AN ANALYSIS OF DOMAIN-SPECIFIC TERMINOLOGY FOR PEDAGOGICAL LEXICOGRAPHIC RESOURCES: TOWARDS A COMPREHENSIVE ENGLISH-ISIZULU LIFE SCIENCES DICTIONARY

by

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DECLARATION

I declare that the thesis titled *An analysis of domain-specific terminology for pedagogical lexicographic resources: Towards a comprehensive English-IsiZulu Life Sciences dictionary* is my own, unaided work and that all the sources that I have used or quoted have been indicated, listed and acknowledged by means of complete references. It is being submitted for the Degree of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

Celimpilo Piety Dladla

……14th ……day of …February……2023……at…Johannesburg…

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DEDICATION

To my mother, who took me to her graduation ceremony at the age of 12 where I saw graduates in red gowns for the first time and told her that that was the colour gown I wanted; not knowing the mountain I would have to climb to reach that dream. MaGatsheni, Boyabenyathi!

ABSTRACT

This thesis examined the structure of published dictionaries as a foundation for creating guidelines for developing a domain-specific lexicographic resource in an African language. The resource developed in the study is directed at Grade 10 to 12 learners as a remedy for the absence of domain-specific lexicographic resources for senior phase learners whose mother tongue was previously marginalised. Subjects are taught in a second language despite the language policy of the Department of Basic Education stating that learners and their guardians are at liberty to choose their language of education (Diko, 2018). The unavailability of these resources deprives potential users of the opportunity of having a choice to use reference material in their home language to understand crucial educational material. This limits their ability to achieve the results they would have had if they had the opportunity of learning in their mother tongue (Osborne & Collins, 2001; Mji & Makgato, 2006). Dictionaries have been identified as assistive resources in increasing learners' understanding of educational concepts (Ranalli & Nurmukhamedov, 2014; Charamba, 2017). Subsequently, this thesis employed the theory of lexicographic functions to develop guidelines for the development of a bilingualised Life Sciences dictionary in isiZulu with English serving as the source language, as users need the information in English in class and in their examinations. This qualitative study garnered data by means of content analysis of existing English-Zulu bilingual dictionaries by examining their structure and function, as a foundation for developing guidelines for the new resource and the ultimate compilation of the resource. Further, the study interrogated the Life Sciences glossary from prescribed Grade 10 to 12 Life Sciences books from the Department of Basic Education and extracted terminology from these resources. Terminology was then translated into isiZulu employing translation strategies applicable in lexicography as this was not a translation exercise but a lexicographic exercise. Nkomo (2019) asserts that most lexicographic practices had been mistaken for a translation exercise because lexicographic theories are often not employed. For this reason, the study employed the theory of lexicographic functions – studying the needs of users, the user situation and the function of a dictionary (Tarp, 2004; 2008; 2012) to create a dictionary development guideline and additionally, produce a digital dictionary to be made available in a freely downloadable form for use and availability to all users. The dictionary developed was analysed according to guidelines set by Ball and Bothma (2018) for analysing digital dictionaries.

KEYWORDS

Language of education, Lexicography, Terminography, Lemma

NOTE

*IsiZulu words are written in italics and their English equivalents are provided in square brackets.

*IsiZulu words part of dictionary definitions are not in italics because they are quoted directly from dictionaries.

*All foreign words are written in italics.

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LIST OF ABBREVIATIONS

ABBREVIATION	EXPLANATION
DBE	Department of Basic Education
DSAC	Department of Sports, Arts and Culture (formerly, Department of Arts, Culture Science and Technology / Department of Arts and Culture)
ISY – LSD	*Isichazamazwi Sesayensi Yezokuphila* – Life Sciences Dictionary
EZD	*English-Zulu / Zulu-English dictionary* by C. M. Doke, D.M. Malcolm, J.M.A. Sikakana and B. W. Vilakazi (2014)
SZD	*Scholar's Zulu Dictionary* by Dent and Nyembezi (2009) 4th edition
OUPEZ	*Oxford Bilingual School Dictionary: IsiZulu & English* by Gilles-Maurice de Schryver (2015) 2nd edition
LS	Life Sciences
LiEP	Language in Education Policy
FET	Further Education and Training

CHAPTER ONE

GENERAL INTRODUCTION

1.1 Introduction

This chapter introduces the entire thesis. It provides the background and outline of the research problem, the problem statement and hypothesis. Research questions and objectives are listed and a theoretical framework to support the study is briefly explained. The research paradigm is highlighted as well as the research methodology, data collection, sampling methods, data analysis, ethical considerations, and study limitations and delimitations. Terms discussed in the study are defined and the structure of the entire thesis is presented. Each of these concepts are discussed in each section of the chapter respectively.

1.2 Background and outline of research problem

Language can be a barrier in knowledge acquisition for learners, therefore they should be provided with lexicographic resources that can help remedy the situation. Charamba (2017) states that the main challenge in the South African multicultural school environment is that learners have different home languages and limited English proficiency which negatively affect their acquisition of knowledge, resulting in them achieving lower marks than learners who have English, the language of education, as their home language. For this reason, Charamba (2017) created an English-Southern Sesotho dictionary and tested it among users, who attained better results after consulting the resource. Subject specific dictionaries for learners have been developed in South African languages for primary school learners but there are no Life Sciences dictionaries for FET learners in isiZulu.

A dictionary is not only a word book, since it also offers varying information that is useful to the user, such as the spelling of words, their meaning, word pronunciation, etymology and many more components as determined by the lexicographic functions of each dictionary. Through this research a bilingualised dictionary was developed. The lexicographic function of the latter aims to help users understand concepts from the subject of Life Sciences. Thus, the content of the dictionary includes the headwords and their definitions in English, with their isiZulu translations. Etymological considerations have also been made for some of the terms that the study managed to find historical information as traces of a word help users identify related words (Simelane, 2000; Charamba, 2017).

The development of this dictionary is important as the language used by teachers to convey concepts and ideas has a direct impact on the quality of education of learners. This is evident in the code-switching and translanguaging practice already taking place in the South African classroom wherein teachers accommodate learner language challenges by switching to their mother tongue. This clearly shows the dedication of teachers and their understanding of the need to explain concepts creatively in the mother tongue for learners to improve the quality of education they receive. Most importantly, the downward trend in Life Sciences Grade 12 results from 2018 to 2020 with 76.3, 72.3, and 71.0 percentages, respectively for learners who performed at 30%, and a similar trend for those who performed at 40% of 51.7, 49.0, and 47.9 percentages, respectively (Department of Basic Education, 2020) shows a need for an intervention (Naidoo, 2017; DBE, 2021).

Not much research has been conducted in pedagogical lexicography in indigenous South African languages, therefore, the current study is a contribution to pedagogical lexicography, specifically directed towards lexicography that benefits senior high school learners who speak isiZulu as a mother tongue. A bilingualised dictionary of this nature will benefit users in understanding the concepts being taught in English, which will be recorded as lemmata in the dictionary, as well as the definitions provided in English and isiZulu. The researcher believes that this resource will decrease linguistic and cognitive strain of the learner and the educator, as concepts and definitions for this dictionary are drawn from educational resources that are part of the public school's curriculum for Grade 10 to 12 (Nkomo, 2008; Taljard & Prinsloo, 2019).

In South Africa, many lexicographic activities have resulted in products that are often referred to as glossaries or teaching resources instead of dictionaries (Nkomo, 2010), and there are few scholarly studies in pedagogical dictionaries in South African languages (Taljard & Prinsloo, 2019). Moreover, these products lack in their selection of lemmata and in their structure for specialised terminology in indigenous languages (Nkomo, 2019). The current study explores practical lexicography, which is the study of the practice of producing dictionaries, through developing guidelines for a comprehensive domain-specific dictionary in isiZulu (to be presented in Chapter 6 of this research) and the production of the resource in digital form, for learners in the Further Education Phase (FET) (Grade 10 to 11), which is a resource that is currently non-existent in the language. The development of this dictionary is necessary to help learners understand scientific terminology in their mother tongue and to understand its meaning

as explained in their mother tongue. This resource is not intended to be distant from what learners are being taught in class, therefore, English will serve as the source language, given that English is the preferred language of education out of South Africa's official languages (Webb, 2004).

History demonstrates that missionaries had to learn the language of the people to preach to them in a manner that would be understandable to them and in order to facilitate this they created dictionaries in African languages (Fernandes, 2019). Therefore, the development of a dictionary in isiZulu will help teachers explain terms in a clear manner and the resource will serve as useful reference material for learners. The need for the development of dictionaries in previously marginalised languages has also been explained by Tarp (2008); Gouws and Prinsloo (2012); Gudula (2017), and Mohohlwane (2020), among others.

This research is necessary and important in African language studies because isiZulu is a developing language, mostly in scientific fields where there is a gap in the availability of terminology as the language was marginalised until it was pronounced as one of the official languages in the Constitution of the Republic of South Africa in 1996. This study examines scientific terminology taught to learners in isiZulu and translates them into isiZulu to enable learners and teachers to obtain knowledge in their mother tongue, which would then demonstrate that isiZulu can be used as a language of science just like English, which is a secondary language for many learners.

Makgato and Mji (2006) identified teaching and learning in a second language as a contributing factor to the poor performance of learners, and emphasised the importance of educating learners in their mother tongue. Life Sciences employ specialised language and vocabulary, and learners on the African continent are required to learn this scientific lexicon in a language that is secondary to their own (Osborne & Collins, 2001). According to Mukhethoni (2019: 20):

> The issue of English language as a medium of instruction affects the performance of learners in Life Sciences. It has been observed by several researchers that learners are unable to communicate and understand questions during teaching, learning and assessment activities. In addition, poor language proficiency and

> language background results in poor grasping of concepts in Life Sciences; eventually, this leads to high failure rate in the subject.

For this reason, the study selected Life Sciences as a subject of focus since the Department of Basic Education Diagnostic Report (2020 – Part 1) states that the Grade 12 final examination results (2016-2020) showed a constant higher percentage of learners who passed at 30% and above as compared to those who passed at 40% and above. Further, in the 2020 results there was a slight decline in the results when compared to that of 2019; in both results of those who passed at 30% and 40% and above. When the 2020 final examination papers were scrutinised, there was evidence that learners had terminology challenges which directly contributed to their declining results. Below is a quotation from the diagnostic report:

> Poor performance in Q2.1 was due to a lack of knowledge of basic terminology which was evident when candidates provided the answer:
> •*Cerebellum* instead of *cerebrum* in Q2.1.1(a)
> •*Oval window* instead of *round window* in Q2.1.2
> •*Cochlea* instead of *Organ of Corti* where the receptors are found in Q2.1.3
> •On *pupillary mechanism* instead of *accommodation* in Q2.2 (Department of Basic Education Diagnostic Report 2020 – Part 1: 147)

The department refers to the above terminology as 'basic' meaning it should be easily understood by every learner in Grade 12. Upon researching the terminology in the prescribed Life Sciences textbook, it was observed that these 'basic terms' had subject-specific definitions which were different from general language. For example, 'oval window' and 'round window' do not refer to the general shape of windows, but oval window refers to the membrane that transmits sound vibrations to the inner ear, while round window refers to the thick membrane stretched across a tiny opening between the middle ear and the lower canal of the inner ear (Chetty, Isaac, Manganye, Mpondwana & White, 2013). Without consulting resources to aid with an understanding of terminology, a conclusion was drawn that the use of the term 'basic terminology' may be relative which had a direct impact on the results. This is supported by Charamba (2017) and Makhethoni (2019) who pose that the understanding of material being taught in a foreign language may interfere in knowledge acquisition and has a direct impact on learners' academic achievement.

In the absence of lexicographic resources in their home languages, learners have to master decontextualised language which is often challenging because of limited language capabilities and level of expertise in the subject. Charamba (2017) asserts that learning environments should be structured around language developments, and should consider the home language of learners in scientific studies, and narrow the language gap by designing language solutions that are suitable for scientific subjects.

Research in pedagogical dictionaries has shown that learner dictionaries benefit second language learners in their linguistic needs. In the same vein, dictionaries should be founded on the requirements of identified users who would form the basis for lexicographers in developing learner dictionaries that satisfy the needs of target users (Gouws, 1993). To this end, Ranalli and Nurmukhamedov (2014:1) contend that "learner dictionaries have been a source of considerable lexicographical innovation, particularly in the way a word's meanings and information about its usage are researched and presented. These innovations, supported by advances in computer technology and linguistic analysis, have influenced the compilation of other dictionary types." However, upon searching for pedagogical dictionaries in African languages, more specifically isiZulu, it was observed that the available published lexicographic resources do not cater for the needs of FET learners of Life Sciences. This stems from the fact that domain-specific dictionaries such as *Isichazamazwi Sezibalo Sezikole sase-Cambridge* (isiZulu) by Robert Mchunu and Karen Press (2015), and domain-specific dictionaries from the Department of Arts, Culture Science and Technology (which is currently the department of Sports, Arts and Culture), cater for learners up to Grade 6 and Grade 7, respectively. Moreover, domain-specific lexicographic projects and products have also been made available in universities, where specialised terminology was developed for university students and lecturers as a viable means of language intellectualisation (Khumalo, 2017).

Thus, a gap exists between Grade 7 and the university phase of education in terms of specialised lexicographic resources. Therefore, the aim of this study is to expand the scope and function of lexicographic resources through the development of dictionary development guidelines and a well-established comprehensive dictionary for learners of Life Sciences who are isiZulu mother-tongue speakers. This was developed from terminology from the Life Sciences glossary in Grade 10, 11 and 12 prescribed books from the Department of Basic Education. This will encourage the flow of learning so that FET Phase learner may better understand fundamental

ideas that are appropriate for their age level in their native tongue; subsequently, closing the literary gap (Taljard & Prinsloo, 2019).

Limited research has been conducted in pedagogical lexicography in indigenous South African languages (Taljard & Prinsloo, 2019) therefore, the current study investigates lexicography which is a study of developing dictionaries. According to Bergenholtz and Gouws (2012), lexicography is a study of theory (metalexicography) and practical lexicography which can be scientific and non-scientific, with the scientific aspect sub-divided further to a linguistic based sub-division and lexicographic based one. This is supported by Fuertes-Olivera (2017:1) who describes lexicography as a scientific study of theories and practices of creating "dictionaries, encyclopaedias, lexica, glossaries, vocabularies, terminological knowledge bases, and other information tools covering areas of knowledge and its corresponding language".

