciation of biological concepts, because they had problems in pronouncing such terms. What the teacher said is true, but pronunciation may be less important when it comes to knowing and understanding the content of biology, as well as performance in examinations.

I am inclined to believe that the need for correct spelling of scientific concepts, and for more biologically acceptable explanations of concepts, is more crucial than is correct pronunciation.

The inability of teachers to recognize how much their learners could learn from practical activities is also an area that requires improvement. The benefits of using practical work as an efficient learning tool are spelt out in Section 5.2.4, with valuable insights from Woolnough (1994), Maselwa and Ngcoza (2003), and Hodson (1990), to mention a few scholars.

Although in Chapter 2, Stears, Malcolm and Kowlas (2003) talked about the Socio-Cultural theory which views a classroom as a social environment where learning has to be socially mediated, it has been noted from the observations that learners sit and listen more, and the teachers do much of the talking. It could therefore be concluded that there is a need for improvement to allow learners to ‘act’ and talk more during the presentation of the lessons in addition to the other strengths that were observed. Lemke (1989, 1990 & 2001) suggests that to talk science means learning to use specialised conceptual language for reasoning and problem solving, which many teachers find challenging (see Section 2.3.2). That is, there is a need to strike a balance between ‘teacher talk’ and ‘learner talk’.

It was further noted from the sample of the learners’ note books that the information provided to learners was not always correct, and was at times contradictory, as is outlined in Chapter 4 (Section 4.4.4). Learners relied more on the notes teachers gave them. If such information is not corrected, it would be misleading to the learners and would be likely to affect their performance in examinations. My views are that if support is being given to learners, it should be reliable and should meet both learners and curriculum expectations.

It was further noted with concern that neither of the participant teachers was implementing learning support concept/compensatory teaching programme (Ministry of Education, 2010). This is a policy approach that requires teachers to identify their special learners to receive either enrichment activities (for faster learners) or remedial lessons for slower learners. Such

additional support intervention needs to be implemented to address skills/competency gaps that exist in some of their learners.

5.4 Analytical statement 3:

Language errors that might lead to misconceptions

In Chapter 2 (Section 3) and in this Chapter (Section 5.2.5), Nelson's (1996) views were put forward regarding the requirements for effective communication of humans. Nelson further emphasized that for effective communication to take place, the mental representation (MREP) of the speaker must be transformed into a language format that represents its intention. In other words, should the mental representation be transformed into incorrect language, the result would be misunderstood and this could lead to misconceptions on the part of the listener.

In the classroom setting, teaching and learning usually occurs in a dialogic format that ought to be purposeful in pursuit of the achievement of the curriculum objectives. From the document analysis, observations and interviews, it was noted that while both teachers and learners were trying their level best to achieve the national objectives of the curriculum through classroom dialogue, a number of unintended language errors were being made and at times reinforced unknowingly, which undermined the efforts exerted in classroom dialogue. The main challenge here seems to be how to effectively bridge the gap between everyday language and science language. For that reason, Gibbons (2002) suggests that it requires more linguistic skills to use language for academic purposes than it does to use it in everyday conversation. This appears to be correct.

Essentially, this study has found more evidence of language errors that were made by both teachers and learners. Many typical examples were presented in Chapter 4. Some of them look exactly the same as those presented in Chapter 2 (Section 3, Language and Concepts in Biology, when examiner's reports were analysed).

Evaluating the language errors made by the teachers, it appeared that some of the mistakes were being made because of mere poor concentration or limited subject content knowledge. For example, T1 said in lesson 3 that enzymes work only if the seed is buried in the soil. As pointed out earlier, teachers should have basic skills, content knowledge, and pedagogical

skills. He observes that teachers themselves have difficulty in articulating what they know and how they know it. I assume that these are some of the issues contributing to many language errors being observed.

The following examples show typical errors that were observed. During the graph interpretation regarding effects of temperature on the activities of enzymes, T2 informed learners while pointing at the curve that the optimum temperature was where enzymes worked best and at that point 'enzymes increases'. To the learner that may be interpreted that at optimum temperature, the amount of enzymes becomes more, whereas such a thing does not happen at all. I assume the teacher wanted to say the rate of the reaction increases. If not corrected, it is likely to create misconceptions in some learners who do not consult more resources.

The teacher further informed his/her learners that at low temperatures, enzymes are not denatured; they are 'alive', but no energy. The misconception here was that the teacher was creating an impression that life could exist at a level of organisation lower than a cell. Biologically, the lowest level of organisation at which life can be said unequivocally to exist is that of the cell. Language errors and misconceptions were also observed with learners. One learner thought that plants need sunlight and not temperature. This implies that the learner does not know the difference between the sunlight and temperature and/or lacks the necessary language tool to tell the difference between sunlight and temperature (Noordin & Yong, 2009).

Discussing with the participant teachers why some of these mistakes were occurring, when they should not, T1 alluded to the fact that teachers are sometimes not critical (making sure, they say what they mean) of what they say and also to the fact that English, in which biology is taught, is neither her mother tongue nor that of her learners. T2 also indicated that as one of the challenges, learners say a word to mean one thing, but in fact, they mean the other and this creates misunderstanding.

This is exactly the same argument that Nelson (*ibid*) put forward as explained earlier in this section. The teacher further argued that at times, teachers try to simplify 'difficult concepts', but in the end the simplification loses the original meaning, and he therefore recommended biological terminologies should always be used instead. Furthermore, on the side of the learners, the teacher felt that another contributing factor to language errors was English. He

said learners' standard of English was not up to scratch, because their vocabulary was limited.

The fact that teachers repeatedly made the mistakes that are pointed out in the examiner's report every year raises questions on the commitment of teachers in terms of their own professional development and keeping themselves up to date with what is happening in the field. There is a need for concerted efforts from the side of the national government to ensure that there are monitoring and evaluation mechanisms in place to ensure that teachers read examiners' reports with understanding and upgrade their knowledge regularly.

These reports point out the mistakes learners make in examinations and such information could be used to improve teaching and learning, because a teacher would know where to emphasise particular points. I also feel that teachers should be encouraged to be reflective practitioners; they should be able to reflect on their own teaching. According to Shulman (1987), reflection is what the teacher does when he or she looks back at the teaching and learning that has occurred, and reconstructs, re-enacts, and/or recaptures the events, the emotions and accomplishments. It is that set of processes through which a professional learns from experience. This is what I believe teachers should adopt.

5.5. Analytical Statement 4:

Challenges faced by teachers when mediating the learning of biological language and concepts

The presentation of findings in Chapter 4 has revealed that the two participant teachers were faced with many challenges, which are summarized into three: Teachers' Pedagogical Content Knowledge (PCK), resources and language.

Although PCK was explained in Chapter 2 and in this chapter under the analytical statement 2 (Section 5.2), I still want to briefly talk about it as a reminder to the reader since I am going to use this theory to explain the challenges facing teachers when mediating the learning of biological language and concepts. PCK is about blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organised, represented, and adapted to diverse interests and abilities of learners, and presented for instructions (Shulman, 1987).

In view of the above explanation, evidence showed that first and foremost the two teachers had limited content knowledge. Several examples were cited in Chapter 4 which supports this contention: namely, the biological content errors being made by both the teachers and learners. In my view, this should be a worrisome trend to all concerned stakeholders in education. Examples given earlier such as enzymes increasing, enzymes being alive, seeds needing to be under the soil to germinate, and many more show that the subject content of the teachers is limited and an intervention to redress the situation is certainly required. If this situation is not attended to, my opinion is that learners are likely to remain within that 'cocoon' of limited content, with the exception of the few who will think out of the box and study on their own.

Another challenge that both teachers referred to was the lack of the necessary resources. They referred to learner and teacher support materials (LTSMs) not being enough, prompting two to three learners to share a textbook. While the issue of resources cannot be denied, the few existing textbooks were not interpreted correctly, because none of the textbooks that the teachers were using contained the mistakes the teachers made.

At School 1, for instance, I observed that teachers had access to the internet, but during the four lessons that were observed; no internet-supported materials were seen in use, either by the teacher or the learners. However, the teacher mentioned during the semi-structured interview that she would use the internet to download videos on enzymes for learners to visualize the enzyme-catalysed reaction.

The other main challenge facing the two teachers was English Second language which is a mediational tool for teaching biology. Both teachers acknowledged that they had difficulties with English. In many cases teachers use what Vygotsky (1978) calls spontaneous concepts instead of the scientific ones during the presentation of lessons. According to Murray (2002), spontaneous concepts develop out of everyday experience and they are contextually embedded. In addition, scientific concepts are conscious and explicit, and they represent knowledge that can be generalised.

In this context, if teachers make use of spontaneous concepts during the lesson presentations, and such concepts are not transformed into scientific concepts correctly, it is most likely that learners would be ultimately affected in terms of performance in the examinations, because they are expected to write their answers in universally accepted science terms.

In Chapter 2, I pointed out Carrier's (2005) views on how teachers should support learners to overcome the challenge of language. Carrier suggests that teachers need to help learners develop scientific literacy by making use of Scientific Literacy Objectives (SLO). These objectives focus on the literacy skills that prepare all learners to effectively participate in science learning. Through SLO development, the teacher would also improve his/her own participation in science talk (Lemke, 1990 & 2001), and subsequently build better science vocabulary and avoid obvious language errors.

Data from this study has pointed out that language 'confusion' was at times created by the teachers who were supposed to direct the learners. For example, T2 was describing a catalyst as 'something' that speeds up the reaction. 'Catalyst' is a new concept to learners and it should have been introduced systematically with its acceptable definition written somewhere on the poster or chalkboard for reference purposes, rather than being defined as 'something'. I do acknowledge that English is a second language to these teachers, which is a limitation as they admitted, but they need to make some deliberate effort to improve their own teaching.

When I analysed these errors, I came to the conclusion that one of the contributing factors was improper pre-planning of the lessons. In Section 5.2.1, I have described the findings regarding the pre-planning of lessons by the participant teachers. Based on the analysis of their lesson plans, I concluded that there was no consistency in the pre-planning, and details of what exactly would be the role of the teacher and that of the learners was always sketchy. Only if the teachers were planning their lessons properly, well in advance, would they be able to anticipate the discussions and have a chance to verify their facts.

5.6 Analytical Statement 5:

Reflections of teachers on feedback given to them during the stimulated recall interview

As presented earlier in Chapter 4, during the stimulated recall interviews, I felt that I should have used the videotaped lessons to ask the teachers to reflect on what went 'right' or 'wrong' during the presentation of their lessons. The main purpose of such reflections was to provide support to the teachers. During my observation of lessons and analysis of the document, I noted obvious mistakes that could lead to or create misconceptions.

I felt that I should not just do research for the sake of doing it, but I should also be an agent of change in terms supporting the teachers to improve their teaching.

Guidance was therefore given to teachers where they had no idea and their knowledge and experience was limited. Teachers thought that their lessons went very well and that the participation of learners was good, but learner participation alone does not constitute a good lesson. Perhaps pedagogical issues such as posing of questions and engaging of learners' minds were very tricky to the teachers; often they felt all was super. One example was given earlier whereby the T1 taught learners that enzymes work only when a seed is buried in the soil, which surely is not correct. I tried to explain to them that there was a need for them to improve their presentation of lessons in terms how they pose their questions, not just firing off one question after the other even before the first was answered. I also encouraged them to try posing more open-ended questions and to give learners an opportunity to discuss first before answers were given. Through that teachers would allow learners to think more critically, but also get some time to process each of the questions posed. Most importantly, learners' questions were also very critical.

What emerged from the discussions was that teachers showed more confidence in me and wanted more support even after I had left. As a result, T1 called me later for guidance. In the next lesson after the first feedback, T2 wanted me to confirm whether what learners said about the existence of acidic foodstuffs was true. I guess he was thinking of what my comment would be during the next feedback if he gave wrong answers, because he was not sure.

Sometime later during the semi-structured interview, the two teachers said the following:

T 2: 'And also, may be get some more assistance or help from people who have the technical knowhow like yourself in correcting these errors, because some errors come in, sometimes you cannot even note yourself as a teacher' and T1: 'I have picked up some of the things that I did right and those that I did not do well and that has made me to improve today' (see IT- 1&2).

That was a product of the feedback discussions I had with the teachers. The above testimony shows that there is need for a comprehensive intervention that can be used to systematically support teachers, right from lesson planning to lesson execution.

5.7 Concluding remarks

In this chapter I have analysed, interpreted and discussed the data generated from document analysis, observation and interviews. From the analysed data sets I came up with five analytical statements. Through these statements, the data were able to speak for themselves as to how the two participant teachers were providing support to their learners in making sense of biology language and concepts, challenges teachers face, language errors being made as well their feelings in terms of support feedback they received from me.

Limited development of Pedagogical Content Knowledge (PCK) as well as poor development of language tools in English came out as being major stumbling blocks in the way of implementing effective support mechanisms for the biology learners at the two research sites.

In the next chapter, I provide a summary of the findings of the study which culminated in recommendations and areas for future research. I further discuss the limitations of the study, reflect critically on it and end with some conclusions.

CHAPTER 6

SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSIONS

6.1 Introduction

This chapter presents a summary of the findings of the study, and its limitations. It then suggests some recommendations that could be implementable within the Namibia Education Curriculum and elsewhere. These recommendations would potentially constitute an effective mechanism of scaffolding learners; especially in making sense of biological language and concepts given that an enabling environment is created and sustained. Finally, the chapter makes some general recommendations, discusses limitations of the study, areas for future research and offers some critical reflections.