The current study is specifically directed towards bridging a gap in practical lexicography and domain-specific resources for learners who speak isiZulu as a home language but are taught in English, which is their second language.

1.3 Problem statement

There is a lack of subject-specific dictionaries, in previously marginalised South African languages, for high school learners as the available resources target Grade 4 to 7 learners. In the same vein, the available resources lack depth as they only provide English terms with equivalents in African languages, omitting definitions and other lexicographic data. This situation is evident in dictionaries for general use and domain-specific dictionaries and has been the conventional pattern in bilingual dictionaries. The researcher contends that there is a need to develop guidelines for dictionary development that will be situated in metalexicography which has been ignored in practical lexicography (Nkomo, 2019) to the detriment of dictionary users who are already disadvantaged by the Department of Basic Education since they are being taught in a language other than their mother tongue.

1.4 Hypothesis

The study hypothesises that the construction of functional dictionaries in previously underrepresented languages can be facilitated by developing recommendations for dictionary building for domain-specific lexicographic resources. These guidelines should be the first step of dictionary development and should comprise of terminology harvesting, etymology, equivalents, definitions and subject-specific information in African languages. The

development of guidelines when developing domain-specific dictionaries will serve as a foundation for lexicographers and benefit dictionary users who will have access to comprehensive lexicographic resources in their mother tongue thus providing resources that can aid in the realisation of mother-tongue education.

1.5 Research objectives

The current research designed guidelines for practical lexicography for the development of a domain-specific dictionary. The main objective of the study was to expand the function of lexicographic resources in African languages through the development of a new dictionary. To this end, the specific objectives for this study were to:

- Analyse terminological challenges faced by learners in Life Sciences terminology;
- Investigate the structure of published pedagogical English-IsiZulu lexicographic resources;
- Analyse harvested domain specific terminology for learners as a foundation for developing a new dictionary;
- Explore the development of domain-specific dictionary guidelines for an English-isiZulu Life Sciences Dictionary; and
- Demonstrate how new lexicographic resources are being developed in order to expand the development of African languages.

1.6 Research questions

The main question to be answered in this study was: How can the function of lexicographic resources in African languages be expanded to satisfy domain-specific needs of users? To this end, the following specific questions were asked:

- Why do learners who speak isiZulu as a mother tongue struggle with terminology in Life Sciences?
- What is the contribution of published English-IsiZulu lexicographic resources in structural developments of new learner lexicographic resources?
- To what extent can the creation of new learner dictionaries be aided by the emergence of domain-specific terminology in African languages?
- What is the contribution of the development of lexicographic guidelines to English-isiZulu lexicographic resources?
- How can domain-specific lexicographic resources expand the function of isiZulu lexicographic resources?

By asking these questions, the study aimed to establish the feasibility of developing a Life Sciences isiZulu dictionary as an expansion tool for the promotion of domain-specific lexicography in African languages.

1.7 Theoretical framework

The theory of lexicographic functions and lexical semantics, a branch of linguistics, serve as the foundation for this study. The theory of lexicographic framework was developed over a period from the work of Scerba (1940) by Tarp (2004; 2013). This theory requires a lexicographer to create a lexicographic tool based on theoretical knowledge that accommodates the needs of potential users according to their types which could be in a form of a monofunctional lexicographic resource or a polyfunctional lexicographic resource (Bergenholtz, Bothma & Gouws, 2012). It also required the study to investigate the user and apply collected data that benefit the user in the development of the dictionary. Additionally, this theory helped to formulate guidelines for developing a domain-specific dictionary.

In a similar vein, lexical semantic analysis was utilised in terminology analysis to investigate the meaning of words, the factors that contribute to that meaning, how speakers understand words, and how words are used in texts and speech. Lexical semantics focuses on the meaning of words and how to explain them so that the person seeking meaning may understand them. (Paradis, 2012).

The relationship between the selected theory and the discipline of lexical semantics lies in the importance of understanding the lexicographic needs of users and the treatment of lemmata in a dictionary. These theories served as a foundation for studying published lexicographic resources as well as the development of the guidelines of the new resource and the end product, which was the digital resource.

1.8 Translation strategies in lexicography

Bilingual and bilingualised dictionaries cannot be produced without the use of translation services, as data has to be translated to the target language (Humblé, 2001). The development of the new dictionary required the application of translation strategies as the microstructure of the developed dictionary had to translated. As an experienced translator, the researcher understands the potential issues on the non-availability of equivalents for scientific terms in isiZulu, and to this end, translation theories to resolve issues of non-equivalence were

employed.

The intention for creating a domain-specific dictionary for learners was to place users at a similar level of understanding terminology in the dictionary in isiZulu as those who read the terms in English, the language in which it was originally written in. Thus, the study employed tailor made translation strategies as required by each dictionary entry, according to Rietveld and Hormelen (2019) and Dlamini (2021) which are discussed in Chapter 6 of this research report.

Given that the dictionary developed is technical, the study envisaged that there might be terms that will not have equivalents because of lexical gaps in isiZulu. Baker (2011) provides for such lexical gaps by offering strategies for the treatment of equivalents at word level and how to handle them as appropriate for each dictionary entry.

The researcher envisaged that this type of resource would clarify words, show connections between them, remove ambiguity in terms assumed to be similar by demonstrating different lexicographic meanings, and provide examples of their usage in sentences (Miller, Beckwith, Fellbaum, Gross & Miller, 1993).

1.9 Research paradigm

The pragmatism paradigm was used in the current study to enable it to benefit from many methodologies, both qualitative and quantitative, which broadens the research's focus by accepting the advantages and disadvantages of both methods (Shannon-Baker, 2015). According to Morgan (2007:67), pragmatism emphasises "shared meanings and cooperative actions" among researchers because it holds that theories can be both contextual and generalisable when they are examined in relation to being applied to different contexts (Creswell, 2009). Morgan (2007) has explicitly shown how pragmatism may link induction and deduction, subjectivities and objectivity, context and generality, and generate new words of abduction, intersubjectivity, and transferability.

1.10. Research methodology

When conducting research to better understand the procedures and methods used in a certain occurrence, researchers may choose to use a qualitative, quantitative, or mixed research approach (Rowlands, 2005). In this study, the researcher used the qualitative approach.

1.11. Data collection

According to Murgan (2015), data collection is a strategy for gathering and measuring data that are relevant to a study in order to satisfy study objectives by enabling the study to respond to research questions, test their hypothesis, and review their findings. The current study collected data through primary resources which is the first record of events from the case being investigated (Dawson, 2002).

Data from these resources were collected through document analysis which is a systematic procedure to evaluate written material to interpret and understand data to answer research questions. Therefore, the analysis is dependent on the researchers interpretation of material and their ability to extract samples they wish to study rather than examine data that have already been selected and analysed by other scholars. When approaching this type of analysis, researchers employ knowledge from available literature to find points that were analysed in the document, and this analysis of documents can contain quotations, themes, and other categories of analysis that the study seeks to find (Frey, 2018).

Document analysis was carried out in the examination of the prescribed textbooks for Life Sciences in Grade 10 to 12, and the megastructure of dictionaries examined in the study. Published resources examined in the study are the Scholar's Zulu Dictionary by Dent and Nyembezi (2009); Oxford Bilingual School Dictionary: IsiZulu & English by Gilles-Maurice de Schryver (2015); and the English-Zulu / Zulu-English dictionary by Doke and Vilakazi (2014). Studying these dictionaries helped the researcher gain new knowledge about a language and its lexicographic resources (Nesselhauf, 2005), thus, serving as a foundation for creating a new resource. The availability of this data was important as it further assisted the study in drawing a distinction between a bilingual and a bilingualised dictionary. The developed dictionary was also examined using the same method to evaluate how it satisfied the research objectives.

1.12. Sampling methods

Sampling enables the study to acquire more constructive data (Onwuegbuzie & Leech, 2007) and has been explained as the process of selecting specific data with the intention of addressing a research objective (Gentles, Charles, Ploeg & McKibbon, 2015). This study employed the non-probability sampling method, which is a form of sampling where researchers identify and select the data required that are not easy to reach using limited resources (Tongco, 2007).

Subsequently, samples for the current study were from selected dictionaries mentioned in this chapter. Further, the development of the dictionary required data, and the same were collected from prescribed textbooks for public schools.

1.13. Data analysis

The megastructure, macrostructure, and microstructure of isiZulu dictionaries, as well as the anticipated isiZulu Life Sciences dictionary, were the data being investigated. According to Marshall and Rossman (1999), they developed a framework for data analysis that entails organising data, immersing oneself in the data, categorising it based on themes, coding the data, interpreting the data, looking for alternate interpretations, and publishing a report. This framework was used in this study to analyse every piece of data that was gathered.

1.14 Ethical considerations

The researcher applied for ethical clearance to conduct the study and it was duly approved by the University of the Witwatersrand Human Research Ethics Committee (Non-medical) and a certificate with protocol number H22/01/04 was issued. (Appendix A)

1.15. Study limitations and delimitations

The researcher had hoped to add learners and teachers as potential dictionary users in the dictionary evaluation stage to determine how useful the resource was to them. However, South Africa has already lost too much learning time because of the coronavirus, therefore every effort is needed to keep learners in the classroom (Fricker, 2021). The researcher did not want to add to the burden already carried by learners and teachers due to Covid-19 hence they were not included in the study. The theory of lexicographic functions and the dictionary evaluation procedure proposed by Ball and Bothma (2018) were employed in the evaluation of the developed resource.

1.16 Definition of terms

a) Language of education: The dominant language used to teach learners in a classroom in a country or region (Beacco, Fleming, Goullier, Thürmann, Vollmer & Sheils, 2016)
b) Lexicography: A scientific study of dictionary that is divided into metalexicography focusing on theoretical knowledge of dictionary development; and practical lexicography which is the practice of making dictionaries. A person working in metalexicography and/or practical lexicography is called a lexicographer (Bergenholtz & Gouws, 2012).

c) Terminography: The process of developing and recording terminology that belongs to a specific domain (Alberts, 2001).
d) Lemma: A word that is the headword in a dictionary entry that represents all other forms of that word (https://dictionary.cambridge.org/dictionary/english/lemma).

1.17. Structure of the thesis

The study's introduction, **Chapter 1**, provides a summary of the entire investigation, including background information, an outline of the research problem, the study's justification, information on language and learning in South Africa, a hypothesis, research questions, research objectives, theoretical framework, research paradigm, research methodology, data collection, data analysis, ethical considerations, the study's limitations and delimitations, definitions of key terms, and information on the structure of the investigation.

An assessment of the published and unpublished works by academics in the subject of lexicography is presented in **Chapter 2**, with an emphasis on the work that was done to create educational lexicographic resources in isiZulu. To this end, the concepts covered were the literature review model, the South African language position, language of education, lexicography, terminology development in lexicography, lexicography meets translation, dictionaries, dictionary structure, dictionary form, isiZulu lexicography, copyright in producing dictionaries, the isiZulu Life Sciences dictionary, following each other respectively. **Chapter 3** provides a theoretical framework, which is a collection of ideas and hypotheses developed by experts in the subject area that holds a research project together and allows for the analysis of data and the interpretation of findings. Semantics, a branch of philosophy, and the theory of lexicographic functions are presented in this chapter. Additionally, the research technique used to conduct the study is provided in the chapter. It outlines both the approach to be utilised for the analysis of the same data as well as the methodology employed for data gathering. This chapter begins with a definition of research methodology and then introduce the ‘research onion’ method, which separates each component of the research methodology used in the study, including the following: research philosophy, methodological choice, research strategy, time horizon, data collection, data analysis, truthfulness, and ethical considerations.

In **Chapter 4**, data and data acquired to satisfy the study's initial goal—the analysis of terminology used in the Life Sciences—were analysed. The chapter begins by explaining the

presentation and analysis of data which is followed by an examination of terminology that is in the prescribed books for subject learners in Grades 10, 11 and 12.

Chapter 5 examines the typology of isiZulu dictionaries and the design of English-isiZulu dictionaries for learners. A structure for the dictionary being built in the study was formed after examining the megastructure of a few chosen dictionaries.

Following this, the development of a new dictionary is laid out in detail in **Chapter 6**. The lemmata for the resource are looked at in light of the idea of lexicographic functions. The produced resource was further assessed to determine whether it fulfilled lexicographic requirements. This chapter evaluates the developed Life Sciences dictionary's contribution to user needs and to develop guidelines for the development of a domain-specific dictionary and an isiZulu dictionary called the *Isichazamazwi Sesayensi Yezokuphila - Life Sciences Dictionary* (ISY-LSD).

Chapter 7 presents the research findings and recommendations for further research.

1.18. Conclusion

This chapter served as the thesis's introduction and supplied the study's organisational framework as well as material that could be found in each of the subsequent chapters. The study's supporting literature is reviewed in the following chapter.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents a literature review of published and unpublished literature that has been written by scholars in the field of lexicography with a focus on work that has been done in the development of pedagogical lexicographic material in isiZulu. To this end, the concepts covered are the literature review model, the South African language position, language of education, lexicography, terminology development in lexicography, lexicography meets translation, dictionaries, dictionary structure, dictionary form, isiZulu lexicography, copyright in the making of dictionaries, and the isiZulu Life Sciences dictionary, follow each other, respectively in consecutive sections of the chapter.

2.2 Literature Review Model

A literature review involves studying scholarly articles, books and other material that are relevant to the topic being investigated to describe, summarise and evaluate these works as a means of resolving a problem. A literature review provides knowledge that has already been reported through research on a subject field in support of the research questions that new research aims to respond to. Therefore, a literature review should deduce and evaluate an array of knowledge from a wide range of local and international resources such as academic journals, books or internet-based resources (Neuman, 1997; Rowley & Slack, 2004).

A literature review can draw new ideas by consolidating and recapitulating the work of other scholars by means of systematic, meta-analysis, secondary and primary literature reviews. The systematic review is explained as a type related to meta-analysis that aims at analysing findings from previous studies to demonstrate the power and accuracy of risk assessment in previously conducted studies already on a topic. Secondary reviews are conducted when a lot of information is already present on a topic or where not much is known about it, or where the study arranges and analyses data in a qualitative form according to required themes. Finally, literature is examined in primary reviews to persuade the reader that the study took into account earlier research on the subject and that the new work presented adds to the body of knowledge already available (Bolderston, 2008).

In the same vein, Arshed and Danson in MacIntosh and O'Gorman (2015) explain a literature review as an exercise of learning and understanding a subject area to enable the study to justify

their study. The researcher studies and writes about the main points, discussions, results, and methods applied during research to construct a strong argument for the study. The scholars also list the four primary categories of literature reviews that have developed over time: traditional or narrative, systematic, meta-analytical, and synthesis reviews. The conventional or narrative literature review analyses the literature by presenting work that will demonstrate recent research on a topic, find gaps, and uncover contradictions, thereby influencing the research questions and the study's focus. The systematic literature review answers specific research questions while meta-analysis captures literature findings and studies them to establish patterns and relationships between them. In meta-synthesis, findings are also studied in a non-statistical manner to examine findings from qualitative studies as a foundation for a new study based on previous conceptualisations and interpretations.

The descriptions of the four types of common literature reviews stated above are the same save for terminology differences in the traditional or narrative literature review (MacIntosh & O'Gorman, 2015) and the primary literature review (Bolderston, 2008), although the definitions are aligned. The primary type of literature review has been selected for the current study as it forms a summary of available knowledge and provides an evaluation of studies already conducted in the field of pedagogical lexicography without restrictions. This will allow the study to capture considerable work done previously to serve as a feasible foundation as opposed to systematic and meta-synthesis reviews which are prescriptive (Li & Wang, 2018).

2.3 The South African Language Position

In an attempt to explain the language situation in South Africa, a multilingual nation with twelve (12) official languages, the paper starts by defining monolingualism, bilingualism, and multilingualism. Monolingualism is the capacity to understand only one language despite exposure to other languages (Ellis, 2006) while bilingualism is the ability to understand two languages which may be at a level of knowing the language or at a degree of being fluent in two languages (Baker, 2011), and multilingualism is understanding several languages (Diamond, 2010).

This phenomenon comes in different forms as one can have bilingualism and multilingualism simultaneously if one learnt language at a very early age. Elective bilingualism refers to when one learns an additional language to equip one with extra language skills while mostly using one's mother-tongue. Another form is circumstantial bilingualism which refers to learning a language for a reason such as for educational or work purposes. With twelve (12) official

languages in South Africa, the knowledge of more than one language is inevitable (Gottardo & Grant, 2008).

The position South Africans find themselves in due to multilingualism and acknowledgement of twelve (12) official languages confines the ability of some linguistic communities from using their languages in various environments such as work or school. The current study looked at the results of such confinement for learners who are taught in a second language by teachers who also acquired knowledge in a second language. This confinement does not only restrict learners from acquiring knowledge in their native language but also restricts teachers from teaching in their mother tongue. This study considers terminological hinderances caused by language restraints in knowledge acquisition, in not only in a study conducted in plain language but in a scientific study requiring extra-linguistic knowledge from learners, and in answering research questions provides a solution to the language position of learners. For this research to provide such a remedy, it considers linguistic changes and developments in the country.

According to Bostock (2018), the history of language change in South Africa can be traced to the arrival of European settlers in 1652, who declared their own language, Dutch, the official language of the nation while ignoring any languages used by the local native population. Due to the South African Dutch's separation from the Dutch, English, French, Portuguese, Malay, and African languages, which all had an impact on their language, resulting in the creation of a distinct tongue called Afrikaans. Dutch was partially recognised as an official language as well, despite being less dominant than English, as a result of the British victory in the battle to take control of the Cape Colony in 1814. Afrikaans, however, regained parity with English as an official language in 1910 when South Africa joined the British Empire as an independent nation. When Afrikaans speakers gained political power in 1948, a Nationalist government headed by Afrikaners was formed to force black people to use Afrikaans and preventing Western influence in Africa.

A policy of Bantu Education was introduced where black people were to be taught in their mother tongue from primary to tertiary education leading to the decline of English in the country. Due to the oppression of the ruling class, English became the language of Pan-African communication whereas Afrikaans was seen as the language of the oppressor. The decision to mandate Afrikaans instruction for black learners in 1976 sparked civil unrest and murder in Soweto, where 600 people—mostly children and teenagers—died. The official languages of

South Africans who were relocated by the government to their native countries were English and an African tongue. The official acknowledgment of South Africa's indigenous languages and the normalisation of bilingualism didn't occur until the dawn of democracy in 1994 (Bostock, 2018).

Evidently, language transitions in South Africa are mostly influenced by socio-political matters which are evident in the change of official languages in a country with ruling parties in the history of the country (Gough, 1996). After South Africa's political transformation into a democracy in 1994, a new constitution was drafted in 1996, establishing Afrikaans, English, isiNdebele, isiXhosa, isiZulu, Sepedi (also known as Sesotho sa Leboa), Sesotho, Setswana, siSwati, Tshivenda, and Xitsonga as official languages. The issue, however, is that since English is the most used language, the ideologies of the colonial and apartheid era languages are still present. The influence of education is apparent in the way language is used in business, government, and educational settings as well as in some recent reports of language use in non-English household settings. (Broeder, Extra & Maartins, 2002; Posel & Zeller, 2016).

Due to the hegemony of English, which is upheld because of its power and influence in the world, and South Africa's twelve (12) official languages, South Africa maintains a bilingual educational system (Molepo, 2008). Although isiZulu is the researcher's mother tongue, she only learned it for language studies and had her schooling in English. Further, in the place of work, as much as she specialises in isiZulu, all instructions, meetings and correspondences are in English. The researcher appreciates that the use of English can be considered as a lingua franca in a multilingual environment but through experience she has realised that even if speakers all speak one native language, the native language does not find its way into the boardroom and in discussions pertaining to work. One of the possible reasons for the hegemony of English in the place of work could be that the information shared was acquired in English because workers attained their education in English resulting in them not having enough terminology to enable them to run smooth work-related discussions in their native languages. An education system that is managed in a second language may also be due to terminology gaps in native languages. Hence, the current study examines how the language of education affects the terminology used to teach learners about the Life Sciences, in addition to adding to the body of knowledge on the issue.

2.4 Hegemony of English in South Africa

Colonialism and external pressure can be used to infer English predominance in South Africa because this scenario is not unique to this nation but is also widespread in other colonised African nations. The language of trade of these nations is English since English is viewed as the language of influence and power. The most regrettable aspect of this hegemony is that even native people eventually come to favour English (Dladla, 2017).

The hegemony of English in South Africa stands out in the language used in government offices, commerce and in educating learners. The only other language used in education is Afrikaans, a former supreme language during the apartheid era, but previously marginalised languages of indigenous people still lag behind. The Education Policy (1997) for schools recommends that learners be taught in any of the official languages, however, as Beacco et al. (2016) state, the language of education in a multilingual environment can be challenging as languages of some learners are sacrificed and the hegemonous language becomes the preferred language of education. The most unfortunate result of this preference is that learners learning in their mother tongue find themselves in a better position than their classmates as all learners are expected to understand general and academic English for them to fully engage the curriculum (Probyn, 2006; Posel & Zeller, 2015; Diko, 2018).

Given that Life Sciences is part of the curriculum, learners who are not Afrikaans speaking or English speaking are expected to fully engage in the subject in the language of education, English, and write their examinations in the same language. This language situation can be challenging to learners and negatively contributes to their results. To this end, Trudell (2016) argues that the language used in schools as a medium for learning is just as crucial to the success of the educational system as the standard of instruction, the suitability of the curriculum, the availability and calibre of teachers, and effective leadership. These features when combined produce successful learners as well as a pleasant learning experience. Issues of language should be prioritised at an equal level as the quality of education because they can become a barrier or a bridge which would be noted in the education outcomes of learners. Therefore, providing learners with tools that can help them achieve optimum outcomes is necessary. There should be collaborations between various stakeholders, such as subject specialists and linguists too in order to help learners understand the knowledge being imparted to them. These stakeholders can work together to produce pedagogical material in language of learners in consideration of the language of education.

Naidoo (2017) identifies language as one contributor to knowledge acquisition as teachers teach and communicate their subjects in English even though not all learners are fully able to understand the work due to language constraints caused by difficulty in understanding scientific terminology. This was particularly observed in the case of Life Sciences and contributed to most learners opting to choose other subjects. Although teachers would at times discuss the subject in isiZulu, the learners found that most terminology was not available in the language, thus making the teachers' attempts less successful than envisaged (Naidoo, 2017). Additionally, South African learners demonstrate poor performance in Mathematics and Science, as highlighted by the 2019 Trends in International Mathematics and Science Study, which determined that South African Grade 8 learners ranked the lowest in the world in science (Mullis, Martin, Foy, Kelly & Fishbein, 2019). Subsequently, this study considers the language of education in the development of a tool to remedy the language position of learners through practical lexicography.

2.5 Language of Education

The language of education, as defined by the Council of Europe, is a phenomenon made up of languages taught as subjects and languages used to teach non-linguistic disciplines like Mathematics or the Life Sciences. The Council goes on to say that language proficiency is necessary for both learners' and teachers' ability to communicate effectively. As a result, it is critical for teachers to be able to determine the language proficiency of their learners since language hurdles have been linked to learner dropout rates. (European Language Council)

In the same vein, the language of education is explained by Beacco et al. (2016:11) as follows:

> The term 'language of education' is widely used to describe the dominant (sometimes only) national or minority/regional language used in the classroom for teaching. 'Language of instruction' is often used for the same purpose, although some object to this term on the grounds that it implies a narrow, 'transmission view' of what teaching entails.

Thus, a language that is broadly used to teach learners is often the hegemonous language in a country or region. Other languages which may be present in that environment do not form part of the language used to impart knowledge to learners in the classroom although they may be used in other environments. The approved language of education is used to relay subject knowledge using language systems solely from that language, omitting other languages that

learners and teachers may have knowledge of. Given the neglect that other languages experience in the educational setting, it makes sense that the language of instruction in multilingual settings could occasionally be a language other than the learners' mother tongue, which has higher linguistic demands than learning in the learners' mother tongue. Learning the educational language is crucial for learners since language skills and deficiencies might affect their academic performance. This helps them to interact with the material being taught, other learners, and the teaching staff in the classroom using the language, which then prepares them to communicate in non-academic settings (Beacco et al., 2016).

The language position faced by learners can be hailed from colonial times where foreign languages were imposed on Africans on the continent. The continent reached the stage of decolonisation and political initiatives pertaining to languages were seen in some countries, such as the northern African countries choosing to adopt Arabic as their language of education and trade. On the other hand, countries such as Mozambique, South Africa, Nigeria and others retained languages of former colonisers as their language of education, and only featured indigenous languages at stages of early education. In South Africa, English and Afrikaans are languages given a higher status even though the most spoken language is isiZulu with 22.7% mother-tongue speakers while English and Afrikaans have 9.6% and 13.5% speakers, respectively (Census, 2011). This is also seen in languages employed in education where the same languages are the only languages used to study after Grade 3 which undermines indigenous languages given that the Constitution of the Republic of South Africa (1996), the Language in Education Policy (1997) from the Department of Education, Language Policy for Higher Education (2002), all promote the parity of esteem of all official languages in the country (Lafon, 2013; Mkhize & Balfour, 2017).

Because most learners are not fluent in English, the Language in Education Policy (1997) for schools calls for the use of learners' native tongues in both teaching and learning. However, from Grade 4 to Grade 12, learners are taught in English. To address this gap, some teachers code-switch between English and an African language of the learners in their classroom. The assessments, however, must be read and written in English by the learners. In order for learners to close the language gap, they must be fluent in academic English as well as conversational English, with all of its features and characteristics that will allow them to fully engage with the curriculum. On the contrary, learners of English and Afrikaans have full access to schooling in

their mother tongue but the same cannot be said for learners of previously marginalised learners (Probyn, 2006).

Beacco et al. (2016) posit that the responsibility of alleviating language issues lies on the decision makers within the education sector. They should be the ones who make policies that clearly state the language requirements pertaining to subject-specific knowledge acquisition and competence. These scholars suggest that all language dimensions should be considered as learning settings may differ and an appropriate procedure should be applied as required in each learning environment as language is the foundation of all learning.

The hypothesis of the study includes that the language of learning should not only be derived from historical elements of the country, and that the availability of study material was written by predecessors because of the supremacy offered to a language once upon a time, but that the language of education should be aligned with the need of learners and the function of the education system. No language should be given power over another on the basis of political history of a country and resources should be made available to enable decision makers to make decisions that can be implemented. To this end, the researcher considered the language of education in the global, African and South African perspectives.

2.5.1 Language of education: A global perspective

As a result of globalisation, English is now used more frequently than any other international language in higher education on a global scale. Since English is widely used in educational settings, there is an increase in the number of international journals published in English, and there is a culture that encourages non-English speaking universities to switch to using English so that learners can more easily access the global job market. English was first used as a language of teaching for learners in northern European nations that do not speak it, and this was not well received by other nations like the Netherlands. The debate on language policies continues as the impact of these policies are examined (Liu, 2019).

Given that the current study is being undertaken in South Africa, a nation that uses English as a lingua franca and a medium of education, English is examined as an instructional language. Children who are educated in a language other than their mother tongue are more likely to struggle academically or leave school early. Thus, the Sustainable Development Goals, which were approved and accepted by 193 countries, were discussed in the United Nations General

Assembly on September 2015. Target 4.5 of the SDGs calls for providing vulnerable children, indigenous people, and people with disabilities equal access to education by the year 2030. (Boeren, 2019)

It is impossible to provide equal access to education on a global scale without taking into account whether learners can access the curriculum and the learning environment as a whole in their language of instruction. For the abovementioned target to be attained the following questions are considered by Dene (2018:7):

> Is the learner taught and assessed in a language s/he understands and speaks well? Does instruction draw on the learner's prior experience and resources to construct new knowledge? Are teachers able to use languages in which they themselves are proficient to provide relevant instruction to learners?

Conversation can be hindered by the lack of understanding and the inability to speak well. Therefore, the first question is crucial for the learner's position to be established prior to imparting knowledge. If this knowledge is ignored a learner who does not understand or speak a language well will not be in a position to acquire the information being rendered. In the same vein, the ability of the learner to apply knowledge already collected through experience is important. Unfortunately, a learner hindered by language constraints is unable to draw information from previous knowledge due to failure in connecting knowledge they already possess with what is being taught. They would also fail to express that knowledge they already have because of not being conversant in the language of learning. Further, the teacher's language ability clearly show that a teacher who may experience language challenges will not be in a position to adequately educate learners in that language of instruction because they are unable to share information with learners eloquently.