6.2 Summary of the findings

The study reported on how the selected Biology teachers in the Namibian context were scaffolding learners in making sense of biological language and concepts when English is used as mediational tool. The study was motivated by my personal experience as Biology and National Marker to investigate what goes on in the Biology classrooms regarding scaffolding of learners at the two sites involved in the study in an effort to find possible answers to the learners' low achievement level in biology. The findings of the study have helped to provide insights on the strengths/best practices that exist out there as well as the grey areas that need to be improved.

The study was constituted as a case study of two schools in Ohangwena region, and it focused on grade 11 Biology teachers. It investigated how biology teachers supported learners to make sense of biological and concepts when English is used as mediational tool in relation to curriculum expectations and other applicable educational policy frameworks.

The study used qualitative methods to generate data, specifically document analysis, observation and interviews. Convenience sampling was used to identify the two selected schools. Ethical issues were taken into consideration throughout the study.

It was found that biology teachers involved in the study do not often employ a variety of teaching strategies to scaffold learners in making sense of biological language and concepts. It also revealed that the limited use of various teaching strategies by participant teachers results from their limited familiarity with the learning styles of their learners, as well as poor pre-planning of lessons, which is associated with poor monitoring by the school management.

The study further found that the participant teachers had fair subject knowledge, but due to inadequate pre-planning and exposure, they made numerous language errors that might lead to misconceptions amongst learners. This in turn would be likely to have an adverse effect on learners' achievement levels. Enough evidence was also found that participant teachers faced several challenges regarding scaffolding of learners in making sense of biological language and concepts. To overcome such challenge, Ali and Ismail (2006) argue that when science is taught to learners in English, special considerations have to be made to the level of vocabulary used to aid them in understanding science, and the science concept itself must be taught in context with the students' experience or previous knowledge. I agree with this argument because learners learn best when they relate new knowledge with their existing knowledge base. This view resonates well with that of Roschelle (1995) on the importance of interaction between prior knowledge and new experience.

The study concludes that capacity building and exposure of biology teachers, coupled with improved monitoring and support network from school management, would help establish an effective mechanism of scaffolding learners in making sense of biological language and concepts when English is used as mediational tool.

The study findings therefore provided some insightful answers to my research questions. As noted earlier, to a certain extent, teachers were trying their best to scaffold learners in making sense of biological language and concepts, but their limited Pedagogical Content Knowledge and inadequate pre-planning put limitations to their efforts. This gives a signal to policy makers and education planners to come up the appropriate remedy so that the teaching and learning of biology may eventually be improved.

6.3 Recommendations

The following are some of the critical recommendations associated with the findings.

- **If learners cannot learn the way teachers teach, then teachers should teach the way learners learn**

The study found that teachers involved in the study made use of limited teaching strategies to mediate subject content. Among reasons given by teachers include being limited in resources. However, after careful observation of lessons, document analysis and interviewing of teachers, it emerged that teachers do not fully understand and are not familiar with learning styles of their learners. In view of this, I recommend that first and foremost, teachers should become reflective practitioners and use reflected experience to improve on their teaching. Shulman (1987) further views reflection as the review of teaching which leads to new comprehension of the purposes teaching, of subjects to be taught and also of students and of the processes of pedagogy themselves. As such, they need to develop a strategy to review their own teaching to see what works and what needs to be improved. That calls for one to be committed and truly have a desire to be an agent of change in the life of a learner.

My experience shows that teachers' knowledge develops through an integrated process rooted in classroom practice, which includes knowledge representation of subject matter and understanding of specific learning difficulties and student conceptions (Van Driel, Verloop & de Vos, 1998). Having taught for at least three years, one is no longer a novice and one is expected to develop the necessary capacity of identifying learners' needs and better ways to support them effectively, provided the necessary resources are available.

In addition, there is serious need to practically implement the learning support programme. The policy is already in place in that regard in Namibia: it just needs implementation. With such a programme, faster learners ought to be given enrichment activities while slower learners require additional lessons/ remedial classes. This approach is likely to ensure that all learners realize their potential.

The study further found that learners at the two schools involved in the study 'sit and listen', with limited opportunities to 'talk and act'. That is, there is very limited learner talk (Lemke, 2001), yet the curriculum emphasises that learners should be central and take responsibility for their learning. There is therefore a need for a shift in the teacher-learner power

relationship to enable learners to get a significant voice in their own learning (Thompson, 2012). The possibility is that through such outward accountability, learners will be treated as individual beings, who, with the support of the teacher, determine their future.

- **There is need for the development of a special intervention programme to build capacity for practicing biology teachers in Namibia, supplemented with the necessary resources**

The study documented numerous challenges facing the participant teachers. These include insufficient Pedagogical Content Knowledge, limited resources and limited language proficiency. Effective teaching and learning will take place only if the teacher has a very good understanding of the subject and of how to convey to the learners what he or she knows (Shulman, 1987). Having mastered the challenge of mediating the content to learners, the probability of language errors and misrepresentation of facts would be diminished. It would also serve as a motivation to teachers to go into the class and speak with authority because they are well-armed with knowledge. It is against this background that a special intervention programme should be put in place to help build the capacity of practicing teachers when it comes to the subject content and pedagogical content knowledge. The programme should also equip teachers with skills to come up with LTSMs which are relevant to learners' lives, and materials they are able to relate to.

The Ministry of Education could enter into agreement with reputable institutions of high learning in the country and craft a programme that would address the needs of practicing Biology teachers, including – with luck - strategies for integrating code-switching effectively in their lessons, provided that the language policy is reviewed in that light. Immediate supervisors of these Biology teachers could also motivate them to keep on upgrading their skills through distance learning so that they would be able to cope with contemporary challenges.

However, capacity development on its own would not be sufficient: the necessary physical resources also need to be made available to help achieve the set objective(s). For example, School 1 has an under-equipped laboratory, while School 2 has no laboratory at all. Even if a teacher has the necessary capacity, the unavailability of equipment and consumables would serve as a stumbling block. It is also hoped that some such programme would enable teachers to adopt a variety of teaching strategies that allow active participation and are adapted to the characteristics of learners, the complexities of subject matter and the teacher's own physical condition (Shulman, *ibid*).

- **Establish assessment activities audit programme at schools to ensure adherence to biology assessment policy at all times**

It has been reported that the assessment activities given by teachers involved in the study were not up to standard. In the study conducted in South Africa regarding similar challenges, the introduction of Common Task for Assessment (CTA) was found to be exciting and innovative in terms ensuring quality standards of assessment tasks (Wilmot, 2003). This idea could be piloted in a cluster of schools in Namibia in an effort to improve assessment, provided there was alignment between CTA, the Biology syllabus and the National Assessment Policy Guide.

Assessment tasks given were infrequent and not planned well in advance, because only some few tasks appeared on the lesson plans. The few that were conducted did not assess all assessment objectives. This study therefore recommends the establishment of an assessment activities audit programme at every school, effectively monitored by the Inspector of Education to ensure that the Biology Assessment Policy – to mention only one such policy - is implemented fully. This recommendation is critical in view of the fact that assessment should be viewed as part and parcel of teaching and learning. Effective teaching without valid and reliable assessment tasks could result in meaningless teaching-learning transaction.

- **Effective monitoring and support mechanism of teachers' work should be established**

Some evidence from this study shows that the two participant teachers have fair knowledge of subject content given the level of tertiary training they underwent and the number of years they have taught Biology.

In contrast, the participant teachers tried their best to unpack the subject content to the learners, but with less success. Evidence from observation and document analysis shows that the level of support given to learners by the teachers involved in the study measured disappointingly low in relation to the guidelines as set out in the National Standards and Performance Indicators for Schools in Namibia [see Section 5.2 (1)].

There was virtually no single practical activity done, no project and the number of assessment tasks given were few and lacked quality. After a closer look at the teachers' lesson plans, learners' note books and exercise books, there was no evidence that the school management

(especially the Head of Department who is a specialist) was monitoring their work in order to provide the necessary support.

It is therefore recommended that schools should set up (revive if exist) effective monitoring and support mechanism for teachers in order to ensure that quality teaching and learning takes place. This approach is in line with the prescription of the National Standards and Performance Indicators for Schools in Namibia. If monitoring mechanism is not properly implemented, school managers would hardly know the teachers' needs. Support could be obtained, for example, through peer coaching, exchange visit to good performing schools and conduction of workshops where issues raised in examiners' reports could be discussed and strategies developed for implementation at cluster, schools/circuit/regional level.

6.4 Limitations of the study

The focus of this study was to investigate how teachers were scaffolding learners in making sense of biological language and concepts when English is use as mediational tool.

Due to financial, time and geographical constraints, the study was carried out in only two schools. As a result, the findings cannot be generalised. Nonetheless, it provided some insights into how biology teachers in these specific schools enabled learners to make sense of Biological concepts and the challenges that confronted them. In addition, this study foregrounded teachers as units of analysis, leaving out the voice of learners on how teachers were scaffolding them. This could have generated more insights.

After transcribing the videotaped lesson observations and interviews, transcripts were sent back to the two participant teachers for member checking. T1 made few grammar and factual changes to the transcripts, which might have compromised the validity of the study, whereas T2 did not make any change.

I recognise that the teachers' understanding of the learners' learning challenges and that of their own was quite limited as observed, and this further limited the insights they could provide during the interview discussions. I also understand that my position as a senior official at the Regional Directorate of Education in the region could serve as a threat to the participants.

6.5 Areas for future research

- A similar study could be conducted, but with an increased number of sample schools, and with learners included as units of analysis, in addition to teachers;
- Further research could be done on the appropriate teaching methods of teaching in the second language;
- Further research should also be conducted on how teachers could be supported in order to reduce the number of language errors they make and which contribute to misconceptions;
- In addition, further research should be conducted on how assessment tasks set by teachers affect meaningful learning of biological language and concepts;
- Further study should also be conducted on ways of encouraging teachers to reflect on their lessons; and
- Finally, there is also a need for further research that would help strike a balance between ‘teacher talk’ and ‘learner talk’.

6.6 My critical reflections

Being a MEd student with Rhodes University has magnified my view of education in particular, and life in general. The study has enabled me to develop new insights about knowledge, teaching and learning. I learned that several factors are interwoven regarding teaching, and all can influence meaningful learning. Capacity-building programmes are required for effective scaffolding of learners in making sense of science concepts, in particular, biological language and concepts in the context of this study. This is likely to result in improved achievement level in biology results.

My study is underpinned by the Social-Cultural Theory, which has mainly been a teaching and learning tool in our MEd class. Our supervisor has consistently reminded us that we were not competing, but that we needed to support one another. Throughout, we worked as a team.

My study revealed that teachers had limited understanding of their learners; therefore, they were not always sure what to do in order to support them, and so they too need continuous support in terms of professional development as well as monitoring.

If I were to conduct this study again, I would be very careful with the setting of the interview questions, especially follow-up questions. During analysis of my data, I realized that there were gaps in evidence produced, because I did not follow up and /or followed up with the wrong questions. I also experienced problems accessing the Rhodes Library through off campus mode and often I missed out on critical literature. I would also try to capture the voice of the learners; however, this was beyond the scope of this study.

Lastly, I came to learn that research is a journey one needs to walk, and to be watchful of essential signposts all the way in order to get to the right destination.

6.7 Conclusion

This study illuminated the extent to which scaffolding of learners may affect the sense-making of biology language and concepts. This was of critical importance given the high failure rate in Biology. Preliminary evidence points to the learners' inability to express themselves well during examinations. The study established that the participant teachers were still clinging to the traditional way of teaching whereby learners 'sat and listened' more than they were 'talking and acting', a situation which needs to be addressed if Namibia is to produce the type of citizens contemplated in the Vision 2030 document.

The study further acknowledged the dual role teachers have (Probyn, 2009) in ensuring that learners master both the language of instruction and the content. This thesis finally suggests a need for the capacity development of teachers in order to expand on their Content Knowledge and Pedagogical Content Knowledge and be able to make use of different teaching styles as they scaffold learners in the process of making sense of, in particular, biological language and concepts in the context of this study.

The thesis ends by concluding that effective teacher monitoring and support mechanisms should form part of the change agenda so that teachers can effectively scaffold learners in making sense of biological language and concepts and help achieve the overall objectives of the National Curriculum.

References

- Abell, S. K. (2008). Twenty years later: Does pedagogical content knowledge remain a useful idea? *International Journal of Science Education*, 30(10), 1405-1416.
- Ali, M., & Ismail, Z. (2006). Comprehension level of non-technical terms in Science: Are ready for science in English. *Jurnal Pendidik dan Pendidikan*, 21, 73-83.
- Bean, T. W., Searles, D., Singer, H., & Cowen, S. (1990). Learning concepts from Biology text through pictorial analogies and an analogical study guide. *Journal of Educational Research*, 83(4), 233-237.
- Boran, G. (2004). *Socio-cultural perspective and language teaching*. Retrieved 22 October 2011 from <http://www.ekevakademi.org/moduller.php?modul=makale&op=1&id=707>
- Bradley, K. S., & Bradley, A. J. (2004). Scaffolding Academic Learning for Second Language Learners. *The Internet TESL Journal*, x(5) accessed on 28 October 2012 from <http://iteslj.org/Articles/Bradley-Scaffolding/>.
- Bryman, A. (2001). *Social Research Methods*. New York: Oxford University Press.
- Carrier, K. A. (2005). Supporting science learning through science literacy objectives for English language learners. *Science Activities*, 42(2), 5-11.
- Chaiklin, S. (2003). The Zone of proximal development in Vygotsky's analysis of learning and instruction. In A. Kozulin, B. Gindis, V. Ageyev, & S. Miller, *Vygotsky's educational theory and practice in cultural context* (pp. 1-21). Cambridge: Cambridge University Press.
- Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education* (6th ed.). London: Routledge.
- Colgrove, A. N. (2012). *Approaches to teaching young children science concepts and vocabulary and science problem-solving skills and role of classroom environment*. Lincoln: Nebraska.
- Collahan, T.C., & Hobbs, R. (1998). *Research ethics*. [Online]. Retrieved August 2011 from HYPERLINK "http://depts.Washington.edu/bioethx/topics/resrch.html" <http://depts.Washington.edu/bioethx/topics/resrch.html> .
- Erni, G. (2009). *Biology and life science*. Windhoek: Unpublished notes.
- Gass, M. S. (2000). *Stimulated Recall methodology in second language research*. Mahwah: Lawrence Erlaum Publishers.

- Gibbons, P. (2002). *Scaffolding language and learning: Teaching second language learners in the mainstream classroom*. Sidney: Heinemann.
- Goos, M. (2004). Learning Mathematics in a classroom community of inquiry. *Journal of Research in Mathematics Education*, 35(4), 258-291.
- Gray, W. (2006). Apprenticing learners in the context of the grade 10 physical science classroom (1). Rhodes University: Unpublished.
- Hart, J. E. (2003). Teacher professional development to improve the science and literacy achievement of English language learners. *Bilingual Research Journal*, 27(3), 475-501.
- Henning, E., V. W. Rensburg, & B. Smit (2004). *Finding your way in qualitative research: An interpretivist framework*. Pretoria: J. L. van Schaik.
- Hodson, D. (1990). A critical look at practical work in school science. *School Science Review*, 70(256), 33-40.
- Kamini, J. (2001). *English second language students in a Grade 11 Biology class: Relationships between language and learning* (1-24). British Columbia: EDRS.
- Kocakulah, S, Ustunluoglu, E., & Kocakulah, A. (2005). The effect of teaching in native and foreign language on students' conceptual understanding in science courses. *Asia-Pacific Forum on Science Learning and Teaching*, 6 (2), 1-30.
- Lankshear, C., & M. Knobel (2004). *A qualitative research: From design to implementation*. New York: Open University Press.
- Lantolf, J. P., & Thorne, S. L. (2007). *Sociocultural Theory and Second Language Learning*. Retrieved April 20, 2010, from The Pennsylvania State University Website: HYPERLINK "http://language.la.psu.edu/~thorne/Lantolf.Thorne.vanpatten.2007.pdf" <http://language.la.psu.edu/~thorne/Lantolf.Thorne.vanpatten.2007.pdf>
- Lave, J., & Wenger, E. (1990). *Situated Learning: Legitimate Peripheral Participation*. Cambridge, UK: Cambridge University Press.
- Leedy, P. D., & Ormrod, J. E. (2010). *Practical Research: Planning and Design* (9 ed.). New Jersey: Pearson Education.
- Lemke, J.L. (1989). *Using language in the classroom*. Australia: Oxford University Press.

- Lemke, J. L. (1990). *Talking science language, learning and values*. West Port: Ablex Publishing.
- Lemke, J.L. (2001) Articulating communities: Social perspectives on Science Education. *Journal of Research in Science Teaching*, 38(3), 296-316.
- Loughran, J., Mulhall, P., & Berry, A. (2004). In search of Pedagogical Content Knowledge in Science. *Journal of Research in Science Teaching*, 4(41), 370-391.
- Lyle, J. (2003). Stimulated recall: a report on its use in naturalistic research, *British Educational Research Journal*, 29:6, 861-878 from [HYPERLINK "http://dx.doi.org/10.1080/0141192032000137349"](http://dx.doi.org/10.1080/0141192032000137349)
<http://dx.doi.org/10.1080/0141192032000137349>
- Maselwa, R. M., & Ngcoza, K. M. (2003). 'Hands-on', 'minds-on' and 'words-on' practical activities. In D. Fisher & T. Marsh (Eds.), *Proceedings of the Third International Conference on Science, Mathematics and Technology Education* (pp. 649-659). East London Campus, Rhodes University, South Africa.
- Merriam, S. (2009) *Qualitative research: A guide to design and implementation*. San Francisco: Jossey-Bass.
- Murray, S. (2002). Multiculturalism education: Core text-Language and learning BED (Hons) Namibia, unpublished.
- Namibia. Ministry of Education (2007). *Education and Training Sector Improvement (ETSIP). Planning for a learning nation programme document: Phase 1 (2006-2011)*. Windhoek: Namibia. Ministry of Education (2010). *The National Curriculum for Basic Education*. Okahandja: NIED Government Printer.
- Namibia. Ministry of Education. (2010). *Learning Support Teachers' Manual (Draft)*. Okahandja: NIED.
- Namibia. Ministry of Education. (2009). *Report on the Examinations NSSC(0)*. Windhoek: DNEA.
- Namibia. Ministry of Education. (2010). *Report on the Examinations NSSC(O)*. Windhoek: DNEA.
- Namibia. Ministry of Basic Education, Sport and Culture (MBESC). (2003). *The Language Policy for Schools in Namibia*. Windhoek: Afrila, GTZ & NIED.

- Namibia Ministry of Education and Culture. (1993). *Toward Education for All: A development brief for education, culture and training*. Windhoek: Gamsberg Macmillan.
- Namibia. Ministry of Education. (2009). *National Policy guide for Natural Sciences (NSHE, Life Science and Biology)*. Okahandja: NIED.
- Namibia. Ministry of Education. (2010). *Biology syllabus Ordinary Level*. Okahandja: NIED.
- Nelson, C. (1996). *Language in cognitive development: The emergency of mediated mind*. USA: Cambridge University Press.
- Neshuku, C. (2009). *An exploration of problems experienced in interpretation of word problems grade 12 learners*. Rhodes University: Unpublished Thesis.
- Noordin, M. B. H., & Yong, B. C. S. (2009). *Students' achievement and language problems in learning Biology in English in public and private schools: Science Parallele* (pp. 1-6). Brunei Darussalam: Brunei University.
- Ogunniyi, M. B. (n.d.). *Contiguity theory: A cultural dialectic of border crossing*. University of Western Cape. Unpublished paper.
- Oloruntegbe, K. O., & Ikpe, A. (2011). Eco-cultural factors in students' ability to relate science concepts learned at school and experiences at home: Implications for chemistry education. *Journal of Chemical Education*, 88(3), 266-271.
- Pea, R. D. (1993). Learning scientific concepts through materials and social activities: Conversational analysis meets conceptual change. *Educational Psychologist*, 28 (23), 265-277.
- Probyn, M. (2004). Making sense of science through two languages: A South African case study. *School Science Review*, 86 (314), 49-59.
- Probyn, M. (2009). 'Smuggling the vernacular into the classroom': Conflicts and tensions in classroom codeswitching in township/rural schools in South Africa. *International Journal of Bilingual Education and Bilingualism*, 12 (2), 123-136.
- Renner, M. (2003). *Analyzing qualitative data*. Wisconsin: Ellen Taylor- Powell.
- Rennie, J. R. (2011). Blurring the boundary between the classroom and the community: Challenges for teachers' professional knowledge. In D. Corrigan, J. Dillon & F. R. Gunstone (Eds.), *The professional knowledge base of science* (pp.13-29). New York: Springer.

- Roschelle, J. (1995). *Learning in interactive environments: Prior knowledge and new experience*. Retrieved May 15, 2012 from <http://www.exploratorium.edu/IFI/resources/museumeducation/priorknowledge.html>
- Rosebery, A.S. (2008). Essay: Creating a foundation through student conversation. In A. S. Rosebery & B. Warren (Eds.), *Teaching science to English language learners* (pp.1-12). USA: National Science Teachers' Association.
- Schram, T.H. (2006). *Conceptualising and proposing qualitative research* (2nd ed.). Upper Saddle River, NJ: Merrill/Prentice Hall.
- Shulman, L.S. (1987). Knowledge and teaching: Foundations of new reform. *Harvard Educational Review*, 57(1), 1-22.
- Snow, C. (2008). *What is the Vocabulary of Science?* In A. S. Rosebery & B. Warren (Eds.), *Teaching science to English language learners*. USA: National Science Teachers Association.
- Stears, M., Malcolm, C., & Kowlas, L. (2003). Making use of everyday knowledge in the science classroom. *African Journal of Research in SMT Education*, 7, 109-118.
- Thompson, P. (2012). Learner-centred education and 'cultural translation'. *International Journal of Education Development*, 33(2013), 48-58.
- Van der Mescht, H. (2011). Interviews in qualitative research. *Research design course* (pp. 1-13). Grahamstown: Rhodes University.
- Van Driel, H. J., Verloop N., & de Vos, W. (1998). Developing science teachers' pedagogical content knowledge. *Journal of Research in Science Teaching*, 80(6), 673-695.
- Van Heerden, L. L. (2010). *An investigation into the readability of the Grade 10 Physical Science Textbooks: A case study*. Grahamstown: Rhodes University.
- Vygotsky, L. S. (1978). Mind in society. In M. Cole, V. John-Steiner, S. Scribner, & S. Souberman (Eds.), *The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Wilmot, D. (2003). The inception phase of case study of outcome-based education assessment policy in human and social sciences learning area of C2005. *South African Journal of Education*, 23(4), 313-318.
- Woolnough, E.B. (1994). *Developing science and technology education: Effective science*

teaching. Great Britain: St Edmundsbury Press.

Appendices

Appendix A- Permission request letter to the Regional Director



OHANGWENA REGIONAL COUNCIL

OHANGWENA EDUCATION DIRECTORATE

Advisory Services

Private Bag 2028, Ondangwa, Tel. 264 65 242516, Fax. 264 65 242552

Enq: E. Nakale

25 January 2012

E-mail: elifas1@live.com

**To: Mrs Sanet Cloete
Director of Education**

Dear Sanet

Subject: Request for permission to carry out a research study at Mwadikange Kaulinge Secondary School and Eenhana Secondary School

I Elifas Nakale, a Senior Education Planner, Ohangwena Region is hereby requesting for permission to conduct a research study at the above indicated schools in February 2012.

I have registered as a part-time student at Rhodes University, Grahamstown (student number 611N5690) as from January last year doing a Master's degree in Science Education. I would be most grateful if you would allow me to conduct my research study at Secondary School 1 and Secondary School 2 during the month of February to March 2012.

My topic of study is “Understanding how teachers help learners make sense of biological language and concepts when using English as a mediational tool: A Namibian case study”.

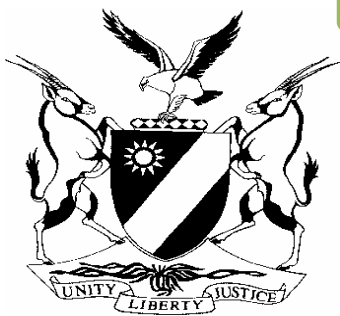
The insights generated from this study will be published in a thesis form and will become accessible to decision makers in education, curriculum developers, teacher educators and Biology teachers in order to bring about improved achievements in Biology. Should I get permission, I will observe and vidiorize four lessons presentation, interview these two teachers at their free time and share my experience with them.

The school, learners and teachers will be assured of anonymity of information provided and teachers will be allowed to go through the draft thesis to ensure that the details are correct.

Your understanding in this regard will be highly valued.

Yours Sincerely,

E. Nakale (Mr.)



OHANGWENA REGIONAL COUNCIL

OHANGWENA EDUCATION DIRECTORATE

Planning and Development

Private Bag 2028, Ondangwa, Tel. 264 65 281968, Fax. 264 65 240190

Enq: E. Nakale

25 January 2012

E-mail: elifas1@live.com

To: The Principal

School I

Dear Mr. E.Toivo

Subject: Request for permission to carry out a research study at School I Secondary School

I Elifas Nakale, an employee of the Education Oshana Region is hereby requesting for permission to conduct a research study at your school as from 14-17 February 2012.

I have registered as a part-time student at Rhodes University, Grahamstown (student number 611N5690) as from January last year doing a Master's degree in Science Education. I would be most grateful if you would allow me to conduct my research study in your school. I have verbally spoken to Ms Alice Xai to be the participant teacher in my research and she indicated her willingness to take part.

My topic of study is "Understanding how teachers help learners make sense of biological language and concepts when using English as a mediational tool: A Namibian case study".

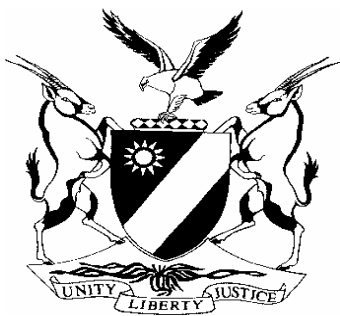
The insights generated from this study will be published in a thesis form and will become accessible to the decision makers in education, curriculum developers, teacher educators and Biology teachers in order to bring about improved achievements in Biology. Should I get permission, I will observe and vidiorize four lessons presentation in a, interview the teacher observed at their free time, look at lesson plans, learners' written work and I will share my experience with the teacher during our discussions.