These questions are crucial in multilingual countries because often the language, and sometimes languages used at school and home, tend to differ in previously colonised countries due to colonial legacies that led to the use of foreign languages in official domains. The use of one language of instruction in such countries has been criticised over the years. The issue still exists, despite the fact that it disadvantages learners whose native tongues are not the language of teaching. This phenomenon has an impact on the learner's access to knowledge, the calibre of the instruction and assessment process, as well as the likelihood of securing work in the future.

Peyton (2015) studied the language of teaching and learning in the United States of America (USA) which is a widely multilingual country with English as the dominant language. There have been studies and arguments on the value of home languages of learners in their academic success for decades in the USA, and conclusions in the matter for and against the promotion of learners' home languages are conflicting. A study was conducted by Slavin, Madden, and Calderón (2011:4) wherein they asked, "How can the child be expected to learn the skills and content taught in the early grades while he or she is learning English?" The latter study discovered that the language of instruction was not key, but the quality of the education was key to the success of the learner in English or Spanish as selected by the education facility.

These academics contend that rather than beginning the study of learner situations with the language of instruction, it should begin with the quality of education the learners are receiving. In other words, even if a learner is taught in their home tongue, they will still perform poorly if the quality of their education is low. On the contrary, Brock-Utne (2014) posits that quality education cannot be obtained without resolving issues that block the transmission of quality education to learners which is the language factor. Subsequently, it is argued that the quality of education may be good but if learners are unable to understand the content due to language constraints, the function of the education system, being to impart knowledge, will not be attained.

India, the fourth most linguistically varied nation in the world, experiences the same difficulties as other multilingual nations when choosing a language of teaching. There aren't many indigenous languages taught in schools; instead, English, Hindi, and state languages are the most common. Language obstacles in the classroom are made more difficult by the variety of languages spoken by this nation. The Indian Constitution encourages the use of mother tongue in the classroom, but in reality, 44% of learners are instructed in Hindi, while English is widely used in higher education, the government, and business. In India, the educational system recognises the variety of regional tongues, and when learners have completed a foundational education in their mother tongue, they move on to learn English, a global language (Jolad & Doshi, 2021).

When learners learn in their mother tongues, they acquire more information than they would have in a secondary language. The argument of the quality of education versus the language of

education has to start with an evaluation of languages of learning as has been observed in the international arena. The researcher observed that minority languages are considered even though English is more hegemonous than other languages. With English being taught as a language, and used for education after the basic education phase, multilingual nations like India provide instruction to their learners in a variety of languages. This directly affects learners' development in a global setting, and the situation is seen in the context of Africa in the next subsection.

2.5.2 Language of education: An African perspective

The quality of education and learner outcomes are the focus of education funders in Africa, who are unaware of the barriers of language impairment brought on by the usage of colonial languages instead of indigenous languages (Brock-Utne, 2014). People working in the education sector have focused more on the quality of education than the language of instruction, as was mentioned above when considering the language of education from a global viewpoint. Similarly, in Africa, education places the quality of education as a starting point for assessing learner outcomes. The language of instruction factor cannot be separated from the quality of education issue which is partially in line with Peyton (2015) who observed that the USA believes in the importance of producing quality education in whichever language chosen by the academic institution. In other words, Africans are the ones who should choose a language of education in environments where education is provided and then the quality of that education can be measured knowing that learners understood the information shared with them.

According to Foster (1966), the African language of education choice is greatly influenced by the period of colonialism when language policies were decided by the colonisers who promoted their languages as languages of instruction rather than indigenous languages. In the nations they had colonised, such as Nigeria, South Africa, and Zimbabwe, the British demanded that education be obtained in English. French is required as the major language of teaching in nations like Cameroon, Ivory Coast, and Gabon, exactly as the French did. The Democratic Republic of the Congo (previously Zaire) and the Republic of Rwanda, on the other hand, were permitted to start their education in their native tongues before switching to French. It is regrettable that the majority of African nations have accepted forced languages as the medium of instruction for learners who speak native languages.

The situation in Ethiopia, an African country colonised by Italians between 1936 to 1941, is different given that the education system was not designed according to the country's set-up but was influenced by the relations of the country with other countries. In the 19th century the country used the Ge'ez and Amharic languages in education. It was only in the 20th century that schools began teaching in French and Arabic. Native languages were used for a short time as a language of teaching and learning in order to disintegrate the country and later Amharic was pronounced by the government as a language of instruction that would reunify the country alongside with English with the dawn of modernisation. However, there were challenges with the use of English noted in the early 1980s which was caused by the lack of command of the language noticed among teachers. This inability of Ethiopian educators to speak English directly impacted the quality of education offered to learners. A language policy allowing for the use of different languages as a language of education was adopted in 1994 overturning the use of native languages as languages for literary studies only but now encouraging their employment in the learning environment as a whole (Karvonen, 2017).

The Ethiopian situation demonstrates the impact of social and political change in the language of education in a country and the current research sees the learners being placed in the position of not knowing their fate in terms of their education as politicians change seats of power. This is based on Obanya (1980) who was of the opinion that language is the foundation of educational problems for an African child because they are taught in a foreign language which is not well understood or used by both the learner and the teacher in most situations. The expectation of teachers to produce learners who will obtain positive outcomes is unfair if teachers and learners are not given an opportunity to use or study in their indigenous languages.

In 1982, ministers of education on the African continent met in Zimbabwe to discuss the languages of learning in education and they emphasised the urgency of using African languages in educating the African child to promote African culture, social and economic development of the continent (Brock-Utne, 2014). These ministers were aware of how language factors affected learners' futures and the calibre of learners generated on the African continent as a result of language-related issues. To this end, MacKenzie and Walker (2015:13), in the policy brief for the Global Campaign for Education stated the following:

> It is estimated that 221 million primary-aged children from minority language and ethnic communities do not have access to education in a language they know. The unsurprising result is that literacy rates among ethnic and linguistic minorities are

> particularly low. Low quality and achievement in many African schools can be partially related to language. As UNESCO notes: 'Africa is the only continent where the majority of children start school using a foreign language'. Education is almost universally offered in the old colonial languages – French, English or Portuguese – which most young people do not speak at home.

Learners who are at the foundational stages of education find themselves in a classroom with a teacher instructing them in a language they are not competent in which results in poor outcomes when tested for knowledge. African learners are not inferior to learners in the international space due to being less intelligent but instead they are hindered by the education system from achieving optimum performance in their learning experience. Therefore, the medium of education is partially responsible for results obtained by learners. It is quite unfortunate that Africa, a continent that prides itself on its culture and the fight against colonialism, is still receiving education in old colonial languages that learners and teachers who are native Africans do not speak at home.

The imbalance in the language situation between the school environment and the home environment requires a bridge for learners' learning in a second language to take their learning to their home environment like learners who learn in their mother tongue carry their learning language home. For this reason, Babaci-Wilhite (2012) argues that language policies should ensure that languages of instruction are languages of everyday communication that learners can relate to. The language of learning should not make education foreign. However, the reality is that this is not the case in most countries in Africa, including South Africa where learners are expected to acquire subject-specific information in a second language and understand and respond to assessments in the second language.

The only African language utilised in secondary education in all of Sub-Saharan Africa is Afrikaans, and the standing of Afrikaans was impacted by the race of its original speakers, who enjoyed a higher social status than the remainder of the population. Developments in a country dwindle that place politics above the success of its learners as some learners may drop out of school due to poor outcomes which could have been avoided had language matters been addressed (Brock-Utne, 2014).

2.5.3 Language of education: A South African perspective

According to Trudell (2016), multilingualism in South African schools is often discussed but not implemented as education is only provided in two languages, namely English and Afrikaans from Grade 4, while indigenous languages are only taught as subjects. The current South African education system emanates from apartheid South Africa which proclaimed English and Afrikaans as official languages and divided learners according to race to provide education of low standards to black children and of Western standards to white children. In 1994, when a democratic government was elected, the country changed from being an officially bilingual country to a multilingual country with the inclusion of indigenous languages. Consequently, this inclusion of previously marginalised languages led to the development of the Language in Education Policy in 1997, which states the following:

> The learner must choose the language of teaching upon application for admission to a particular school. Where a school uses the language chosen by the learner, and where there is a place available in the relevant grade, the school must admit the learner (Language in Education Policy, 1997:3)

According to this policy, learners have the option of selecting a language that they would like to be taught in when they apply for admission at a school. The irony of the matter though is that schools that are expected to offer learning opportunities in African languages do not offer the same but instead offer subject-specific knowledge and instruction in English, and African languages are only learnt in literary subjects. Although this policy accommodates indigenous languages in the learning environment, parents are still resistant towards education in African languages because of globalisation and undermining the ability of these languages being used for educational purposes (Kruger, 2007). Additionally, although this policy allows for the choosing of an educational language, it does not solve the issue of the accessibility of study materials in all official languages, as the Department of Basic Education only makes them available in English and Afrikaans, starting in Grade 4 (Mohohlwane, 2020).

A learner is allowed to select a language even though study materials are not available in that language. Teaching material from Grade 1 to 3 is available in indigenous language but 78% of the learners from Grade 4 upwards have to shift to English save for Afrikaans-speaking children who have material as a benefit from the apartheid era (Heugh, 2013). This clearly demonstrates that the political change in the country did not have a practical impact on the language of education as 79.1% of learners are still faced with a situation no different from the

pre-democratic era as found in the Annual Surveys of Schools from 2007 to 2011 by the Department of Basic Education (Taylor & Coetzee, 2013).

The South African situation is no different from that which the African continent is grappling with as most education on the continent is provided in English followed by French due to the influence of colonisation and political influence. Due to the fact that African children must learn in a language different than their home tongue, which directly affects their access to high-quality education in some developing nations, language is a well-known barrier to the education of African children. As a result, learning in African languages has been established at various universities, including the University of KwaZulu-Natal, the University of South Africa, Stellenbosch University, and the University of Pretoria, among others, without lowering the standard of instruction. However, when language-related research is conducted in educational institutions, the impact of teaching in indigenous languages on ethnicity and racial discrimination should be considered as separating learners according to language group can lead to ethnicity and racial challenges. The concern though is the possibility of the unintended formation of 'island universities' that will only be able to cater for people who speak a particular language and not another thus creating division while the use of an international language could create a mixed society. A language like English, although not superior to other languages, leads to socio-economic development in developing countries, such as South Africa which makes it the preferred language of education despite the impact it has on learners (Nyika, 2015).

South Africa is aware of linguistic challenges faced by learners. This was confirmed by the Minister of Basic Education, Angie Motshekga as reported in *Inside Education* (an online newspaper by Charles Molele on 10 March 2022 that a pilot project was conducted in 2015 in schools using isiXhosa and Sesotho as the language of learning and teaching beyond Grade 3. Mathematics was one of the subjects taught in these languages. These languages were also used to teach Technology and Natural Sciences. The project proved to be successful; however, the minister noted that its implementation in multilingual provinces such as Gauteng would be impossible as learners have different mother tongues, unlike in the Eastern Cape where learners speaking similar mother tongues are often found in one area. Mother-tongue education is beneficial and previous studies demonstrate that when learners are tested, they are not tested on the knowledge taught but on their language ability which is something the South African government has to consider to create an enabling environment for learners to be assessed in

their mother tongues. The minister continued by saying that in order to translate challenging scientific and mathematical concepts properly into languages that lack them, the government would need to deploy translation technologies.

Further, the minister, in a speech delivered on 20 May 2022, as part of her Budget Speech for 2022/2023, stated the following:

> Speaker, given the demographics of our country, more than 80% of our learners, continue to learn in a language other than their mother tongue. We must begin a serious debate on mother-tongue teaching and learning. Currently, learners learn in their mother-tongue until Grade 3, then switch to English or Afrikaans as the Language of Learning and Teaching (LOLT). Not doing so, will continue to contribute greatly to under-achievement. We must have a policy shift in this area (Motshekga, 2022).

The minister of Education acknowledges that most learners are not being taught in their mother tongue and that this matter should be discussed with responsible parties. The impact of the learner language situation is understood to be detrimental to learner outcomes. As part of acknowledging and responding to language challenges of learners in senior high school grades, the current study focuses on a scientific subject, Life Sciences, taught in English to second language learners. Studies on education and learning at higher levels in a second language demonstrate the need for reading and writing science literacy because it forms the basis of understanding the subject.

For this to be successful, Rollnick and Rutherford (1993) propose a bilingual form of education where learners in the Eastern Cape, for example, would be able to learn science in English and isiXhosa thus enabling them to have a linguistic access to the subject. The DBE, Department of Higher Education and Training and the Department of Science and Technology collaborated in a project aimed at improving the learning experience for learners. As much as they noted language challenges among learners in learning natural sciences in Grade 8, they sought to understand causes for the challenges which could have been the learners not grasping the concepts in English, the teacher not being able to explain well or the lack of understanding of scientific language which could have started at previous grades. Gudula (2017) conducted a follow-up investigation to ascertain the extent of the issue, concentrating on the impact of language on the instruction and understanding of natural sciences in Grade 7 and established

that learners had challenges with English, and as much as teachers code-switched from English to isiXhosa, concepts were still in a scientific language that the learners could not grasp (Gudula, 2017).

Language challenges faced by South African learners, demand interventions and teachers, as the first point of contact with educational data that have to be learnt, dedicate themselves to helping learners achieve better results by code-switching between the language of education and the indigenous languages of learners. This intervention is, however, hindered by terminological challenges under discussion in the current study because teachers are unable to translate terminology on the go as terminology development is a science on its own. A study on providing scientific concepts and terminology in African languages are therefore necessary to elevate the challenges of learners being taught in a secondary language. Additionally, El-Sayed and Siddiek (2013) alluded that dictionaries can be used as a teaching resource and not only as a reference resource. Learners can read dictionaries as they would with literature and gain subject-specific knowledge that will enhance their learning experience. Therefore, the development of subject-specific dictionaries can provide an additional resource that can be used by teachers and learners; not only for reference purposes but for knowledge acquisition.

The South African language dilemma promoted by the Department of Basic Education is discussed without practical solutions being offered by the department through the development of learner resources in African languages (Mohohlwane, 2020). As a result, this study encourages the creation of scientific content in African languages as a means of reducing lexical and terminological issues brought on by the national language of instruction in South Africa. Teachers are already code-switching which is inadvertently creating a bilingual classroom. Therefore, this study views subject specific study-aids, such as dictionaries, in African languages as a potentially useful tool for learners. This study contributes to the development of a dictionary to cater for this purpose; and for such a resource to be developed, the study interrogated the science and art of dictionary making which is called lexicography.