I assure the school, learners and Ms Xai that everything will be treated confidentially and the participant reserves the rights to withdraw. Ms Xai will be allowed to go through the draft thesis to ensure that the details are correct and I will not use the really name for the school and the teacher.

Your cooperation in this regard will be highly valued.

Yours Sincerely

E. Nakale (Mr.)



OHANGWENA REGIONAL COUNCIL

OHANGWENA EDUCATION DIRECTORATE

Planning and Development

Private Bag 2028, Ondangwa, Tel. 264 65 281968, Fax. 264 65 240190

Enq: E. Nakale

25 January 2012

E-mail: elifas1@live.com

To: The Principal

School 2

Dear Mrs. A. Shamena

Subject: Request for permission to carry out a research study at School 2 Secondary School

I Elifas Nakale, an employee of the Education Ohangwena Region is hereby requesting for permission to conduct a research study at your school as from 13-16 March 2012.

I have registered as a part-time student at Rhodes University, Grahamstown (student number 611N5690) as from January last year doing a Master's degree in Science Education. I would be most grateful if you would allow me to conduct my research study in your school. I have verbally spoken to Mr. Mao Lee to be the participant teacher in my research and she indicated her willingness to take part.

My topic of study is "Understanding how teachers help learners make sense of biological language and concepts when using English as a mediational tool: A Namibian case study".

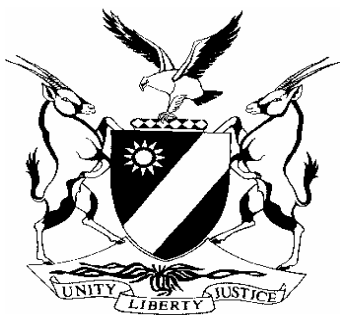
The insights generated from this study will be published in a thesis form and will become accessible to the decision makers in education, curriculum developers, teacher educators and Biology teachers in order to bring about improved achievements in Biology. Should I get permission, I will observe and vidiorize four lessons presentation in a, interview the teacher observed at their free time, look at lesson plans, learners' written work and I will share my experience with the teacher during our discussions.

I assure the school, learners and Mr Lee that everything will be treated confidentially and the participant reserves the rights to withdraw. Mr Lee will be allowed to go through the draft thesis to ensure that the details are correct and I will not use the really name for the school and the teacher.

Your cooperation in this regard will be highly valued.

Yours Sincerely

E. Nakale (Mr.)



OHANGWENA REGIONAL COUNCIL

OHANGWENA EDUCATION DIRECTORATE

Planning and Development

Private Bag 2028, Ondangwa, Tel. 264 65 281968, Fax. 264 65 240190

Enq: E. Nakale

25 January 2012

E-mail: elifas1@live.com

To: The Biology teacher

School I

Dear Madam

Subject: Request for permission for Ms Alice Xai to be a research participant in my research study at School I Secondary School

I Elifas Nakale, an employee of the Ohangwena Education Directorate, am hereby requesting you to be a participant teacher in my research study to be conducted at your school as from 14-17 February 2012.

I have registered as a part-time student at Rhodes University, Grahamstown (student number 611N5690) as from January last year doing a Master's degree in Science Education. I would be most grateful if you would allow me work with you during my research study in your school.

My topic of study is "Understanding how teachers help learners make sense of biological language and concepts when using English as a mediational tool: A Namibian case study".

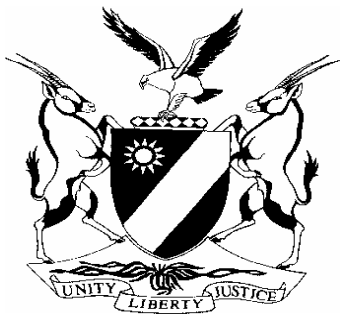
The insights generated from this study will be published in a thesis form and will become accessible to the decision makers in education, curriculum developers, teacher educators and Biology teachers in order to bring about improved achievements in Biology. Should you give me permission, I will observe and vidiorize four lessons presentations in one topic that we will have to agree upon, interview you at your free time, look at lesson plans, learners' written work and I will share my experience with you during our discussions.

I assure you that everything will be treated confidentially and you reserve the rights to withdraw. You will be allowed to go through the draft thesis to ensure that the details are correct and I will not use your really name and that of the school.

Your cooperation in this regard will be highly valued.

Yours Sincerely

E. Nakale (Mr.)



OHANGWENA REGIONAL COUNCIL

OHANGWENA EDUCATION DIRECTORATE

Planning and Development

Private Bag 2028, Ondangwa, Tel. 264 65 281968, Fax. 264 65 240190

Enq: E. Nakale

25 January 2012

E-mail: elifas1@live.com

To: The Biology teacher

School 2

Dear Sir

Subject: Request for permission for Mr Mao Lee to be a research participant in my research study at School 2 Secondary School

I Elifas Nakale, an employee of the Ohangwena Education Directorate, am hereby requesting you to be a participant teacher in my research study to be conducted at your school as from 14-17 February 2012.

I have registered as a part-time student at Rhodes University, Grahamstown (student number 611N5690) as from January last year doing a Master's degree in Science Education. I would be most grateful if you would allow me work with you during my research study in your school.

My topic of study is "Understanding how teachers help learners make sense of biological language and concepts when using English as a mediational tool: A Namibian case study".

The insights generated from this study will be published in a thesis form and will become accessible to the decision makers in education, curriculum developers, teacher educators and Biology teachers in order to bring about improved achievements in Biology. Should you give me permission, I will observe and vidiorize four lessons presentations in one

topic that we will have to agree upon, interview you at your free time, look at lesson plans, learners' written work and I will share my experience with you during our discussions.

I assure you that everything will be treated confidentially and you reserve the rights to withdraw. You will be allowed to go through the draft thesis to ensure that the details are correct and I will not use your really name and that of the school.

Your cooperation in this regard will be highly valued.

Yours Sincerely

E. Nakale (Mr.)

Teacher: Alice Xai

Grade 11B

Date: 14.02.2012

SUBJECT: BiologyTHEME AND TOPIC: EnzymesTEACHING AIDS AND RESOURCES TO BE USED: module 1, Posters

LEARNING OBJECTIVES WITH THE LESSON: Learners will:

Realize the importance and application of enzymes

IC COMPETENCIES (Refer to Syllabus): Learners should be able to:

- Define enzyme as proteins that function as biological catalysts
- Describe the properties of enzymes!
- Describe the effect of changes in temperature & pH on enzyme activity

PRESENTATION OF THE LESSON:

1. Monitoring of homework done: Friday, learners were given the topic task, which is to read about enzyme. Teacher ask them question about enzymes.
2. An appropriate short introduction: Teacher present the lesson objectives loud and learners are listening and asking questions if any
3. presentation of subject content and learning tasks: Based on the learners answers about enzymes, teacher present the feedback by the help of a poster, teacher present information more about enzymes through presentation and questioning methods. Teacher also ask learners to explain how do they understand the word enzymes, temp, pH, substrate with properties we also

Consolidation: Summarize the main points

ASSESSMENT / HOMEWORK / TASK / EXERCISES

oral questions, Classwork & Activity 2 & 3

OPPORTUNITIES TO DEVELOP LEARNERS' ENGLISH READING AND WRITING SKILLS IN THE SUBJECT:

Reading activities: Teacher ask at least one learners to read loud correct mispronouncedWriting activities: Teacher marks learners work and correct misspelled

Teacher: Alice Xai

Grade 11B

Date: 14.02.2012

SUBJECT: Biology

THEME AND TOPIC: Enzymes

TEACHING AIDS AND RESOURCES TO BE USED: module 1, Posters

LEARNING OBJECTIVES WITH THE LESSON: Learners will:

Realize the importance and application of enzymes

IC COMPETENCIES (Refer to Syllabus): Learners should be able to:

Define enzyme as proteins that function as biological catalysts

Describe the properties of enzymes

Describe the effect of changes in temperature & pH on enzyme activity

PRESENTATION OF THE LESSON:

1. Monitoring of homework done: Friday, learners were given the topic task, which is to read about enzyme. Teacher ask them question about enzymes.
2. An appropriate short introduction: Teacher present the lesson objectives loud and learners are listening and asking questions if any
3. Presentation of subject content and learning tasks: Based on the learner answers about enzymes, teacher present the feedback by the help of a poster, teacher present information more about enzymes through presentation and questioning methods. Teacher ask each learner to explain how do they understand the word enzymes, temp, pH and its effect on properties of enzymes

Consolidation: Summarize the main points

ASSESSMENT / HOMEWORK / TASK / EXERCISES

oral questions, Classwork Activity 2 & 3

OPPORTUNITIES TO DEVELOP LEARNERS' ENGLISH READING AND WRITING SKILLS IN THE SUBJECT:

Reading activities: Teacher ask at least one learner to read loud correct mispronounced

Writing activities: Teacher mark's learner's work and correct misspelled thing

6. Digestive enzymes

- Most digestive enzymes are ^{produce} by salivary glands and the pancreas
- Glands in the epithelial lining of the stomach and the small intestine also produce some enzymes
- Enzymes work well at optimum pH and temperature
- Digestive enzymes work well at about 37°C - 40°C
- The temperature of the human body is about 37°C - 38°C
- The optimum pH may vary from one enzyme to another.

Digestion of Carbohydrates, fats and protein

NB * We need to ^{know} the functions of three digestive enzymes:

- * Protease
- * Amylase
- * Lipase

- Each enzyme acts on a particular type of molecule called a substrate and breaks down the substrate to form products.

- Amylase breaks down large carbohydrate molecules, such as starch, into smaller molecules such as simple sugars
- Amylase hydrolyses the glycosidic of polysa

Appendix E cont.: S1 – N3

Carbohydrates, such as Starch which is changed to maltose.

- AA - Pepsin → Breaks down large molecules of protein into small amino acid molecules.
- Pepsin hydrolyses the peptide bonds in different regions of the polypeptide chain.

Lipase → breaks down large molecules of fats into small molecules of fatty acids and glycerol.

- Lipase hydrolyses the fats to ~~sm~~ fatty acids and glycerol.

Action of amylase in the mouth.

- Amylase is secreted from salivary glands in the saliva.
- Amylase starts the digestion of Starch in the mouth.
- The pH of saliva is slightly alkaline, and provides the optimum pH for amylase.
- The enzyme works by hydrolysing the glycosidic bonds of the polysaccharides, such as starch to form maltose.
- Amylase cannot hydrolyse maltose, maltose is broken down into smaller units of glucose by another enzyme in the small intestine.
- The action of amylase stops when the food enters the stomach, because the pH in the sto-

Appendix F: S1 CA1
S1-School 1; CA1- Class Activity 1

Excretory system consists of the kidney, ureters and the bladder.

8/7

(4)

14 March 2012

4/9

Class activity

a) 0°C and 60°C ✓

b) 45°C

c) the two of them will increase ✓

* d) it will begin slowly destroyed ✓

e) the enzymes break down from about 45°C to 60°C ✓

Check: f) because the temperature of enzymes will break down from 45°C .

Correction

c) It increase by a factor of two

f) At a temperature of 40°C , the proteins in the enzyme may break down and the enzyme will no longer be able to perform its job in the body.

Activity 4, page 105

4/9

14 March 2012

(a) from ~~50°C~~ to ~~60°C~~ 0°C ✓

(b) from ~~45°C~~ ✓

(c) The reaction start to work fast and increase ✓

(d) The temperature is ~~not~~ ^{not} at normal rate of reaction, they slowly destroyed ✓

(e) because ^{more} reaction of enzymes you will breath too difficult at 45°C

(f) is dangerous because your body is not at normal temperature, so that person get die.

Appendix H: Transcribed interview at School 1 (s1)

Part 1

Key: T1= teacher 1

R= Researcher

R= Yes good morning once again Ms Xai .

T1= Good morning Mr. Nakale

R= How are you?

T1= I am fine, how are you sir?

R= very good, I am fine. So... aa.. I am really glad that I have enjoyed being in your class, it has been a wonderful lesson, you did a great work. So, now I am going to ask a few questions if you can try your best to answer these questions and where you don't understand, you can still ask me to elaborate.

T1= Mh....

R= Now from the two lessons that we..we been in or that we saw this morning, aa... if you reflect on these, what do you think has gone right and what do you think can be improved? And here we are talking about in terms of aa..a learners' ability to..to..to make sense of biological language ana..and concepts. So what ..what..what has been your experience in the past two lessons we just had this morning?

T1= Mh...

R= yes

T1= I think with regards to the ..to the aims and objectives of the syllabus, I think I have... specified objectives I think.. I have attained that very well. When it comes to lesson presentation, I think I did it well, and ja... and I think also learners got it well. They....some of them were experiencing problems in pronouncing... pronouncing the biological terms, but I really tried by all means aa... to help them on how to pronounce them, ja..so I think aa.. that is what went wrong...went well, ja... And also I have also experienced some challenges there with learners their English you know is not their mother tongue and they struggled here and there. And it is also not mine, so I was also a bit struggling with pronunciation of words like catalase and catalyst... So I also made it the same, but then I have realised it and I think with time I am going to work more on that. So is just the .. the terminologies which is a problem..ja..so..ja.. that is all I think so.