2.6 Lexicography

Lexicography is a scientific study of the process of writing, editing and compiling dictionaries. Principles and practices of compiling this resource are studied and practiced by professionals in the field. There are two branches in this field which are metalexicography (also called

theoretical lexicography or dictionary research) and practical lexicography (Pearsal, 1998; Bergenholtz & Gouws; 2012; Nthambeleni, 2016).

Metalexicography consists of carrying out numerous research activities, such as systematic dictionary research, research on dictionary usage, historical dictionary research, and critical dictionary research; these activities contribute to the guidelines and rules established for dictionary-making exercises. Similarly, practical lexicography, which has also been called the 'art of generating dictionaries' and 'the holistic planning and compilation of concrete dictionaries,' is a scientific endeavour that yields dictionaries. (Wiegand, 1984; Bergenholtz & Gouws, 2012).

The reasoning about lexicography being an art or science was pronounced by scholars such as Landau (2001), Atkins and Rundell (2008) and Béjoint (2010) who argue that lexicography was not a science but instead found to be more of an art of linguistics. In the same vein, Tarp (2008; 2012) argues that the field is indeed a science and should be regarded as such. In support of his position in the matter he placed lexicography as a field as a science and listed steps involved in the lexicographic process which distinguished lexicography from other disciplines – thus making it a science. These steps are listed below:

1. Creation of user profiles that include all pertinent user characteristics
2. Detailed descriptions of pertinent extra-lexicographic user scenarios
3. Defining information requirements based on particular user categories and user contexts
4. Data preparation and selection that allows for the retrieval of the necessary information
5. Creating quick and straightforward access points to the pertinent data
6. Organised study of a certain subject area
7. Fundamental rules for lexicographic tool layout and design
8. The resulting inference from the discussion above. (Tarp, 2008:30)

Tarp (2008) posits the following methodical and meticulous steps to be taken in the act of studying material to be employed in the development process: studying the user as the receiver of the resource; the preparation required in the profession; the systematic arrangement of the content; the developing dictionaries and the deduction of conclusions pertaining to the

complete process, places it in a position of being considered as a science. Nevertheless, Margalitadze (2018:248) states the following:

> Modern lexicography is a complex, multidisciplinary field incorporating multiple components, viz. semantic theories, corpus-based methods, methods and techniques for natural language processing, e-lexicography, research in dictionary use, etymology and so on. Consequently, claims that working on a dictionary does not constitute a scientific activity, or that lexicography has no theory, seem to be an unbelievable misunderstanding.

He argues that lexicography is a multifaceted field comprising of elements drawn from other disciplines and with various theories from many disciplines which could not be regarded as a lexicography but instead as an art. The claim was that those who advanced the broad theory of lexicography had not succeeded in persuading the public of the field's importance outside of linguistics. They contested that a theory should provide a set of ideas that explains a phenomenon which would not have been clarified without those explanations. Given that they viewed the field as a craft they posited that an art did not need a theory as opposed to a science, which required it. They articulated that although scientific methods may be applied in the development of dictionaries, the field has not yet morphed into a science.

These opposing opinions raise questions about what can and cannot be considered as a science. To this end, the term ‘science’ has to be defined to ascertain whether lexicography is accommodated by the definition.

The following definitions of the term ‘science’ are provided:

> knowledge or system of knowledge covering general truths or the operation of general laws especially as obtained and tested through scientific method
> b: such knowledge or such a system of knowledge concerned with physical world and its phenomena: NATURAL SCIENCE (Merriam-webster, 2022)

> The study and knowledge of the physical world and its behaviour that is based on experiments and fact that can be proved, and is organized into a system (https://www.macmillandictionary.com/dictionary/british/science)

> A science is a system of knowledge growing out of social practice and developing on an on-going basis, comprising the acknowledgement of the most important properties, causal connections and legal considerations of nature, society and philosophy; rooted in the form of concepts, categories, defined goals, laws, theories and hypotheses, and constituting the basis of Man's growing mastery of his natural and social environment. A science also consists of its own history, pre-theoretical ideas, contributions to methodology, directions for practical action etc (Tarp, 2012:223)

According to the definitions above, a science is a body of factual information about the physical world that can be methodically organised and learned. Lexicography is a collection of the body of knowledge, the creation and an examination of work produced in the field. This body of knowledge results in a tangible product which can also be available online in the real world. Work conducted in this field can be learnt and arranged methodically. Lexicography has its own history about pioneers in the field, knowledge obtained from the practice as well as historically developed resources.

Therefore, from these conclusions the study supports Tarp (2008; 2012) who contends that developing dictionaries is not an art but a science because the study of lexicography requires planning, production, design and then only can it be used. It is also found on models, categories, systems, and hypotheses that are tested. It includes the history of dictionaries and how they came to be, including pre-theoretical concepts. It also comprises fundamental principles as well as original contributions to technique. The two subdisciplines of this science are discussed below. Further, the study considers a type of lexicography called pedagogical lexicography, reflects on dictionaries as products of lexicographic practices and also considers the copyright element of dictionary production.

2.6.1 Metalexicography

The original work in lexicography was conducted without research in the field, which means the act of practical lexicography, through the creation of word lists, preceded the development of principles and procedures for dictionary development and the establishment of the scientific discipline of lexicography. Word lists employed in this discipline are studied on the basis of linguistic principles which were established prior to the existence of lexicography as a scientific field (Hüllen, 1999; Gouws, 2020).

According to Wiegand (1984), lexicography necessitates more than just applying linguistic theories because the study requires not only language knowledge but also expertise in the science of developing dictionaries. Supporting this opinion is Tarp (2000) who states that a technical dictionary would be better written by a person trained in that field with the assistance of a linguist rather than a linguist with the assistance of an expert, and further emphasised the importance of training lexicographers rather than handing over the task of dictionary making to subject field experts. This shows the importance of acquiring knowledge of dictionary development principles.

The independence of lexicography from linguistics has been attested to by Piotrowski (1994) and Burkhanov (1997), among others, arguing that it is not considered a sub-discipline of linguistics or applied lexicology anymore, because it employs different methods to linguistics. Bergenholtz and Gouws (2012) concur stating that, the era in which dictionaries were solely discussed by linguists and their linguistic content were the only things that were of interest is long past. Although they acknowledge that some dictionaries' linguistic content will always be a key component, it's also crucial to understand that many lexicography-related practices and theoretical debates transcend the study of language.

Undoubtedly, metalexicography has grown over the years and its relation to technical fields and linguistics has been established (Nkomo, 2009), and given that dictionaries were born before the development of metalexicography, it can be deduced that the aim of developing lexicographic theories was to rid lexicography of inappropriate and hastened lexicographic practices by providing theoretical knowledge for planning and compiling dictionaries. The goal of metalexicography is to improve the dictionary-making process so that it finally results in a lexicon that meets users' needs rather than just lexicographers' aspirations. By considering the contents and examining the processes used to create dictionaries, theoretical models have been produced, such as Wiegand's General Theory of Lexicography (1984) and Nkomo's Theoretical Model for LSP Lexicography in Ndebele (2008). This was followed by a focus on the identification and discussion of dictionary structures by Wiegand (1983), among other scholars (Gouws, 2017).

Metalexicographic practices contributed to the current position of lexicographic resources which are produced through practical lexicography. The study of lexicography in African

languages which examined resources that had been developed in indigenous South African languages found that lexicographic theories had not been employed in their development as they had been formed based on translation knowledge and not lexicography. Resources referred to are dictionaries developed by the Department of Sports, Arts and Culture (DSAC) which were multilingual resources in the twelve (12) official languages of the country. Another notable issue in African languages was the agglutinative structure of these languages which demanded a detailed examination of dictionaries in those languages and clear procedures to be made for future developments of new resources. Thus, metalexicography does not only provide historical knowledge about dictionaries but it sets a foundation for planning, designing and developing functioning dictionaries (De Schryver, 2008; Nkomo, 2008).

The current study considers theories derived from metalexicography and develops a new resource which is a domain specific dictionary. A theory from linguistics and lexicography were employed in this dictionary development because the study begins by analysing terminology through linguistics and then develops a dictionary by means of a lexicographic theory. This dictionary development contributes to practical lexicography which is discussed below.

2.6.2 Practical lexicography

As already indicated, practical lexicography refers to the development of a dictionary and the holistic planning and compilation of concrete dictionaries (Bergenholtz & Gouws, 2012). This subdiscipline is the entire work involved in the preparation, planning, data collection, researching and drafting of a dictionary by a professional in the field. The current study takes into account the creation of dictionaries with a pedagogical lexicography—a form of specialised lexicography that is designed to serve learners—as the primary focus.

According to Tarp (2008), a pedagogical dictionary – which is sometimes called a learner's dictionary, didactic dictionary, or school dictionary – is a dictionary created to satisfy the lexicography requirements of learners in relation to foreign-language learning. South African dictionaries exclude specialised terminology such as subject-specific terms that could benefit learners (Gouws & Prinsloo, 2012), and current dictionaries lack sufficient information because the lexicographic process has at times been mistaken for a mere translation exercise, excluding ontological issues of terminography and lexicography (Nkomo, 2019). Therefore, the current study addressed this problem by offering a resource that will meet learners' demands by putting

lexicography theories to use. Thus, a quick overview of the evolution of practical lexicography in the contexts of the world, Africa, and South Africa is provided below.

2.6.2.1 Practical lexicography in the global context

Practical lexicography in the global context can be traced back to the language of Sumerian from Southern Mesopotamia in the Middle East. The practice also began in the later years in other parts of the world such as China where it can be traced back to the *Dictionary of Er Ya* or the *Dictionary of Erya* which is known as the first dictionary of the world. In Europe the practice emanated from Greek glossaries which were the earliest works used to explain difficult words in literature to help religious leaders in the 8th century BC. A similar pattern was found in India 1000 years ago where difficult words were written and explained to help people understand Buddhist scriptures of Veda and this is considered as the genesis of dictionaries in that country (Gao, 2010).

The first act of practical lexicography in English was the development of *A Table Alphabetical* by Robert Cawdrey in 1604 which had around 3000 words. This resource was followed by the work of Samuel Johnson in 1746 and 1747 in *A Dictionary of the English Language* also published as the *Johnson's Dictionary* extended the headword count to 43500. A *Noah Webster's Dictionary of Americanism* was developed by Noah Webster in the early 19th century where variations of the English language were acknowledged. Many more dictionaries have been developed by various publishers in English-speaking countries. These dictionaries have developed into various types such as dictionaries for general purposes for example *Paperback Oxford English Dictionary* by Oxford University Press (2001) and subject-specific dictionaries, for example, the *Advanced Dictionary of Mathematics Formulas* by Rajesh Thakur Kumar (2021).

The conception of dictionary development in the 1700s began as monolingual exercises; however, with the interest in attracting foreigners in dictionary-related work lexicographers developed resources for a mixed-language readership. Subsequently, bilingual dictionaries were developed in the 1930s to cater for foreign learners which was the *English Vocabulary for Foreign Students* compiled by Simeon Potter in 1930. The resource was, however, not without strange features as it provided lemmata explanations for German native language of users to assist users but lacked sufficient information to help users who were French natives which made the resource not as beneficial as intended. A useful feature of this resource were

sentences and phrases because they had equivalent pairs in target languages thus helping users learn how to articulate themselves between these languages. More user-friendly dictionaries were developed such as *The New Method English Dictionary* by Michael West and J. G. Endicott (1935), *A Grammar of English Words* by H. E. Palmer (1938), *A Beginner's English–Japanese Dictionary* in 1940 by Hornby and a Japanese colleague. The former resource by West and Endicott was a learner dictionary with 24000 words and a vocabulary of 1490 words created with the intention of catering for learner needs, in developing reading skills in English, while the latter was developed as translation exercise to help Japanese learners learn English. As much as Hornby did not believe in teaching English in any other medium than the language, bilingual teaching of the language proved to be necessary and worthwhile through the development of bilingualised resources. Later generations of teachers and researchers accepted the usage of multilingual dictionaries conceding that it helped in clarifying meaning (Cowie, 2008).

As bilingual learner dictionaries gained momentum, Shcherba (1940) cautioned against the use of such resources arguing that their lack of definitions did not prove them to be sufficient lexicographic resources for learners. There is a need for the addition of semantic elements in resource for learners to fully grasp the meaning of words. But both within and outside of the classroom, bilingual dictionaries played a significant role in teaching world history. They helped with trade and assisted in communication among speakers of different languages (Tarp, 2004; Cowie, 2008).

Lexicographic practices led to the development of subject-specific dictionaries. This too came with notable challenges pertaining to the extraction of meanings which were identified as being caused by inconsistencies in definitions and embedded definitions. Proposed solutions were that lexicographers should provide semantic labels to add to the users' knowledge about the lemma, consider the function of lexical entries when providing definitions, and advocate for consistent and complete definitions in lexicographic resources. Along with emphasising the function of dictionaries, it was emphasised that while designing a learners' dictionary for specific objectives, the demands of the user should come first. In order to make the role of the dictionary more evident, lexicographers are responsible for determining the needs and reference abilities of the target users (Barrios, De Cea & Ramos, 2009; Gouws, 2010).

Bergenholtz (2012) studied concepts for multifunctional accounting dictionaries and analysed three databases with six polyfunctional dictionaries for English-Danish/Danish-English between 2002 to 2009, in electronic versions and printed versions. During the development of these dictionaries, national and international accounting laws were taken into consideration and terms were given one equivalent for each meaning and other equivalents were listed as synonyms. The following major communicative functions of text transmission and text reception were performed by these dictionaries: making them multifunctional; understanding accounting terminology is a supplementary cognitive process; main purpose for communicating and a secondary purpose for receiving text for the terms being translated; text creation and accounting terminology comprehension; and information on spelling, grammar, or vocabulary.

The current study developed a Life Sciences dictionary in an African language. This is a subject-specific learner dictionary that does not exist in an African language. The development of this resource demonstrates that the development of *A Beginner's English–Japanese Dictionary* in 1940 and the development of subject-specific lexicography paved a way for not only the translation of dictionary knowledge from one resource into another language but the potential for employing a single resource to teach knowledge from one language to another. The translation of subject-specific data into various languages helps learners attain more from using the resource than they would have, had they used a monolingual resource in a secondary language. IsiZulu, as a developing language, is in the current study on the receiving end of translation of scientific knowledge from the English language which is a major contribution to pedagogical lexicography in the African context.