R= Aa.. apart from aa..the challenges of aa.. pronouncing words correctly, did you notice for example where a learner to say something, you ask a question and the learner wanted to say something, but what the learner said did not really mean what you expected or what a learner wanted to say, mean differently from what.. from what you expected?

T1= m.....mm... (not agreeing), I did not, I did not take note of that, but what I took note is that they.. they tried to say the word, but they are struggling saying it, that is the only thing that.... I picked up from them..ja...ja.

R= Ok... somewhere along the lesson although we are going to watch the video, you emphasized that ok when it comes to enzymes aa..and temperature, you...you told them ok enzymes are specific with regards, it comes to temperature and you emphasized the..the..the.. the component or the part that says when we say optimum temperature it is where enzymes works at its best and you said the learners should not say the best temperature, but rather optimum temperature. Can you clarify what.. what is the reason?

T1= What is the reason? Did I really say that?

R=Ja.. you said ok.. if I quote you correctly, you said ok, they should not say the best temperature. They should rather say optimum temperature where an enzyme works best.

T1= Ok, so ..aa... when you talk about biological terms, we mean..... for them to say best it is like more simple, and then if they talking more biologically, they rather say optimum temperature, because that is the right word to use ...aaa...in biology even though it is the best temperature, they are required to know that word optimum temperature when it regards to..to..to the...to the how this temperature affects the activity of an enzyme... ja..so that is also one of the biology...biological or biology language we talk about. Ja.. so for me to..to..to teach them how those..aa.. terms work or biological language work, first I need to put it in simpler English that is when I bring them to the.. to the term that they need to use. But it is not wrong to say best temperature, it is not wrong, but we need them to know the type of language that they can use.

R= Mh... ok.. (taking a deep breath) ee... can, let us spend a bit of time there because aa... from my experience, ee... learners are experiencing difficulties and from the marking of paper 3, ee...a couple of learners do not get marks when it come to that specific questions regarding the optimum and best temperature and so on... You just said it is not necessarily wrong for them to say it is the best temperature. Ee... help me understand one thing, when we talk about optimum temperature, do we mean, is the best temperature or it is the temperature where the enzyme work best, what.. what are views on that?

T1=we mean ...aa.. it is the temperature where enzyme work at the best level, that is what we mean there.

R= And not the best temperature?

T1= Not the best temperature.

R= Because what is really.....ja.

T1= Ok I just took note of that that, it is the best temperature where enzymes works at their best level.

R= Ok, that is great! Aaa... ok , maybe we can move on..... aa.... (paused to watch the video)

Part 2

R= Aa.. Ms Star, welcome back to the second part of our interview after that short break, aa.... We are now going to continue with question three onwards. Now that we have watched the video together, aa.. what challenges regarding learners' ability in making sense of biology language and concepts have emerged from the video? ..Yes.....

T1= challenges regarding learners' ability in making sense of biological languages?

R= Mh.....

T1= Is from the side of the learners or from the side of the.....?

R= Ok...ee., the question is about on the side of the learners, but you can also or if you want to say something on own side, you are also welcome, Yes.....

T1= On the side of the learners sometimes is just the shyness of the to say something in class, because if the learner did not try to participate in class, they will also not learn how to pronounce the words.... Aa..biological languages and if they are not practicing that pronunciation, I think it also has to go down with... the way they write those terms. I think that is one of the challenge that I picked up from them, and I think they are still struggle, because it English, it is not their mother tongue. So, those are some of the challenges and those are biological words are also difficult, because they are new words to them, even if they are trying their best of course you... you can still see some difficulties, still see..... here and there, ja...those are some of the challenges that I have picked up. Even also from the of.. of the teacher, myself.... Also pronunciation also,..it is the problem, because if the teacher did not pronounce the word...aa...very well in class, the learners themselves are also going to..to repeate the same mistake and if the teacher is not saying the..the right terminology like aaa... instead of saying the rate of the reaction, you are saying again the way of the reaction, of course the learners will go along with that mistake and it is going to affect them in the way they are going to answer or they are going to pronounce themselves aa.. biologically, jaa.. those are just some of the challenges that I have picked up.

R= thanks for that... aa.. the next question is what do you think could have caused that particular problem that you just pointed out? Jaa.. What are the contributing factors?

T1= contributing factors?

R=Mh....

T1= aa.. on the side of the learners I think is just lack of motivation and aa... poor background, but I think I it also has to do with the teacher, the teacher need to motivate the learners , when they motivate the learners then they can able to stand up and say something in

class , just to encourage them, just to make to make it more interesting so that will also get involved. I also think on the side of the teacher, aa... sometimes the teacher, also need to do some pre.. pre-planning and more research on the topic and then also more... more easy ways of pronouncing the words, I think more informations on the subject area.. is also needed and then also just to emphasize on the biological terms not to be taken for granted. Jaa... so those are some of the.... Problem that could have contributed or that is

on the side of the teacher could poor informations and bad ways of how to say the right term and the also taking those ... biological words for granted aa.. not really emphasizing them. Jaaa...because of they did not emphasize them using other words, then it is also going to contribute to poor performance of learners.

R= Thank you very much for that detailed answer. Aa... the next one is to what extend do you think such problems or such challenges that you just spoke about may affect learners achievement in biology?.. Yes...

T1=Like I said it would really aa.. affect them greatly.. more specifically because the syllabus wants the learners to know those terms, those terminologies, those biological words and if the syllabus is demanding that that it means that even in the test, even and in the exams, they are also going to be tested upon those aa... in the subject, biology. So it means that if they don't know to express themselves in biology, they don't know the terms, aa..... and they don't know how to pronounce it and they can also not know how to write it, aa..... it means that it going to contribute to..to the poor performance of learners and they may not achieve the.. the desirable standards that are needed.

R= Mh.....

T1= Ja..

R= Aa...And now that you just pointed out some of the challenges that emerged from the video, aa...can you suggest some ways how you.. you may support learners aa... in making sense of biological language and concepts better? Iyaa...

T1= I think also one of the..the way that could be coming in or to support the learners aa...aa.. aa..pronouncing of the concept of biological languages, I think the most problem it has to do with pronunciation. I think may be the teacher can come in with the.. aa.. video, may be someone is presenting and is saying those ..those words out loudly, and the I think by that the teacher and the learner could pick up more on these aa..terms. And then aa.. with the other one. I think may be teacher or with the class must just come up either with a big poster and this one must contain all of the biological terms in that topic. And I think that one would also contribute to..to that one that could have supported the learners and I think also the..the teacher also lacking some of the insights on those pronunciations, saying them better and the just to incorporate them in the topic... in the lesson.

I think also the teacher must do more on that... and by doing that she/he may be able now to support learners in picking up those biological concepts. Iyaa.... And the most important

thing is just to listen to someone pronouncing them better and then also just to watch a video on them. I think that is the most important part.

R= Ok! Ee.... You seem to emphasize more on pronouncing biological concepts, ee...ee..may I ask what...what is your understanding of the phrase, making sense of biological language and concepts?

T1=making sense is like, they should try to get something out those terms, I think that is the way that I understand it.

R=get something like?

T1=trying to understand as to what do they mean, what are they trying to say so that they are able to digest it and put it in the way they sees it and think about it

R= great! Not necessarily how to pronounce the concept, but also to understand, to unpack the whole concept and..and get the details of it?.

T1= jaa....

R= ok

T1= I think also by that...aa the teacher first must just try to..to..to explain it in simpler terms and then if the teacher explains it in a simpler term and then also give real life examples, if the.. real life examples are given, and then learner knows what does it mean, and I think from there, the learners are able to start from there and then they can be able to understand them very well.

R= ok..

T1=ja..

R= Eeee... they say for somebody to assist the other person better or to support them better, unless you understand what their needs, do you think you understand the learning difficulties of your....of your learners?

T1=Yes I do understand.....I do understand their learning difficulties, and if the learning difficulties is already English itself which is the basic one, when it comes now to a more complex and detailed one, which are biologically terms then we can all see the ...the difficulties there, ja.... that is... the language....ja.....

R= So the difficulties starts with the language, the medium through which the content is delivered?

T1=Ja...

R=Ok..

T1=so that is the difficulties, mh.....

R= But, are there some more, apart from the language, apart from English, are there some more difficulties your learners are facing regarding the learning of biology?

T1= Ja.. It also has to do with resourceses, the.. the..they also don't have enough resourceses as you can see when we were in the lesson, you can see two or three learners looking at one book. So it also has to do with resources, if you expose them with a lot of resources and you encourage them to use them , I think that one could also help.....(coughing) be the case that one of the challenges is the resources.

R= so are you saying the fact that the resources..the textbook that they are using is probably one that may also limit the understanding of the....concepts?

T1=ja..ja..they all standby it... it may also limit them, because they cannot do more research, because they are just looking at one book, if they were having more than one, then they can pick up.. aa ..information here and there, and thus when they are able to pick up the concept very well and understand it.

R= Mh...

T1= Jaa...

R= ok..

T1= mh...

R= I think the last questions ...we..you covered..you cover it earlier about yourself under number...under number 3 and that means we have come to the ender of our interview and I would like to thank Ms Xai for your willingness and time and I wish you all best in your next presentation.

Part 3 (covers Lesson 3&4)

R= Good morning once again Ms Xai, and a warm welcome to our... is it third interview for lesson 3 and 4?

T1= Ja.....

R= And.. Yes, thank you for availing yourself once again,

T1= Okay good morning sir?

R= Yes, good morning! Aa.. for today I would like you to also one again reflect on the lesson for today . Aa ... and probably it will be ideal if you...you.. do it in relation to that of yesterday. The questions remain the same, like.... Aa...aaa... what has gone right and what need to be improved?

T1= Ok yesterday after seeing the video of my presentation of the lesson yesterday, I have picked up some of the things that I did right and those that I didn't do well and that has made me to improve today, ja....so.. I have seen myself that I have improved

and I have seen myself that I have done quite a lot to help the learners to understand the terms and concepts. And I have seen that the lesson went well, ja...so.. it was just some minor things like forgetting to.. to give some of the little bit important information to the learners, but thank God to the learners, some of them asked questions that has made me to mention all , everything that needed to be said. Ja.. so .. to me it was an improvement after I have seen that video.

R= For today's lesson, did you notice.. aa.. learners experiencing aa... language challenges or making sense of biological language and concepts or may be yourself, did you also experience that today?

T1= For the learners, I have seen that they were quite surprised to.. to hear some of the words that they have never heard it. Let's say for example when I mentioned fatty acids and glycerol, they were very surprised, because they have never heard it, but they tried to digest it in their own ways and ..I have also seen that when I was trying to explain the role of enzymes in seed germination, it is like I needed some else to help me to ...to explain that to them that I didn't have. For example may be they could have seen aa...the video showing the seed germinating and forming all those parts, so that they can see it very well and or I could have just brought in the seeds just to see it that it is normally dry and when you soak it into some water, it becomes a little bit soft so that the chemical reaction inside will take place. Yes...

R= don't you have you... don't you think that you still have an opportunity to demonstrate that phenomenon to the learners, say for example aa...aa... doing a practical activity with them?

T1=I think it could help them because if we try to get those seeds and try to saw them and try to observe them and see what is going to happen, I think in that process they are going to learn more from that practical experiment. Yes

R= And they can for example take note of aa.. they are observing every day, okay the can come and observe their seed every day and see and note what are the developments that are happening.

T1= Mh.....

R= Ok,... Mh.....now you just said with this particular area of seed germination you could have used something else to explain the concept better. Don't you think that aa... You can explore that area further to other area, not just about seed germination, but aa..other areas like the one that taught yesterday. Say for example how the enzymes breaks down aa....aa.. certain type of food. I am not sure whether you have done any practical activity with your children in that regard?

T= Mhm...(not agreeing) we did not do any practical, I just given them example of how humans are digesting those food.

R= But are you aware any practical that you can do to show.. to proof to the learners, yes enzymes can digest for example carbohydrates?

T1= Ok,.. ja..we could do that, we could do this practical of using salivas, which is it a little bit too much, but you just have to do that for sake of the leaners to understand, just to see that it is true that we are having enzymes in our salivas, and then that one could also help them to understand that it is true, it is there, and it is digesting food into simpler forms. And they able to see and test that food which is being.. or that product.

R= Mh.....

T1= Ja....

R= Okay. Aa... now having observed your lesson today, aa..... I..I... notice somewhere were you have indicated that okay, the enzymes in the seeds convert starch to glucose. Okay...aa.. I think there was something that you could not explain to the learners, and that is the reason. Whether is protein to whatever, starch to whatever, fats to whatever.... You did not explain why are they have to be or why do they have to be converted to those simple forms? Do you remember those particular reasons?

T1= Ja... I could have at least explained to them, they needed to be digested from large complex compound to simpler forms so that they can be easily used by the plant. And also to say that starch for example start is not soluble and when you convert it to the simpler form it becomes soluble to dissolve in water.

T1= Okay....

R= And....now..from now on We have discussed a few of these things aa. What is the way forward? What are the strategies that you are thinking of... that can help the learners? Because the whole idea is for your learners to have better conception of the concept... to understand it better.. so what sorts of methods or forms do you think can demonstrate this concept to your children, What is the way forward from now on?

T1= Ok... From now, I think I its need for the teacher to reflect on their lesson, when you are presenting, after the end lesson you normally go back and sit down. When you sit down and think about what you have presented, you also realise that there are some of the things that you did not say or omitted. So.. that is why normally when you come back the next day you make the lesson reflection and when you ask them what have learnt yesterday, the kind of answers that they are telling you, you able to detect or deduce that there is something that I did not give or presented to them. And that is when you bring in re-enforcement. So the main idea is to re-enforce the concept to them and then you give them more work to do. Assess them more, and then when you assess the more you will be able to see the part where they are lacking and they you also bring it back again to their attention.

R= the misconception?

T1= Yes

R= No... I think our interview for today is not that long. I would like to thank you very much for your time again and for having accommodated me in your lessons. Thank you very much.

T1= you are welcome sir!

_____End_____

Appendix H cont.....

Interview transcribing: School2 (S2)

Date: 14.03.12

Key: R= Researcher

R= Yes good morning Mr Lee!
observed

T2= Second teacher to be

T2= Yes good morning

I 2= Interview 2

R= How are you?

T2= I am fine thank you, and how are you?

R= Ok, I am doing fine. So.. I am very happy that you have taken sometimes from your, aaa...fully packed schedule to have an interview with me regarding our lessons I have observed. So thank you much for that.

T2= You are welcome sir.

R=Ok, aa...Mr Lee, reflecting on your lesson that I observed yesterday, aa... what do you think has gone right and what needs to be improved?

T2= Aa..... looking at the lesson of yesterday that we have observed. The right things that learners were able to f... definition of words..... they were able to define the enzymes as well characteristics of enzymes that was really-really a understand that part, however, they have a problem of differentiate some of the aspects of the enzymes, for example they could not differentiate between substance and substrate. Now, even the terms- to them then what exactly a substrate is, so they could not identify or they could not knew know that the substrate is basically a food substance which a certain enzyme have to act on, that they have given a characteristics that enzymes are specific, but they don't know what they mean by saying that enzymes are specific, an elaboration could be needed on that.

R= Ok...aa.. thank you for that, aa.. when you were planning or preparing for this lesson, aa.. what was going through your mind, what difficulties you foresaw that your learners might experience so that what then did you take into consideration when preparing for the this lesson presentation.

T2= Ya.. those are the things like just I have mentioned, . I mentioned some of those terms aa... that learners could not differentiate.

I had aa.... Thought that learners that they will have aa... misunderstanding and sometimes they even think that it is wrongly spelt, so because they are used to the word substance and not a substrate, they would think aa.....think no, when they read in the book, they find that.... Consider it as the book is wrong. I have already put that and that I have to be careful so that I can make them understand that....that is not substance, but it is a substrate.

And again, the....on thee... reverse part of the enzymes catalyze reaction..... either direction. They still have aaa...I considered that they might have problem with understanding with either side..... Enzymes catalyze reactions either side, so I put in this preparation, I...I have to look at it.

R= mh.... Ok, aa...thank you very much, now the topic we discussing is enzymes, now for the children to have holistic aa.. understanding of this concept or this topic, as teacher, I think you might have thought of ideas that the learners need to have in order to put them together, you know learners understand this topic. What do you think are the main ideas, this whole topic of enzymes, critical ideas or big ideas that that they need to now?

T2= aa...basically...aa this... this...aa.. it have to do with digestion, you see and when this topic will be discussed, you have to to...to refer to food that learners have eaten, that they eat then when.. when ..when you refers to that they will understand exactly, they will be able to get to notice how this food have been used into our bodies, and how the.. the enzymes play a role in making possible for the food to be utilized in the body of the living organisms, be it is your animal.

R= Ok, those are some of the.. the big ideas that you think that the learners must know?

Deep breathe..... ok, aa... cleaning throat. If we may continue now, reflecting on...on.. your own lesson, did you notice any challenge regarding learners experiencing difficulties in making sense of biological language and concepts?

T2= ya... I may say...yes learners really have a problem of understanding some of the biological terms, just like I have mentioned those....that words substrate & substance you see, those are biological terms.

R= That is correct yes,

T2= But there is difficulty in understanding some the two or understanding the two so it is quite a challenge to them.

R= Now, apart from probably explaining the difference between substrate and substance, do you think there is any other method or mediation for how you can make the difference between the two more clearer to the learners, is there anything you might use apart from explain the difference, is there anything else you could do so that they can clearly tell the difference?

T2= Ya..ee...aa...aa..I was planning to may be to get a diagram, use a diagram. I have to draw an enzyme, just to...to write it to try to make that substance that fix itself to an enzyme in different shapes of enzymes so that they will know what it means being specific and... and May be getting some videos from the internet showing enzymes, and I can show them how the connect- or how the rate would bring itself to an enzyme and what would be the product.

R= Ok, no thank you. Aa.. During the.... When you introduced your lesson, you started by telling a story of when you were still in school with a certain gentleman. With this specific gentleman who is letting others fight, who kind of instigating others so that they fight each other. Aa... what..what is, what was the usefulness of the story to learners when it comes to the topic of enzymes? You can just explain.

T2= Iyaa... aa.....this story was aa...to look on the characteristic of enzymes when they catalyse reaction and remain the way they are. You see... when somebody instigate, you fight, the pain is between the two who are fighting, but the one who brought up the fight not touched, same way, enzymes necessitate reactions... the two things are reacting, but the enzymes remain untouched, it just catalyse. It is just to add more oo....of a fastening the reactions, this person also fasten the reaction, speed up, the more they instigating, the... the people can get fight, but if may clash, but if there no one is instigating, they may not. It also fits the definition.. that something that speed up the reaction, that is it.

R= In other words, you were trying to create an analogy? Or to create a situation to what happen when enzymes catalyse reactions or rate of reaction?

T2= Exactly

End part 1

Part II

R= Good morning once again Mr Lee

T2= Yes, Good morning Mr Nakale

R= Thank you once more for availing yourself for this interview; aa..it is our second part of first interview that we had. We are going to continue with third question after we have watched the video.

T2 = you are most welcome sir, we can continue.

R= Aa.. our third question reads as follow. Now that you have watched the video, aa.. what are the challenges regarding learners' ability in making sense of biological language and concepts that have emerged from the video?

T= Yes thank you for the question sir. There are a few challenges that I have noticed when I have watched the video. So.. learners for instance they say words that they actually meant a different thing and instead are using a different word, for example they use substance instead of substrate. The is not only the side of learners, also appears on the side of myself, for example a s you have seen in the video that enzymes are things or something, but in biological terminology, enzymes are not something. I could have used the word substance instead of using the word something, because if learners would write in examination and they use the word something, planning now enzymes, it is aa.. unscientific word in terms of biology, they end up losing marks aa.. on that point even if it is making sense. An..an..an.. also aa..aa.. I have also talked about where the.. the hydrochloric acid has been produced,

instead of talking about the cells in the lining of the..the. the.. the what?..of the .. the stomach, I said in the wall of the stomach. Learners may..may...may learn that hydrochloric acid is produced in the wall of the stomach, but in the lining.. in the cells in the lining of the stomach.so saying in the wall is wrong. So, these are some of the things we ..we we.. noticing that it is in actual fact a wrong. So something that you did not intend to do. Through examinations we use those words.

R= Ok, thank you very much for that explanations. Now, What do you think are the contributing factors to what you just pointed out? What do you think are contributing factors?

R= Mh.... I think sometimes English is also a contributing factor. So the English language more especial on the side of the learners in not up to the scratch and they fail to use proper word and they may search for a word that is proper, but they could not find any word rather than that one, so they just use that one. On the side of teachers, it sometimes something you don't plan to do and you those words with the hope that you make it easier for the learners to understand, but the more you are trying to take it from the biological conceptual point and you are on the other hand you are making it wrong.

R= So you were trying to simplify it for the learners, but in the end you are losing the meaning of the concept?

T2= Exactly.

R= Okay, aa.. what do you think or rather to what extent do you think such a problem may affect learners' achievement in biology?

T2= It would really really affect them, their achievement. When it comes to examinations, learners should write in that language, the biology language. If they wrote our daily English, sentence may still be correct, the way they are saying it, but in effect, in biological terms, it is not correct. If I write enzyme is something that catalyses the reaction, saying that is correct, by listening to it, but there is no biology technicality in it, because it is rather a substance and not a thing.

R= Okay, now that you have pointed out that it can affect learners dearly, now are you able to suggest ways how you may support your learners in making sense of biological concepts?

T2= Ja,...as..as..as a teacher aa.. sometimes we need to be more critical when we are presenting lessons. We should try to avoid using of those words which are not necessarily biological so that learners they get used to the critical or biological language and word that will be able to apply in writing. And also, may be get some more, much more assistance or help from people who has the technical know how in correcting these errors, because some errors come in, sometimes you cannot even note yourself as a teacher. But if in the workshop or visits by Subject Advisors or whatever kind of people will have to look at thing or the whole thing share ideas and also reading the what?.. as teachers, we need to read the examiner's report, in most cases they point out errors that learners have made and then we can connect to our presentations.

R= wonderful, ...mhhhh.... Now, apart from may be getting support from workshop and may be site visits by Advisory Teachers and so on, is there any method apart from mere explain the concepts to the learners, if you want to really get the essence of the concept is there any other method or mediation method how you can, which you can use to communicate the content to the learners, do you think you can make use of a different method?

T2= Ja ... you can make use of videos for example may be if you get the video of the reaction of enzymes, you can explain to the learners as so that they see how the substrate and enzyme are attached to each other and they can make sense out of that. When you use pictures learners use their eyes .

R=Using different senses, they can see how things are related to one another when reacting and so on?

T2= Exactly

R= Mhh.....In your opinion, what challenges that you are facing regarding learners in making sense of biological language and concepts? This is now yourself.

T2= Teacher taking deep breath!

R= the challenges you yourself that you are facing?

T2= The challenges are a lot, since this the second year I am teaching the subject, I am not very much experienced in the subject, so still in the sense of get to know the content at very best level that I can be, of course mistakes will be here and there in presentations. And.. and sometimes also resources when one can get information they are very limited in our area. You may just be limited to a certain textbook which does not give you as much information as possible, you cannot compare information. Those are just some of the challenges

R= Now you referred to books, how useful are the textbooks you are using?

T2= Not all of them, like learners' text books, like the learners rely much on the modules and there so much of the language errors in terms of the biology and one need to be careful if you go on and if you go on and present something and you do not notice the error and that error will be carried over to the learners, it is really a problem.

R= So, in other words, in the absence of the competent teacher to support the learners so the learners just go on to capture the information although they are wrong?

T2= Exactly

R= Thank you very much Mr Lee for your aa... for your time once again, we have to the end of our interview and I wish you all the best.

APPENDIX I: SCHOOL 1 VIDEOTRANSSCRIPTS (S1)

Lesson 1 (Less1).

Teacher informs the learners about what they need to know by the end of the lesson. These are the definition of enzymes. Enzymes are proteins that functions as biological catalyst.

From the definition, learners were requested to identify two terminologies/key words which are biological and catalyst.

The teacher tried to explain what each of the two terms entails. “ Catalyst meaning to speed up”

Teacher asked learners to wander what happened to the breakfast they have had that morning. She indicated that such food is digested by enzymes.

Enzymes are there to speed up reactions in all living organisms. Without enzymes food will never become part of the body cells. Learners asserted without any question. Teacher outlined the three types of digestive enzymes alongside their substrates. Teacher told learners that they should be fine with the definition of enzymes and no questions were posed.

Teacher identified two types of reaction and learners mentioned them as Anabolic and Catabolic reactions.

Learners defined anabolic reaction as the breaking up of substances.

Teacher 1(T1): When we are building up complex compound into simpler compounds e.g. respiration and digestion.

Properties / characteristics of enzymes

Learners, School1 (Lnrs1): Enzymes are proteins, not changed by the reaction they catalyse e.g. lipase remains as is at the end of the reaction and that they are specific.

T1: Lipase is only responsible for breaking up fats and not others and they work like Lock and Key. They work at a certain temperature- optimum temperature e.g. 37-38°C. She cautioned learners not to say best temperature, rather optimum temperature.

T1: At 0°C, enzymes are not going to work because they are inactive- not optimum temperature

She asked learners to ask questions. Enzymes have certain PH at which they work best and she asked learners to define PH

Lnrs1: degree of acidity and alkalinity of a solution.

T1: At what PH does each of the three enzymes work and further asked what would happen to the enzyme that works at the PH of 7 in acidic condition.

Lnrs1: it will not work because it is not the optimum, it will be denatured.

T: further went back to the temperature to indicate that the temperature above 40°C would denature enzymes.

LESSON 2 (Less2)

T1= Last property that we did not talk about. For example digestive enzyme lipase, we do not need a large amount of it, we just need a small amount to break down fats which can break a great deal of the substance.

Lnr1= Yes

T1= Let's move to substrate, you also need to know more terminologies when it comes to enzymes. We have what we call su.... substrate ee..., we are having enzymes and then products, you need to know those terms ee. We are having pe.... Pepsine ee.. pepsin breaks down pro...protein into amino acids ee., but biologically, we have the terms we use ee. We do not say pepsin, we are having a biological term for it ee...

For example in this one, pepsin breaks down proteins into amino acids: which one is an enzyme here?

Lnr1 =Pepsin

T1= Yes, What is the substrate here?

Lnr1= protein

T1= Very good, the product?