2.6.2.2 Practical lexicography in an African context

Dictionary development in Africa was introduced in the form of bilingual dictionaries by missionaries and colonial administrators. This can be seen in the development of most Kenyan lexicographic resources, as an example, and most of these resources were word lists and grammar supplements to help the drafters communicate with local residents. In Kenya, English was the official language which meant little attention was paid to developing indigenous languages. Foreigners contributed the most to dictionary development because even the most comprehensive dictionary in Kenya, the *Kikuyu-English Dictionary,* was compiled by T.G. Benson in 1964 who was authorised by authorities from London to edit the Kikuyu dictionary. However, in their neighbouring country Tanzania, Swahili – an indigenous language developed

lexicographic resources in the language and Kenya and other countries in East Africa, benefited from developments from Tanzania. Swahili had a few monolingual dictionaries and many bilingual ones because of colonisers and foreigners who had interest in East Africa. It was only in the 1990s that interest in lexicography began among Kenyans (Mageria, 1996).

Mavoungou and Assam (2000) studied lexicography in Gabon where they found that little attention had been given to the field of study. Indigenous languages had been undermined, and French was the language for government, education, and the media. It was only in 1994 that the government promulgated intentions to promote indigenous languages, and recommendations to include them in the education systems were made (although there were no policies to that effect). The government also planned on intellectualising the languages through the production of education material which would enable them to be used as a medium of education.

The situation of Hausa, a language spoken in West Africa, is totally different from that of Kenya in that indigenous speakers are involved in the development of their dictionaries, with inference being drawn from work of foreigners too. Dictionaries in this language are focused on reference work which is for scholars; specialised works which are domain-specific glossaries and vocabulary; pedagogical works aimed at learners in the form of monolingual, bilingual and trilingual dictionaries for daily communicative use; and terminological work which focuses on enhancing the development of the language (Newman & Newman, 2001).

Osunade, Dawoda and Phillips (2015) discussed the development of a Yoruba language dictionary even though Nigerians are moving away from their indigenous languages. Their objective was to create a dictionary that will encourage the use of African languages through digital tools. They envisaged that the dictionary would promote African skills and knowledge and employed a two-phased approach which was the preparation of the database and the creation of the digital lexical resource.

The African continent has also seen lexicographic and terminological developments studies that focused on the future of printed dictionaries, given the potential threat of online dictionaries. To this end, Nkomo (2019) discusses challenges in African lexicography with regard to the scarceness of language resources and approaches employed during the

development of lexicographical resources, while theoretical lexicography could help to resolve issues and result in the production of better dictionaries.

> Situating specialized lexicography in African languages within a broader historical context of African lexicography enables an appreciation of the vital role that specialized dictionaries could play in solving communication and cognitive problems facing African societies and the challenges confronting this branch of lexicography. (Nkomo, 2019:98-99)

Domain-specific lexicography in African languages can contribute to terminological challenges faced by learners and teachers alike for communication and the understanding of subject content. In the same vein, the study noted a gap in subject-specific lexicography and hereby contributes by introducing a new resource that will promote the use of African languages in highly ranked educational institutions and subjects, as compared to conducting yet another research on dictionaries for general use that have been studied by many researchers.

Lexicographic practices on the African continent indicate much historical dependency of foreigners for resources as it was only in the 1990s that Africans began to show an interest in developing resources in their mother tongue. Still, most resources developed are not monolingual which is a further reflection of the slow attainment of independency of African languages in lexicographic practices. The main cause of the lack of autonomy is that indigenous Africans are distancing themselves from their mother tongue and moving towards English not only in educational settings but even in communication outside of the classroom. The African context situation directly relates to the South African language of education dilemma which the current study responds to by developing a pedagogical lexicographic resource in an African language.

2.6.2.3 Practical lexicography in the South African context

Linguistic developments in South Africa, already mentioned in this chapter, did not only contribute to the dream of providing and receiving education in previously marginalised languages but it also contributed to lexicographic developments. Dictionaries had to be developed for the standardised languages which required new professional lexicographers to enter the lexicographic space. National Lexicography Units were developed by DSAC for each official language. This led to much interest in principles and acceptable practices in

lexicography among academics, freelance lexicographers and publishers as new dictionaries were to be developed (Mongwe, 2006; Gouws & Prinsloo, 2012).

Atkins (1996) observed that speakers of previously marginalised languages did not have access to comprehensive dictionaries at the same level as those written in European languages. Dictionaries in indigenous African languages did not have a good structure which necessitated the urgency of forming lexicographic units that would develop dictionaries to be aligned with recognised and established lexicographic practices. In the same vein, dictionaries for special purposes were developed by DSAC which was also assigned the task of terminology development which resulted in publishing these resources in the twelve (12) official languages. These dictionaries were followed by the work of the isiXhosa Lexicography Unit which has developed *Isichazi-magama seMathematika neNzululwazi*, an isiXhosa Mathematics and Science dictionary for primary school learners. The interest in developing subject-specific lexicographic resources was also for commercial dictionaries, and ultimately, universities also developed scientific terminology in line with their language policies implemented in their institutions (Atkins, 1996; Cowie, 2009; Nkomo, 2019).

Charamba (2017) developed a physical science dictionary, as part of a study research, founded in the Curriculum and Assessment Policy Statement (CAPS) for Grade 11 to help learners better understand the subject. The dictionary was meant to serve two functions, which were to enhance how learners understood subject content, and language teaching. To this end, Charamba (2017), with the help of multilinguals, translated key physical sciences concepts from English to Southern Sesotho on the topic of mechanics, which was prescribed in the CAPS document. The findings were that the language of teaching had an impact on learners' academic achievement.

It became clear that more tools needed to be created to support learners who are being taught in a foreign language rather than their native tongue. Undoubtedly, the aforementioned study contributed to the intellectualisation of Southern Sesotho, subsequently contributing to better knowledge acquisition by learners through a practical lexicographic practice. Without a lexicographic resource in their language, learners must master decontextualised language which is often challenging because of limited language capabilities. The language gap should be closed by creating language activities that are appropriate for scientific subjects, according to Charamba (2017), who also argues that learning environments should be organised around

language development and take learners' native languages into account when teaching them scientific subjects.

Historical traits of dictionaries and continuing development of the same demonstrate the importance and necessity of this scientific study. The increase in the number of headwords recorded in resources is another example of how lexicography has grown and become a vibrant science in its own right. By creating a subject-specific lexicon in a nation overrun by the hegemony of English, the current research expands our knowledge of the formation of dictionaries. In the same vein, English makes up a big part of bilingual dictionaries and multilingual dictionaries in indigenous languages and other world languages. In the current study, learners are taught in English, therefore, the terminology and educational resources that they have are written in English. Subsequently, the dictionary developed in this study is bilingual with English as a source language and isiZulu as a target language. The dictionary is focused on isiZulu mother-tongue learners and is developed with an understanding of practical lexicographic exercises that have taken place in the language.

2.6.2.4 Practical lexicography in an isiZulu

According to Fernandes (2019), the first substantial *Zulu-English / English-Zulu dictionary* was published by James Perrin in 1855 and edited by Reverend John William Colenso who was a bishop of the Anglican Church. This dictionary is believed to have been founded on the work compiled by American missionaries. However, Nkabinde (1999) identified the *Zulu/Kaffir Dictionary* by J.L. Döhne as the first publication in the practice of isiZulu lexicography. The former dictionary took 20 years to develop as the lexicographer faced linguistic and referential challenges given that he was not a native speaker of the language (Döhne, 1857).

Döhne's bilingual dictionary is very detailed as it firstly introduces the experiences of the lexicographer and provides information about the language as a foundation to the lexicographic work. The dictionary itself has isiZulu lemmata and English definitions and etymological explanations are structured alphabetically according to the roots of words supported by prefixes.

The next dictionary contribution to the language was the *Zulu/English Dictionary* by Reverend J.W. Colenso in 1861 and had 548 pages of entries. This lexicographer emphasised the purity

of isiZulu in the dictionary stating that it did not have any influence of closely related languages such as isiXhosa. He also omitted dialects within the language and words coined by missionaries from European languages. This dictionary was revised by his daughter Harriet Emily Colenso with the help of native people from the province called Natal (now KwaZulu-Natal), which resulted in a larger print of 728 pages. The revised dictionary contained names of birds and other animals. It was also inclusive of hybrid words provided by missionaries which were considered to not be purely isiZulu words and they were placed in the appendix section of the dictionary (Nkabinde, 2011; Fernandes, 2019).

The researcher discovered the third published dictionary according to years of publication to be *An English-Zulu Dictionary* by Reverend Charles Roberts in 1895 which explained the principles of pronunciation and classification of isiZulu words. This dictionary which was born from the acknowledgement that Perrin's small but commendable dictionary (1855), in the language, was not sufficient (Roberts, 1895). Subsequently, this dictionary provides an explanation about the orthography (of that time) and accentuation of isiZulu words; table of nouns; verbs; and which is then followed by the wordlist which has English lemmata with isiZulu equivalents.

In the same vein, Nkabinde (2011) and Fernandes (2019) agree that the third lexicographic work was produced by Alfred Thomas Bryant in 1905 who was a British Roman Catholic secular priest. This bilingual dictionary (*Zulu-English Dictionary*) comprised of approximately 22 000 lemmata and Zulu history, comparative philology and grammar. It also included the *hlonipha* language of Zulu women and an appendix with additional words, and lexical changes. His arrangement of the wordlist was advance in that he included pronunciations, arranged words according to the stem, and included verbal derivatives.

This is not exhaustive of practical lexicography in isiZulu as dictionaries have been enhanced over the years with an addition from bilingual dictionaries to monolingual, multilingual, as well as the classification according to grades for younger users in publications such as the *Picture dictionary: English-IsiZulu. Gr R-3* which the official English-IsiZulu foundation phase CAPS-linked illustrated dictionary of the Government of the Republic of South Africa by M.O. Mbatha (2006), among others. There are various dictionaries available in isiZulu as monolingual and bilingual resources, and the development of the Life Sciences dictionary in

this study is a contribution to these resources and a promotion of practical lexicography in the language.

Thus, the current study in conducting a practical lexicographic exercise considered multidisciplinary knowledge from metalexicography and practical lexicography. The researcher considered theoretical information that contributed to the creation of a novel dictionary and also learnt from the structure of isiZulu dictionaries in order to create a resource that will be aligned with set lexicographic principles and contribute to practical lexicography in isiZulu. Given that the novel resource developed in the study is intended for learners as users of the resource, pedagogical lexicography is considered extensively.

2.6.3 Dictionaries

An alphabetical list of terms with definitions or a function that provides spelling, meaning, and parts of speech can be used to explain what a dictionary is. Bergenholtz (2012) provides a detailed definition of a dictionary cited below:

> 1. Lexicographic reference work containing dictionary articles related to individual topics or elements of language, and possibly several outer texts as well, which can be consulted if someone needs assistance with text reception, text production or translation or would simply like to know more about a word, part of a word or a combination of words.
> 2. Lexicographic reference work consisting of several dictionaries, each of which corresponds to the definition of an individual dictionary, i.e. a reference work containing dictionary articles related to individual topics or elements of language, and possibly several outer texts as well, which can be consulted if someone needs assistance with text reception, text production or translation or would simply like to know more about a word, part of a word or a combination of words. (Bergenholtz, 2012:30)

A dictionary is described as a reference book containing words, phrases or glossaries based on a topic, depending on the type of dictionary, that has linguistic elements about that word, phrase or glossary. It also has information outside of the lexicography parameters that a user can engage with to facilitate communication or translation purposes or even when they merely want to gain more insight on the researched item or items. Dictionaries vary according to different types. For example, there are dictionaries about maps where one will find information about

maps and not about technology as that would be in a technology dictionary. Some information can be available in specific dictionaries and also in dictionaries for general use, therefore, when dictionaries are compiled, authors have to ensure that they provide data relevant to the type of dictionary and the same can be said about users because they have to select a dictionary according to the function, they hope to achieve through dictionary use. Dictionaries do not only vary according to topics but they differ even in terms of the target age group, therefore, a dictionary for preschool learners will have information relevant and readable among people of that age.

Words recorded in dictionaries as main words to be searched are called headwords or lemmata and dictionaries can be monolingual, bilingual or multilingual. A typical monolingual dictionary provides a lemma with its part of speech, pronunciation, definitions, and an example of how it is used. More comprehensive dictionaries include etymological information, illustrative quotations, and dialectal information. In the same vein, dictionaries are classified according to categories such as encyclopaedic dictionaries which are dictionaries that define lemmata and further provide extralinguistic information about them focusing mostly on information about the lemma. Other dictionaries are linguistic dictionaries dedicated to linguistic matters of the lemmata. Thus, there are various types of dictionaries created to accommodate various purposes as users have become an important driver of the types of dictionaries produced. (Zgusta, 1971; Bergenholtz & Gouws, 2012)

The list of dictionary types is of a great length; however, this study only considers the ones aligned with the current study which are general purposes dictionaries, pedagogical dictionaries, specialised dictionaries and bilingualised dictionaries. These dictionary types are examined for various purposes. Most isiZulu dictionaries are bilingual general purposes dictionaries; therefore, the study examines the structure of these resources to learn from them and establish a structure for the new learner dictionary comprising of domain-specific data. For this reason, these dictionary types helped the study develop a resource that will satisfy the function of a research dictionary that will expand the lexicographic functions of isiZulu dictionaries and enable them to help learners find a tool that will make learning Life Sciences less challenging linguistically. The study further examines the dictionary structure and the dictionary format as this knowledge assisted the research in determining a structure for the novel dictionary.

2.6.3.1 General-purposes dictionaries

General purposes dictionaries contain general information about lemmata from various spheres of life as determined by target users who can be anyone in the family due to their nature of being resources for learning. The function of these resources is to preserve words for future generations to avoid their extinction and for referential purposes. These resources can be monolingual, bilingual, multilingual or even pictorial. Monolingual resources record definitions for all lemmata recorded and these are explained in a manner that is simple to understand and when creating definitions, the word being defined, should not be part of the definition or the word being described while bilingual and multilingual dictionaries often contain equivalents of headwords in another language (Nkomo, 2008).