Lnr1= Amino Acids

T1= Yes, these are the terms that we use. We need to know what is the substrate.

Lnr1= The substrate is a substance which is present at the beginning of the reaction.

T= Then we are having a product

Lnr1 = A product is substrate is a substance which the substrate is turned into

T1= Did we really get that?

Lnr1= Not really.

T1= I am giving you another example. Which enzyme again which is breaking down starch food?

Lnr1= Amylase

T1= Amylase is breaking down starch into maltose, isn't? Which one is a substrate there?

Lrns1= starch

T1= Which one is the product?

Lrns1= Is the substrate the product is turned into.

T1= Did you all get it? You are lying come on! I am going to see if you all got it. We are coming to active site and its specificity; we are still on properties ee!

We now know what is an enzyme, substrate and product ee? When we say an enzyme is catalysing a reaction, we mean we are having an enzyme which is a protein molecule and there is a site that we call active site. Only one substrate that fit in a particular active site to form enzyme-substrate complex. When that happened, the enzymes is going to catalyse the reaction, breaking down that substrate. The enzyme is going out unchanged. Can you see that the substrate is broken down and the product is released on its own.

Enzyme catalyse reaction, the enzyme remain the same, it is not changed at the end of the reaction. The last thing that I want mentioned is that enzymes are denatured, meaning 40°C and above, we are referring to the active site which is becoming loosened. Substrate is no longer fit in, are you fine with that?

Lrns1= yes

T1= Ja, it is the active site which is changed, making it impossible for the substrate to come and fit in, do you understand?

Lrns1= Yes

T1= That is why if the temperature is 25°C, nothing is going to happen to the active site, do you understand?

Lrns1= Yes

T1= But the problem is that if the temperature is very low and the reaction is going to be very slow. Take your exercise book and do activity no 2 and 3, individual activity.

Lrns1= Two learners were asked to read the activity aloud.

T1= Walked around marking the learners' work and indicated that if she write abbreviation 'SP' something was wrong with the spelling.

Lesson 3 (Less3)

T1= What have you learned about enzymes?

Lnr1= Enzymes are protein that function/ act as biological catalyst

T1= what else?

Lnr1= Properties of enzymes

T1= give us anyone or two of the properties

Lnr1= Enzymes are proteins, they are specific to the reaction they catalyse; they are not changed by the reaction they catalyse.

T1=The last thing we discussed was?

Lnr1= substrate and products

T1= Do you know what is a substrate? Do you know what is a product?

Lnr1: Yes

T1= We also talked about enzymes and what?

Lnr1= Enzymes and active site as well as enzymes and temperature.

T1= We learned that enzymes are having optimum te.....?

Lnr1: Temperature

T1=We learned that enzymes are having optimum temperature, the temperature at which at which the enzymes are working at the best rate ee....., meaning that enzymes at this temperature, enzymes are working at their best levels, molecules have gained kinetic energy and start moving and bumping in each other and therefore increasing the rate of the reaction. That is why the reaction is going to be increased at optimum temperature. That is what we mean there. Are you clear on that?

Lnr1= Yes

T1= We mean, at optimum temperature, the molecules are gaining energy and start moving faster and therefore increasing the rate of the reaction. We also said yesterday that optimum temperature is about 37°C-38°C, but it is rather 40°C. If you go beyond 40°C, the enzymes are going to be denatured and therefore, the reaction will stop, because the shape of the active site has been changed and therefore we say the enzymes are destroyed, yes! We gave an example of 25°C , we said at this temperature, the enzyme activities are slower than 37°C – because it is not the optimum temperature. Is that fine with us ee..?

Lnr1= Yes

T1= We also talked about enzymes and what?

Lnr1= PH

T1= We also have learnt that they have optimum what?.....optimum PH. We have learnt about Lipase and Amylase which works at the PH of alkaline while Pepsine works in the PH of acidic. And we have learnt that if we take enzymes that works at alkaline condition and put them at acidic condition, their shape will be changed because it is not optimum PH.

For today, according to the syllabus, we are going to describe the role of enzymes in the germination of seeds. Enzymes are having quite a lot of work both in plants and in animals. Are you clear on that?

Lnr1=Yes

T1= Who is having an idea when we are talking about the role, what do we mean here?

Lnr1= The uses of enzymes

T1= Yes, the uses or the part that is played by in enzymes in the germination of seeds. Are we clear on that?

Lnr1= Yes

T1= who can give us an example of common seed?

Lnr1= Bean

T= How is the structure of this seed?

Lnr1= It is divided into two parts

T1= Meaning it is a what?

Lnr1= Dicotyledon

T1= How is its texture

Lnr1= It is hard

T1= Yes , it is hard and tough ee...?? We are interested in knowing how do enzymes play a role in the germination of seeds. For the seed to germinate, what do you need to do with this seed? Or we don't sow at home?

Lnr1= We put it under the soil

T1= We put it under the suitable soil type. But, why do we do it during rainy season and not dry season?

Lnr1= So that it can germinate, because it needs water.

T1= It means that the seed itself is dry and tough and inside it we said it has two cotyledons?

Lnr1= Yes

T1= Do we know that we can eat this seed?

Lnr1= Yes

T1= What do we get from there?

Lnr1= proteins

T1= What else do we get from there?

Lnr1= Starch

T1= And also soya beans, we get some fats, it is good that we have that understanding. The reason we eat beans is because there is stored food such as starch, proteins, fats, but we also have there stored enzymes. We are going to understand what are they doing there? And why they not catalysing the reaction there? We have enzyme amylase, lipase and pepsin nee....? We want to understand what are these enzymes doing in order to help the seed germinate, do you understand?

Lnr1= Yes

T1= What are these stored enzymes doing in order to help enzymes to germinate?

Enzymes only work if the seed buried in the soil and water gets in it in order to activate the enzymes to start working. Once activated, the enzymes start digesting the food. So starch is digested by amylase into maltose or glucose, proteins digested by pepsin into amino acids, fats digested by lipase into fatty acids and glycerol. Glucose is used during the process of respiration to get energy. Amino acids to be used by the germinating seeds for the formation of new tissues- because proteins are for growth. Fatty acids and glycerol are used for the formation of cell membranes. When leaves form, photosynthesis will start, making own food.

Enzymes, during the germination of seeds, they help to breakdown the stored food used by the plants for respiration as well as for other functions. Do you understand?

Lnr1= Yes

T1= Can you ask questions?

Lnr1= There was silence

T1= Questions?

Lnr1= Does the soil contribute to the germination of the seed?

T1= Do you think the soil contribute to the germination of the seed? In what way?

Lnr1= As a source of nutrients

T1= What else?

Lnr1= Store water

T1= That means that when we sow our seeds in a type of a soil that will be able to sustain enough water for our germinating seed ee.... Different type of soil, they germinate and grow in different type of soil. For example, not all plants are able to germinate there, only some, those with shallow roots that can absorb water from the surface of the soil. At home, our grannies use to grow ground nuts in sand soil, although they are not able to give us the reason, but they know that is the right soil for the ground nuts. Any question?

In the absence of questions, the teacher continued. According to the syllabus, you need to describe the uses of enzymes in biological washing powder. This means enzymes are very useful e.g. in food industry, in washing powders, seed germination as well as play a role in the digestive system. Washing powder is a soap that we use to wash our cloths while biological refers to living organisms. Examples of washing powders are Omo, Surf, Sunlight and more. The remove what from cloths?

Lnr1= Stains

T1= Which stains?

Lnr1= fats

T1= Remove dirt see..?

Lnr1= Yes?

T1= What is a stain? Stain of what? Do these powders remove stains of blood from our cloths?

Lnr1= Some

T1= Why do you think it is like that? Give examples of stains

Lnr1= Sweat

T1= We talk about sweat ee... and what else?

Lnr1= Wine

This means that these powders contain detergents which are able to remove dirt, but coming back to biological washing powders, meaning that something was added from living organisms. They contain what?

Lnr1= proteins

T1= They are made in industries and they added enzymes from living organisms. They are made in such a way that they are able to remove biological stains which cannot be removed by ordinary washing powders.

By the way, what do we mean by biological stains? It is because they coming from living organisms e.g. blood and wine and egg yolk. These are problematic because they get deeper into the fibres of the cloths and only enzymes in the washing powder that can remove them. For example, pepsin breaks down blood stain into smaller droplets and this increase the surface area for the wash. To sum up, the biological washing powders contain digestive enzymes which help break down stains, but washing powders with detergents are not able to do it. Remember enzymes have optimum temperature, so you have to be careful when using biological washing powder. If you use water from the tap where the water temperature is around 15°C, the enzymes are unlikely to work, so make sure that the water temperature is right.

LESSON 4 (Less4)

The teacher used an activity to support learners' understanding of enzymes and their properties.

T1= Read for us the instructions for activity no 4

Lnr1= One learner read aloud

T1= It means these kind of questions are trying to test your understanding of enzymes and temperature. It also tries to test whether you able to read and interpret the graph correctly ee...? Whatever the answer you are going to give, it should be based on the graph. On the Y-axis, we have rate of the reaction and X- axis is temperature in °C. The first question: At which temperatures is the reaction taking place slowly?

Lnr1= 0°C and 60°C

T1= Are we fine with that answer?

Lnr1= Yes

T= At which temperature did the reaction take place mostly?

Lnr1= 45°C

T1= You can see that when we were discussing, we said 40°C is the optimum temperature ee..., but this graph is showing us that 45°C is the optimum, meaning, we answer based on the graph. Are you clear on that?

Lnr1= Yes

T1= What happened to the reaction as the temperature was raised from 0°C to 20°C? Look at the graph.

Lnr1= The reaction has increased.

T1= What do you think is going to happen to the enzymes at 45°C? You can see the curve is falling down, the reaction has started to slow down, because the enzymes were starting to be destroyed/denatured. Some of the learners wrote disnatured, who wrote that? We do not say disnatured, but denatured, there is no s.

Lnr1= Yes

T1= Another one say, explain why the reaction got slower when the temperature was raised from 45°C to 60°C? You see the reaction was going up/it was increasing, meaning as the enzymes are destroyed, the reaction becomes slower until it stops- The reason is that the enzymes are destroyed or denatured.

The last question is that human body temperature is normally around 37°C, if you are very ill, your temperature can go up to 40°C, why is this dangerous? The enzymes are the ones that catalyse chemical reactions, if the temperature is too high, the enzymes are going to be denatured. If denatured, they cannot speed up the rate of the reaction. That is why they need to take you to hospital. Are you clear on that?

Lnr1= Yes

T1= And also some chemical reactions like digestion, they also need enzymes and by that temperature, enzymes will be denatured. Remember, we have physical digestion, when food is digested by the contraction of the muscles of the alimentary canal, that one will not be affected. So the answer there is that at 40°C, the enzymes may break down/they may be denatured and can no longer catalyse any reaction.

The end!

School 2 Video Transcripts (S2)

Lesson 1 (Less2)

Topic: Enzymes

T2= Define an enzyme

Lnr2= A protein that act as a biological catalyst

T2= what is a catalyst?

Lnr2= substance that speed up the rate of the reaction

T2= right, substances that speed up the rate of the reaction. That is when I came to know that this gentlemen who has been necessitating fight between learners is a catalyst. He made people fight. Enzymes have some properties and as we go on with properties, you will realize that this person is a catalyst.

One of the properties of enzymes is that they are?

Lnr2= proteins in nature

T2= Two?

Lnr2= They are specific

T2= What does that means?

Lnr2= They work on one type of substrate/substance

T2= What is a substrate?

Lnr2= there was no answer

T2= Give me one example of a substrate

Lnr2= Breaks down starch

T2= What is that which breaks down starch?

Lnr2= Amylase

T2= Amylase is an enzyme, the substrate on which it act is?

Lnr2= Starch

T2=If you have proteins in the body, can amylase digest it? That is why we say that they are specific to a certain substrate. There should be another one that digest proteins, sucrose etc. Right, which one else is the property?

Lnr2= They work best at certain temperature

T2= The difference or the change in the temperature affects the enzyme activity, if the temperature is high, they are affected in one way and when it is low, they are affected in one way. Are there some more?

Lnr2= Speed up the reaction, but not changed

T2= They are not changed at the end of the reaction. That is why, after the fight, there is no swollen faces, no bleeding for that guy, but you and I we have swollen eye, bleeding nose etc and like myself I have a scar because of that guy. This is why this person was a catalyst.

“Oku hongaiifa omukushi ndishi? (Do you know instigation?)

Lnr2= Yes

T2= I just came to realize that this person was a catalyst. I was the one winning the fights and I enjoyed the fights.

Lnr2= was that person in grade 11 where this topic is?

T2= No, he ended up in grade 5, I bet, because he was the big boy on the road, that is why he made us fight to enjoy his life,

Lnr2= What is the difference between enzymes and catalysts, I am confused.

T2= Enzymes are proteins that function as biological catalyst. Catalyst is something that speeds up a reaction. In other words, enzymes are catalysts. Another properties?

Lnr2= Smaller amount of enzymes catalyse large quantities of substrates.

T2= Just imagine the amount of rice you might eat after school which contain a lot of starch. How much amylase is contained in saliva?

Lnr2= Not much

T2= The small amount will catalyse the digestion of the rice. What are other properties?

Lnr2= They work best at certain PH

T2= We know the PH, isn't? We learnt about PH scale in Physical Science which runs from 1-14 nee?

Lnr2= Yes

T2= The smaller numbers being acidic while larger numbers are alkaline. Some enzymes work in acidic, neutral or alkaline depending on the area of the body where enzyme is working. For example Amylase which works in the mouth, what PH in the mouth?

Lnr2= Neutral, alkaline.

T2= is it acidic or alkaline?

Lnr2= Alkaline

T2= Which means Amylase which works in the mouth cannot work in the stomach because it is acidic. What makes the stomach acidic?

Lnr2= Because the stomach has hydrochloric acid.

T2= Which enzyme can work in the stomach?

Lnr2= Pepsin

T2= Pepsin digest which type of substrate?

Lnr2= Acidic

T2= Acidic is a substrate that can be digested by pepsin?

Lnr2= No

T2= Which one?

Lnr2= Proteins

T2= Acidic is not a substrate people, it is basically a condition in which pepsin is able to work. A substrate is a food in a way or a nutrient which is digested by the enzyme. To digest protein in the stomach, the condition should be acidic, but if the condition is changed, proteins cannot be digested. Any other property?

Lnr2= Catalyse reaction in either direction.

T2= What does that mean? For example, starch is digested to maltose and vice versa.

Lnr2= What if I eat acidic food?

T2= Is it possible for food to be acidic? For example?

Lnr2= Lemon Juice

T2= Lemon juice, is it acidic? Let's ask our new learner (observer), do we have the food that are.....?

Observer= Ja, the example given by the learners is correct.

T2=What is the question? The tongue is the one that feel the taste.

Lnr2= Where are the enzymes located? In the mouth?

T2= Different enzymes, different locations in the digestive tract. For example, pepsin is in the stomach. In the intestine, there are also a number of enzymes produced by the pancreas.

Lesson2 (Less2)

Topic: Effects of temperature on the activities of enzymes

The teacher started the lesson with the recap of the previous Lesson

T2= What is an enzyme?

Lnr2= Enzymes are proteins that function as biological catalyst.

T2= Enzymes are protein in nature, what are other properties?

Lnr2= They are specific in nature

T2= Are they specific in nature?

Lnr2= No

T2= Specific in what?

Lnr2= specific in the reaction that they catalyse.

T2= I want us to look at the effect of temperature on the activities of enzymes. How does temperature affect the work of enzymes? The teacher then started making some notes on the chalk board. Good, I have a graph on the table, which will help us explain the effect of temperature on enzymes. We are going to make use of human being example. What is the normal body temperature of a human being?

Lnr2= 37°C

T2= If the temperature is around 37°C, the enzyme must be working properly in the body. If the temperature fall or rise then that should be a problem to the activity of the enzymes. I want somebody to come in front to give us an explanation how do you understand this graph with reference to human?

Lnr2= According to my understanding, the enzymes work best in optimum temperature (showing 40°C on the graph). If the temperature is low, the enzyme is not working well or higher than the optimum temperature.

T2= Yes, you heard it, is there anyone who wants to make it clearer?

Lnr2= I think that (showing on the graph) this side is where the low temperatures are and that side is where the high temperatures are, here is where the optimum temperature and it is showing where the average temperature of a human is.

T2= Any other explanation?

Lnr2= As you can see on the graph, the more the temperature increase, the more the reaction is increasing as you can see on the graph.

T2= Guys, where is the temperature is being increased on the graph? Is it going like this or like that? (showing on y- axis and x-axis)

Lnr2= This axis (showing y-axis) is showing the rate of the reaction, and this one (showing x-axis) is telling us the temperature. Which means, as the temperature increase, the rate of the reaction also increase until such time/temperature or degrees. So, what this explains, at the temperature 0°C or below, the enzymes are not working that is why 0°C means zero reaction. As the temperature rises, the reaction increases as well. The temperature of 0°C and below, the enzymes are inactive. At the temperature below 20°C , enzymes do the work, but slow. They gradually rise. At 30°C, a bit faster and it reaches its highest point at about 37°C. We say that is the optimum temperature. The optimum temperature is where enzymes work best. Enzymes increases (showing the peak of the reaction). They reached their peak point, that is their optimum point, and as it increase to 40°C (showing temperature) they gradually fall down (showing the curve going down). At the temperature above 50°C , enzyme molecule gets heated up and they are destroyed and they cannot catalyse reaction any longer and we say they are denatured. When the temperature increases, the reaction also increases until such a time that they reach optimum temperature when it starts going down. Even if you increase the temperature, the enzymes cannot work, because they have reached the maximum point. If you are putting air in the balloon, it expands, expand.....until such a time that it burst, because it has reached the maximum point.

Lnr2= Is temperature and reaction in direct proportion?

T2= 0-37°C yes, but after that it becomes indirect. When the temperature is low, enzymes are not denature, it is there alive, but no energy, but at high temperature, molecules are damaged, become denatured. Don't say they are killed.

Lnr2= When you put a person in a fridge, a person die and when you put him on fire, he will die as well, why don't enzymes work in similar way?

T2= Enzymes become inactive, reaction stop for example respiration and the person die. While increased temperature makes an enzyme to lose its structure making it impossible for the substrate to fit in (he drew sketches on the chalk board). Learners were then an exercise to do on temperature and enzyme activities. This activity was drawn from a Biology module book.

Lesson 3 (Less3)

Topic: Effects of PH on enzymes

T2: What is PH?

Lnr2: It is a scale which is trying to measure the acidity and alkalinity of the solution

T2: What does PH stand for?

Lnr2: Phosphorus

T2: Phosphorus?

Lnr2: per hydrogen

T2: is that correct?

Lnr2: Potential hydrogen

T2: Yes, potency or potential of hydrogen in a solution. Now, the effect of PH is more or less the same as the effect of the temperature. High or low PH affects the work of enzymes differently. We have different enzymes in the body working in different areas or digest food in different areas of the body which have different PH. Like we said, a PH is a scale that runs from 1-14 and in the middle, we have seven (drawing the PH scale). This side is acid (low numbers), middle (7) neutral and above 7, alkaline. The PH of the mouth is about 7.0-7.5 which is neutral to slightly alkaline. Only certain enzyme able to work in that condition, in this case Amylase. This is the only enzyme that can work in the mouth. That is why in your mouth, only starch that can be digested, because the condition is not suitable for enzymes such as Lipase. It needs a different condition/PH for it function properly. Pepsin function in the stomach, what is the condition of the stomach?

Lnr2: Acidic

T2: The PH in the stomach is around 2, and Pepsin will be able to function properly under this condition. What makes the stomach to be acidic?

Lnr2: Because of the acid

T2: Yes, because of hydrochloric acid produced by the wall of the stomach. Your stomach contain hydrochloric acid, protein can be digested there, but not starch. Lipase is an enzyme that digest fats to fatty acids and glycerol, where does it function best?

Lnr2: Small intestine

T2: At the Ph of about?

Lnr2: 13

T2: Which is strong alkaline, it will not be able to function in the stomach neither in the mouth. Fats passes the mouth and the stomach without being digested, but upon entering small intestine, Lipase is secreted. Because digestion must be completed in the small intestine. Although the digestion of proteins is not completed in stomach, Pepsin does not continue to small intestine, another enzyme must be secreted i.e. Protease produced by the pancreas. Protease are protein enzymes , a collective name for protein enzymes. We have a protease called Trypsin which is also produced by the pancrease to further digest the proteins which were not digested in the stomach. If you increase the PH of the stomach, you affect the functionality of Pepsin. It will not properly digest food in the stomach.

Lnr2: does PH has unit?

T2: No, any other question? If not, let us quickly at the role of enzymes in seed germination. What do seeds need to germinate?

Lnr2: Water, optimum temperature and oxygen

T2: What about sunlight?

Lnr2: It is part of the temperature

T2: Is it included?

Lnr2: Plants need sunlight, but not temperature

T2: Temperature is basically how hot or cold the weather is- it can be measured even at night

Lnr2: What is between cold and hot temperature?

T2: Is it sunlight?

Lnr2: It is optimum temperature

T2: what is optimum to you might not be optimum to another, Optimum temperature is best temperature, Optimum PH is best PH. For the seed to germinate, water, oxygen an optimum temperature are required. A seed can germinate anywhere, where there is no soil or sunlight. Once enzymes that are stored in the cotyledons of the seed are activated, they make it possible for the digestion of starch which is in the cotyledons of the seed, proteins are changed by the enzymes to be soluble. Enzymes convert starch (insoluble) to smaller soluble that can be absorbed by the embryo. Enzyme amylase converts starch to maltose. This maltose is easily used by the embryo not like starch. Maltose is a disaccharide (two molecules) while starch is more complex. Proteins can be changed by enzymes into amino acids that can be used by the plant a very young age, because it cannot photosynthesize.

Lnr2: What types of enzymes are found in the cotyledons of the germinating seeds?

T2: Amylase, Lipase and protease, remember there are fats, proteins and starch are stored there and for them to be digested, those enzymes must be there.

Lesson 4 (Less4)

Topic: Role of enzymes in biological washing powders

T2: What kind of washing powders are these?

Lnr2: There was silence- no answer

T2: Powders that can wash biological.....?

Lnr2: Stains

T2: Now, biological stains, still not clear on this

Lnr2: Stains like blood

T2: Why are you saying blood is biological stains?

Lnr2: Can be seen.

T2: Those that cannot be seen are not biological?

Lnr2: Those that are difficult to be removed.

T2: Bio means what?

Lnr2: It has to do with life.

T2: These are stains that are delivered from living organisms. Now, these stains are difficult to remove from clothes. For them to be removed, biological washing powders need to be used. Because ordinary washing powders do not have those detergents that can remove these kinds of stains, not only blood, we have sweat, eggs, wine, fruits etc. If you use ordinary washing powders to remove that, it does not clean the cloth. What is contained in these biological washing powders that makes them to remove these stains?

Lnr2: Proteins

T2: They contain enzymes in them that digest the protein structure of these stains. Blood is protein in nature. Sweat is from your body, it contain urea from your body and urea is protein (excess protein in the body which is digested to urea). Those protein nature within the stain

is digested by the enzymes, enzyme which digest proteins are protease. So they digest the protein structures which is in the egg, sweat etc and they neutralize it to colourless structure. Now the detergent which is in the powder will easily remove it and the clothes will be clean. Most of the biological powders contain those enzymes. Most contain coloured granules which represents enzymes. It is advisable that when using these types of powders, you leave clothes there for some minutes to give time for enzymes to absorb or digest the protein structure of that stain.

Can we go onto enzymes in food industries?

Lnr2: Yes

T2: In food industries, people who are manufacturing food, they use enzymes in three types of industries: Dairy, baking and brewing

Now, in the dairy industries, how are they used? They use it to prepare cheese. You like cheese nee?

Lnr2: Yes

It is prepared using enzyme called renin which is the enzyme that digest milk. This enzyme is extracted from the alimentary canal of a cow and they make use of it. It makes milk to clot or coagulate.

Traditionally, we also make milk to clot, but use some plants roots, how do we call that tree?

Lnr2: *Omunghudi*

T2: Exactly, the reason for our forefathers to put that in milk is make the milk a little bit thicker 'okwoota'. So, in the body of the calf or a child, there is this enzymes, renin. It makes milk in the body thicker so that it can be digested. But as you grow, it disappears. Today when you eat milk, it is not purely digested. That is why for some people if you drink too much milk, it will develop into diarrhoea, more especially if you drink fresh milk, because there is no functional enzyme that can digest it. '*Nomolwaasho owu wete kutya omashini ohaadulu oku longifwa piinima ihapu ngeenge wanwa nande uudiyo wonhumba ohodulu oku nwefwa omashini mahapu, oku dja opo ototondoka wu uka kokatoileta ile tokungu ndee oudiyo tau dim, osheshi kutya medimo kamuna oenzyme oyo tayi dulu okudigestinga omashini oo*'. Translated: This is the reason why milk is used in many instances such as when you have consumed poisonous food. They let you drink a lot of milk after which one runs to the toilet or vomit so that poison is discharged, mainly because in the stomach such enzyme is absent.

The End!

Appendix J- Document and Semi-structured interview schedules

Document analysis

Some of the issues to look at are:

- (a) How the chosen topic is presented in the textbook ;
- (b) Lesson plan- has the teacher made any effort to develop strategies that help learners make sense of the language and concepts better; what evidence is there?
- (c) Learners written work
 - Do learners make use of biological language when answering questions?
 - How often do they make use of everyday language in the context where they should have used the biology language?
 - Is there evidence that learners understand and use biological concepts appropriately? What misconceptions id there?
 - To what extend do teachers encourage appropriate use of biological language when marking learners' work?
 - Is there any evidence that teachers reward marks for unintentional errors made by learners?

Semi-structured interview schedule

1. Reflecting on your lesson, what do you think has gone right and what need to be improved?
2. Reflecting on your own lesson, did you notice any challenge regarding learners experiencing difficulties making sense of biological language and concepts?
3. Now that we have watched the video, what challenges regarding learners' ability in making sense of biological language and concepts have emerged from the video?
4. What do you think could have caused that particular problem that you pointed out?
5. To what extent do you think such a problem may affect learners' achievements in biology?
6. Suggest some ways how you may support your learners better in making sense biological language and concepts
7. In your opinion, what are the challenges that you are phasing regarding learners making sense of biological language and concepts?