An example of a general purposes dictionaries is the *Scholar's Zulu Dictionary* by Dent and Nyembezi (2009) which was one of the resources examined in this study. This resource is bilingual comprising of English and isiZulu. Data categories found in this resource are the lemmata, grammatical information (part of speech), equivalent or description and sometimes examples of usage. In the same vein, Singh (1982) holds that a dictionary has the following features: lemma, spelling and pronunciation, grammatical data, meaning, illustrative examples, phrases and idioms, etymology, synonyms and antonyms. Considering that the presence of these elements in the general dictionaries and the dictionary by Dent and Nyembezi, not much has changed in the structure of dictionaries since the 19th century and all countries depend on them for general linguistic information (Béjoint, 2016).

2.6.3.2 Pedagogical dictionaries

Assam (2006) describes these dictionaries by dividing them into school dictionaries and learner dictionaries. A school dictionary is meant to fulfil a need for learners; therefore, it has a simple macrostructure and limited categories of a microstructure. The definitions provided in these dictionaries should be at the level of comprehension of the users which means simple language and illustrative examples should be provided. As there are different age and class groups of children at school, the target users should also be determined according to age or grade of users and be constructed to be comprehensible and useful to target users. A learner dictionary is also regarded as a resource for people who want to learn a foreign language. These dictionaries should not be developed under the assumption that users will know certain words already, but

its content should be simple enough for the user to not struggle to understand; therefore, the number of entries is restricted and more glossary and explanatory notes are added.

The distinction between the types of pedagogical learner dictionaries is important because it determines the content and the handling thereof during the dictionary construction as target users of these resources are not the same. The goal of the current study is to create a learner dictionary for learners in Grade 10 to Grade12. This dictionary for learners, limits data categories to those necessary for the age group of learners and provides semantic information that satisfies the function of the resource. The learner dictionary developed in this study is a record of lemmata and semantic information that help learners in their terminology-related challenges.

2.6.3.3 Specialised dictionaries

These dictionaries have specific terminology for a specific domain field of study which may be at different levels dependent on the target users of the product. For example, a mathematics dictionary, dictionary of slang, dictionary of synonyms, phraseological dictionaries and so forth. There are several projects at universities where these dictionaries are being developed for learners as target users. The DSAC produced several resources of this type for primary school learners focusing on subjects such as the *Multilingual Natural Sciences & Technology Term Lists* for English, Afrikaans, IsiZulu, IsiXhosa, Siswati and IsiNdebele from the Department of Arts, Culture Science and Technology (2013) which were analysed in this study (Sibula, 2007; Nkomo & Madiba, 2011; Khumalo, 2017).

The learner dictionary developed in the current study is a specialised resource based on the field of Life Sciences. The glossary of prescribed textbooks in the field lists terms and provides definitions at the back of the book. The researcher opines that the glossary is insufficient as learners are not English mother-tongue speakers and may face linguistic challenges and be unable to understand the content. Thus, a specialised dictionary in isiZulu is created for not only the contextual needs of Life Sciences learners but also for their linguistic needs.

2.6.3.4 Bilingualised dictionaries

Bilingual dictionaries are lexicographic resources developed for foreign language speakers. A bilingualised dictionary provides entries in a foreign language, defines them in the same

language and further provides a translation of these entries in the language of target users. Sometimes only the definition is translated because the intention is to assist the user to learn the meaning of the entry clearer in a language, they understand better. Users of bilingualised dictionaries perform better than users of monolingual and bilingual dictionaries because the data are explained in the first language of the users even though the term being defined is of a foreign language because a bilingualised dictionary is a combination of monolingual and bilingual dictionary data (Corrius and Pujol, 2010:121). (Laufer, 1995; Laufer & Kimmel, 1997; Humblé, 2001).

Subsequently, the dictionary developed in this study is a bilingualised dictionary because target users learn in English while their home language is isiZulu, and this type of dictionary will clarify the terms, they are learning in English, in their home language. This dictionary is a bilingualised domain specific learner dictionary as a combination of these three classifications of dictionaries are necessary to produce a novel resource that will fulfil the function of the dictionary. English-isiZulu bilingual dictionaries are general dictionaries, subject-specific dictionaries created by DSAC that caters for primary school learners; therefore, high school learners are left without a resource they can use with content in their mother tongue even if it is just the provision of equivalences as the department's dictionaries. Therefore, this resource is an innovation that will provide users with translations of not just the lemmata but definitions too and also provide additional data in isiZulu.

De Schyver (2005) edited the *Oxford Bilingual School Dictionary: IsiZulu & English* which is a dictionary for general purposes with bilingualised structure. This resource provides lemmata, equivalents and examples of usage in English and isiZulu for all lemmata which was a new structure in isiZulu dictionaries. The difference in the dictionary developed in the current study lies in the target users and the speciality of the resource as it is domain specific.

2.6.3.5 Dictionary structure

The structure of lexicographic resources shapes and organises dictionaries in a manner suitable for each function of a dictionary. When users consult lexical resources, they can either be searching for meaning of words they already know or be searching for words they can use to complete sentences. The current study focuses on the structure of dictionaries being consulted for words already known with the intention of engaging the microstructure of the resource.

Learners, as users of the study dictionary, are already faced with words that they may seek clarity in given that the lemmata are part of the curriculum and employ dictionaries to extend what they are being taught. Definitions of components of the megastructure of dictionaries as explained by Gouws and Prinsloo (1998); Nkomo (2008); Nielsen (2009); and Brangel (2015) are as follows:

- **Megastructure:** The wordlist and dictionary's contents in relation to the dictionary's outer portion.
- **Outside matter:** A section of the dictionary, usually referred to as the outer text, is made up of the dictionary's front, middle, and rear contents.
- **Front matter:** The introductory information about the dictionary and its contents which is found on the left side of the main body and its features.
- **Main body:** The macro and microstructure of the dictionary, which will be discussed in the following section, are made up of this wordlist, which serves as the dictionary's primary body.
- **Middle matter:** The dictionary content that is in the middle of the dictionary but is not part of the lemmata and its features such as explanations of information relate to the language of the resource.
- **Back matter:** The contents of the dictionary on the right side of the main body and its features which is the last information entered in the dictionary.
- **Macrostructure:** The arrangement of the wordlist of a dictionary in relation to how lemmata are arranged which can be according to the alphabet or themes.
- **Microstructure:** The data entered after the lemmata in the dictionary such as part of speech, pronunciation or meaning.

Components of the dictionaries provide a formulated structure that make dictionaries more accessible. The outside matter provides insight about the resource and the language or subject of the resource as aligned with the function and type of dictionary. The main body provides information that makes the dictionary a reliable resource to find information. This study examined dictionaries to learn from the components of their structures. In the same vein, the resource developed in this study comprises of all components save for the middle structure as there were no data that required clarification in the middle of the resource. However, the rest of the components are found as the front matter and provides explanatory information about the new resource and the new type of resource. This dictionary is unique and adds to the body

of knowledge and lexicographic resources in the language. The main body provides information that is the main context of the resource which will assist users with terminological challenges in the subject of Life Sciences.

2.6.3.6 Dictionary format

Lexicographic resources are commercial products which could be in the form of "dictionaries (computer-based or not), computer games, automatic hyphenation, spellchecking, writing aid, computer-aided learning, computer-aided translation, etc." (Gellerstam, 1995:59). Fuertes-Olivera (2009) holds that printed and online dictionaries are valuable tools for the users' language requirements because they provide useful language tools that cater for various user requirements. However, isiZulu dictionaries have been found to be problematic due to the structure of the language which is agglutinative in nature; which led to various lemmatisation approaches which have been found to be still lacking and not user-friendly in the printed form as compared to electronic dictionaries (De Schryver & Wilkes, 2008).

Granger and Paquot (2012), describes electronic lexicography as a general phrase used to describe the design, usage and application of electronic dictionaries which are the collection of structured electronic data that provide information about words, their meanings and usage in one or more language. The usage of digital lexicographic resources are no longer new and most new lexicographic resources are in digital format which are structured in various forms, including by arranging lemmata according to semantic relations (Stanković, Stijović, Krstev & Sabo, 2018). However, this does not mean print dictionaries are any less important – although they have been found to be limited in terms of space. By comparison, digital lexicographic resources can provide more data due to the availability of space, subsequently providing room for terminology revision (Mészáros & Kiss, 2018). The dictionary developed an electronic version because the target users are from a generation that is much interested in technological developments.

Rohmatillah (2016) provides formats of dictionaries which are as follows:

Table 2.1: Types of dictionaries

Form	Description

Printed Dictionary	This is a dictionary that has been printed onto paper and can be of varying sizes, from pocket-size to a large multi-volume printed book.
Handheld electronic dictionary	A small keyboard, speech recognition software, or a scanning device can be used to input data into this device, which can then read printed text. It then displays the necessary information about the word on the screen or via a voice-activated output.
Dictionary programs	These apps are pieces of computer software that choose which words should be typed and translated on a screen.
Online dictionaries	These dictionaries are found on the computer web which are easy to search since they are similar to dictionary programs.
Visual dictionaries	These dictionaries come in a printed form and rely on illustrations that enable the user to identify correct translation of data.

The current study examined published dictionaries which are available in print form, and electronic form as e-books which according to the table above is an online dictionary. The print format of dictionaries has been the norm since the beginning of lexicography; however, electronic forms vary and are still relatively common. Thus, Leaf (2003:9) describes an e-book as "an online version of printed books accessed via the internet". Further, Vassiliou and Rowley define an e-book as cited below:

> (1) An e-book is a digital object with textual and/or other content, which arises as a result of integrating the familiar concept of a book with features that can be provided in an electronic environment.
>
> (2) E-books, typically have in-use features such search and cross-reference functions, hypertext links, bookmarks, annotations, highlights, multimedia objects and interactive tools. (Vassiliou & Rowley, 2008:363)

2.6.4 Copyright in the making of dictionaries

A novel dictionary wasdeveloped in the current study and as it was subject specific, the study had to consult various resources to find terminology equivalents. These equivalents were adopted from other dictionaries as dictionaries are resources considered to be copyrightable because lemmata have to be used in their original form (Alberts & Jooste, 1998). However, the researcher recorded each source used to gather terminology equivalents as an acknowledgement of the work of the original author (lexicographers).

A copyright is an exclusive right for a creator or creators of products to commit any act or to reproduce their product. Magalla (2015:1) explains copyright as an "exclusive right granted by law to the author of a work to disclose it as his own creation, to reproduce it and to distribute or disseminate it to the public in any manner or by any means and also to authorize others to use the work in specific ways." Since the first copyright legislation was passed in 1701, the main goal of this right is to protect the sole reproduction ownership of the creator of the work (Joyce, Laeffer, Jaszi & Ochao, 2016). This could apply to books, music, dictionaries, buildings, and many other classified intellectual property assets, according to South Africa's Copyright Act, No. 9 of 2002.

In discussing the issue of copyright in relation to dictionaries and terminology, Alberts and Jooste (1998) cite Trittipo (1996) who states that when facts are written and true regardless of whether they are known or not cannot be regarded as copyrightable data because they belong to the world and not the individual who displayed them to the world. Thus, copying that data will not be an act of criminality. Subsequently, words that are used by the general public which are found in dictionaries cannot be considered as copyrightable data because the dictionary author did not create them, they already existed in the world. When developing a dictionary, the lexicographer needs to make reference from reliable sources which ultimately leads to incorporating terms and their meanings in a new resource that could have already existed in another source. To this end, Alberts and Jooste (1998:130) state the following:

> Because terminology deals with the exact coining of concepts, these entries should not be modified to circumvent copyright ownership of the source material, since it would be unethical and terminographically wrong. Terminologists want the word-for-word rendering of standardised definitions and live contexts. It is obvious that within a specific subject field these terms, definitions and contexts are (and are supposed to be) the same. There is no way that these concepts should be allowed to be expressed differently, otherwise it would defy the whole purpose of terminology, namely that of exact and precise communication with a standardised technical vocabulary (terminology) within a specific subject field.

Terminology is not considered as copyrightable because the words are already out there in the world for people to use. Therefore, if a lexicographer has an entry that already exists in another

dictionary it cannot be regarded as an infringement on copyright. For instance, the study found the lemma *umuntu* (meaning person) in all isiZulu dictionaries. None of the dictionary publishers can claim copyright of the word just because their work was published earlier than other mentioned dictionaries. If an author is unable to omit a term because of its necessity in the dictionary there is no infringement; however, if they have a choice, infringement exists (Trittipo, 1996).

As the current study's aim was to develop a learner dictionary, the research had to ensure that the terms and definitions were aligned with the school curriculum and then translated into isiZulu. Where room existed for extension of meanings and supporting explanations, the study made reference to the resources employed. In support of this method, Albert and Jooste (1998:131) agree stating that:

> One may argue that the selection of terms in a subject field involves original thought in execution and is therefore protected, since selection entails the application of certain terminology skills. However, fair dealing would allow a terminologist to use these terms as well as their definitions to a large extent. The concept and its expression in the code of language are also inseparable and it belongs to the respective discourse community, thus it cannot be copyrighted.

Subsequently, terminology and definitions from the prescribed resources by the Department of Basic Education for Life Sciences were used in the study as dictionary entries and definition sources. The internet was used to further explain the terms and each website that data were extracted from is acknowledged. All print and electronic resources employed are acknowledged in the back matter of the dictionary. The following sections provide reasons that necessitated the development of the dictionary developed in this study.

2.7 Terminology development

According to Alberts (1990:102), terminology is a "collection of terms systematically naming the coherent system of concepts of a specific subject field, discipline, domain, profession or theme". In other words, terminology refers to a group of words that have been categorised according to subject domains for a particular profession. Thus, terminology is a medium of knowledge dissemination which should not only be understood by specialists but by other terminology users too; hence, it should be documented in a user-friendly way. It can also be explained as a means of facilitating or aiding communication within a community of language

users because it is used to address social needs of people within a subject field and their subject-specific community with the intention of enhancing communication among those people (Alberts, 1999; Mabena, 2020).

Derived from the term ‘terminology’ is ‘terminology development’ which is a process referred to as terminography sometimes called language for specific purposes lexicography. Terminography refers to a process of describing existing terms, suggesting preferred lemmata, standardising them and even proposing new terminology for such lemmata. Further, it consists of a set of practices and methods employed while collecting, describing and presenting terms; the application of theory that explains relationships between terms and concepts; and the subject-specific terminology focused on (Bergenholtz & Kaufmann, 1997).

Alberts (2001) defines terminography as the process of recording terminology that focuses on a specific subject unlike general lexicography which is not restricted. A lexicographer (a person who develops dictionaries) can record various meanings of words and forms of usage whereas a terminographer (a person who develops terminology) only provides meaning related to the subject field of focus as that moment for a specific target group. This explanation is supported by Bergenholtz and Gouws (2012) who describe this form of lexicography as the development of terminology for a specific subject rather than the general explanation of terms from many fields of study through the process of general lexicography. In the same vein, Khan (2016) explains terminography as a science of describing terminology, the practical work of compiling, classifying and arrangement of sets of terms in a specified field of study through the application of scientific theory which can be founded on linguistics, pragmatics and cognition.

Definitions and descriptions given to the term ‘terminography, it stands to reason that another study for studying recorded words exists besides lexicography. Terminography is the study of how to create terminology for a specific subject field. Terminology is created to satisfy a need of a closed linguistic community comprising of people within a particular subject environment. These terms help these communities communicate better among themselves. The difference between lexicography and terminography is in the development of words because in terminography terms are created and recorded while in lexicography terms are recorded from existing terms and where no existing terms exist in a language, they are given equivalents or descriptions, in the case of a bilingual dictionary. When terms have been developed through

terminography they can be recorded in dictionaries as lemmata that have already been approved by professionals in the field.

The terminology development posture employed in South Africa has been a collaborative one between DSAC's Lexicographic Unit and the National Terminology Office. The DSAC as guided by the PanSALB Act of 1995 acted upon its duties of placing languages on par with each other and enabling them to be used in business and education through the provision of resources that will enable a multilingual society. Subsequently, DSAC has eleven Lexicographic Units concentrating on each of the official languages. These units collaborated with linguists and specialists in subject fields and produced dictionaries in all official languages for learners according to terminology development procedures (Alberts, 2003).

The DSAC differentiates between the work of terminography and lexicography. The collaboration of all units helps South Africa develop terminology that is envisaged to place its languages on par with the world and also provides a platform for subject-specific terminology to be developed in previously ignored and undermined languages. The researcher has been exposed to terminology development projects via a workshop at the University of South Africa and several other workshops at the University of KwaZulu-Natal where terms that are part of the university studies were developed in isiZulu from English terms. The University of Stellenbosch and the University of Cape Town are also highly active in developing terminology in isiXhosa. (Sibula, 2007; Nkomo & Madiba, 2011).

The University of Stellenbosch began its terminology development project as a means of assisting first-years to understand terms that were in Afrikaans and English by providing their equivalents in isiXhosa. The results of this project were 344 Sociology entries; 325 Social Work entries; 514 Psychology entries; 283 Law entries. The 1846 entries under the heading of Economics and Management Sciences included Accounting, Business Management, Economics, Industrial Psychology, Information System, People Management, Public Development Management, and Statistical Methods (Moropa, 2013).

A number of organisations focus on terminology development, including the National Language Service of DSAC, which houses the Terminology Coordination Section, a national terminology office with trained terminologists who caters to each of South Africa's official

languages and registers the terminology in the appropriate term bank; South African universities, the government, and other organisations (Albert, 2014).

The University of KwaZulu-Natal (UKZN) developed its terminology development model based on the structure of PanSALB and *Umkhandlu WesiZulu Kazwelonke* with the following five stages:

> 1) harvesting of existing usage terms; 2) description and translation of terminology that has been harvested or created; 3) consultation and verification with end-users about terminology proposed, and 4) authentication and standardization through official national structures. The "finalization" of the process in the current model takes place in 5) through the listing of these terms on the terminology databases for wider institutional and national usage. (Khumalo, 2017: 257)

The procedure employed by the University of KwaZulu-Natal involves different stages which are terminology harvesting, description and translation of harvested terminology, consultation, and verification, authentication and standardization, and finalisation. Once terms have been approved and authenticated by PanSALB bodies it is uploaded to a mobile compatible application called the *Zulu Lexicon* that contains a corpus of validated terminology in English and isiZulu.

Due to advances in terminology development, it comes as no surprise that “new technologies have, in turn, allowed for the creation of novel content types and newly-created professional translation-related roles in the course of their own development” (Doherty, 2016:962). These new developments in language studies and terminology development resultant from technological advances have had a positive impact as can be seen in the terminology dissemination model developed by the University of KwaZulu-Natal. Research conducted by this university is consistent with a study by Letsoalo (2018), who looked into changes in South African political terminology and found that they do have an impact on terminology management, terminology usage, and terminology development, especially in former marginalised languages. Therefore, the goal of the current study was to create a digital dictionary that will be easy to use for the target consumers living in the modern day (Doherty, 2016; Khumalo, 2017; Letsoalo 2018).

According to Moropa (2018), the terminology development process requires terminology developers to collect and create terms in their target language. The Pan South African Language Board (PanSALB) then verifies and authenticates the terminology, which calls for a team composed of a chairperson, coordinator, secretary, linguists, lexicographers, and members of the National Language Bodies. Similar to this, the National Lexicography Unit of PanSALB is a specialised unit that creates dictionaries and other lexicographic materials to advance the status of indigenous languages in addition to verifying terminology.

Netshiheni (2018) presented the process of terminology development in South Africa required by PanSALB. She stated that once terminology is developed by an entity it should be sent to the National Language Board for quality assessment which is made up of the following phases, namely, the verification phase; authentication phase and the final authentication phase conducted by the Terminology and Lexicography Technical Committees of the NLB.

The researcher found the UKZN model clearer in that it presents the entire process rather than starting from the quality assessment from PanSALB and applied the same in the development of terminology for the envisaged Life Sciences dictionary. Subsequently, to avoid creating another glossary list or teaching resource instead of a dictionary, as cautioned by Nkomo (2010), the current study embarked on a study of lexicography in order to develop a product that encompassed theories for the development of dictionaries. The current study is not a terminography exercise as it is not creating new terms in isiZulu, but it is a lexicography exercise, where terms that already exist in the language and field of Life Sciences, are translated into isiZulu to provide dictionary users with equivalents and descriptions in the latter language. Hence, the interest of this study is not on terminography studies but on lexicography.

The relationship between lexicography and terminology development lies in that terminology developers treat terms to equip a language that have terminology gaps, and once that word is created it can be recorded in dictionaries or other lexicographic resources. The current study, however, did not focus on terminology development and only employed translation strategies as the study was developing a resource for learners who are taught Life Sciences in English. The resource developed will help users understand the meaning of Life Sciences terminology in isiZulu. As a bilingualised dictionary, the dictionary will benefit users and teachers alike, as teachers are already code-switching between English and an African language to help learners understand subject content (Gudula, 2017).

2.8 The need for translation skills in developing user-friendly dictionaries

The development of bilingualised and bilingual dictionaries inevitably requires the application of translation strategies as required in the treatment of each dictionary entry. Translation is the rendering of information in another language so that the reader of the text in another language (hereinafter referred to as the target language) will get the same or closest message that the reader of the language that the text was written in (hereinafter called the source language) (Baker, 2011).

Issues of translatability of lemmata; lexical gaps; and equivalence in meaning are discussed by Baker (2011) and Dlamini (2021), among other scholars, and they provide strategies that can be employed when engaged in the translation process. These scholars state the importance of bringing the readers of target documents as close as possible to the original text by applying applicable forms of translation required in each case even when there is a shortage of translation equivalents in the target language.

Baker (2011) discusses the problem of non-equivalence which she describes as a situation where the target language does not have a direct equivalent for a word from the source test. She argues that non-equivalence is frequently brought on by culturally-specific concepts that must be translated into language from a different culture; instances in which the source language concept exists but has not been given a term in the target language, instances in which the source language word is semantically complex and difficult to convey in the target language; instances in which a word has multiple usage situations within it that are not present in the target language; and instances in which the target language does have a superordinate word. Remedies provided for such cases are dependent on each case of non-equivalence and are handled according to what is available in each language in relation to the expectations, background knowledge of the translator and target readers, and the situation of the translator, author, and target reader.

Inevitably, an understanding of the language and background knowledge of users are directly linked to an understanding of semantic properties and the user profile which is the foundation of lexicographic functions. This necessitates the need to have knowledge of semantic fields that source language terms come from to help translators when faced with challenges of non-equivalences in the target language. This helps in identifying words that can be associated with the term not available in the target language. In translating and developing terminology for

dictionary development purposes, knowledge of translation challenges and their remedies cannot be ignored as it will help the lexicographer produce effective dictionaries. It is for this reason that the current study considered translation skills, given that Life Sciences present a lot of foreign terms although they may not necessarily be referring to objects outside of the isiZulu language.

According to Dlamini (2021), an assessment of the translatability of the source text is paramount in guiding the translator on the translation strategy to be employed in each case. She further states that translation techniques are applied differently in language for general purpose (general language used in any situation) and language for specific purposes or technical language (language only used among people in a particular field or scientific field, and those words only carry meaning that is understood by people in that field). Understanding translation techniques required in each situation can resolve translation problems, and Vinay and Darbelnet (1995) provide procedures that can be employed as a remedy to translation problems. These procedures are presented in Table 2.2 below.

Table 2.2: Translation procedure by Vinay and Darbelnet (1995) adapted from Dlamini (2011:77)

Vinay and Darbelnet's translation procedures	
Direct translation strategy	**Oblique translation strategy**
Borrowing	Transposition
Calque	Modulation
Literal translation	Equivalence
	Adaptation

Given that the languages involved in the study are isiZulu and English and are structured differently, this method does not always work. Each of the direct translation strategies are briefly explained according to Dlamini (2021).

- Borrowing: When there is no equivalent word in the target language, the source word is changed in the target text. The word can be employed in its natural state (e.g., English: baking powder = isiZulu: baking powder) or transliterated by giving it the morphological and phonetic forms of the target language (e.g., English: cheese = isiZulu: *ushizi*).
- Calque: The use of words and phrases from the source language in the target language (e.g., English: throw in the towel = isiZulu: *phosa ithawula*).

- Literal translation: The translation of the text as it is from the source text to the target text in a logical and natural manner (e.g., English: the child wants to cry = isiZulu: *ingane ifuna ukukhala*).

Oblique translation is employed when the source and target languages are from different language families thus possessing different language structures, like isiZulu and English. Techniques applied in this method are briefly explained below according to Dlamini (2021):

- Transposition: This occurs when a word is changed from one portion of speech to another without compromising the text's meaning. For example, a wheel of a car = *isondo lemoto*. The words of a car are made up of a preposition + article + noun and the translation of the same to isiZulu as *lemoto* which is a possessive which incorporates the English preposition.
- Modulation: The change of the target text forms in a manner that makes it hard to trace from the source text literally. For example, good night = *ulale kahle* which means sleep well.
- Equivalence: This is using different words to describe the same thing in another language. For example, bye = *usale kahle*.
- Adaptation: In this case, the translator substitutes a situation that can convey the same idea in the target language even though it does not exist in the culture of the target language. For example, *isangoma* = diviner.

These examples demonstrate the different methods applied in the translation process. As this study created a bilingual resource, there was a need for the application of appropriate translation methods as required by the terms to be recorded as lemmata in the resource. These examples are presented in this chapter for explanatory purposes and in Chapter 6, the methods applied in translating terms will be presented. As explained in this subsection, translation methods are determined by the text being translated; therefore, instances of non-equivalence were handled as directed by Baker (2011), and text-specific methods were applied in translation of each text, as explained by Dlamini (2021).

2.9 Rationale of study: The isiZulu Life Sciences Dictionary

This study developed a novel dictionary that will enable learners to have a subject-specific lexicographic resource in their mother tongue, and was created with the learner as the starting point of dictionary development. There is a shortage of pedagogical lexicographic resources in South Africa, and scholars have argued for the development and promotion of pedagogical

lexicographic resources to assist learners in their language and learning situation (Diko, 2018; Gudula, 2017; Tarp, 2008; Gouws & Prinsloo, 2012; Mohohlwane, 2020). Subsequently, this study provides a dictionary, for the subject of Life Sciences, that is bilingualised targeting learners in Grade 10 and 12 who are isiZulu mother-tongue speakers. Bilingual dictionaries were developed by missionaries in the past to help missionaries understand African languages (Fernandes, 2019). This study developed a Life Sciences dictionary as this is one of the subjects with terminology that is not easy for learners to comprehend. Therefore, a language resource was produced to elevate their language challenges, in a similar manner that was employed by missionaries that resulted in the development of dictionaries in African languages.

This study developed a resource that differs from existing dictionaries because it considers the two-fold challenge faced by learners of not only the necessity of understanding the English language but also the challenge of understanding the jargon of Life Sciences as an academic field. Published dictionaries in isiZulu are mostly general language dictionaries, which only assists learners seeking scientific information to find equivalents and meanings of words in general languages instead of field specific usage. Therefore, field specific dictionaries are much needed in African languages.

Language resources focusing on subject specific terms are terminology lists produced by DSAC and public universities. These resources do not provide definitions for the terms in indigenous languages which means that resource users have to consult English resources to find meaning of the terms. This is a gap in African lexicographic products which the current study bridges through the development of a resource that has subject-specific terms translated into isiZulu with their definitions due to the hegemony of English and its controversial position as a language of education. Subsequently, the dictionary developed has English as the source language of the terms and isiZulu as the target language. Most bilingual dictionaries only have the lemma and its equivalent without definitions. Laufer (1995) introduced a bilingual dictionary, called a bilingualised dictionary, that would place the user as close as possible to having a similar user experience as a user of a monolingual dictionary by providing a dictionary with definitions of lemmata in the target language. This study adopted the structure of bilingualised dictionaries which has not been done before in isiZulu dictionaries. Subsequently, this dictionary has dictionary data presented equally in both languages, providing lemmata and definitions in both languages.

Further, the study did not want to create a resource that will not have information contained in prescribed material for learners. The study foresees learners encountering English terms in their prescribed material and consulting the new dictionary in order to understand those terms in their mother tongue. The source data were translated skilfully and with the application of appropriate translation methods for target users resulting in user-friendly dictionaries. Additionally, this dictionary will be available as an e-book in a freely downloadable from www.smashwords.com and usable offline once downloaded, thus enabling access to all learners with mobile devices. Currently, published dictionaries are available in printable form, therefore, a dictionary in this format is not only new in the language but will also be a start in the development of technology-based lexicographic resources, as an e-book is a simple form of a digitised resources.

The availability of the resource is at no cost as the study aims at equipping learners in their learning experience with a resource that will enable them to show their true intelligence without language constraints. Acquiring knowledge in the mother tongue contributes to results of learners as was recorded in a study conducted by Prophet and Dow in 1994, among secondary school learners who were observed to understood concepts better in science when taught in Setswana, unlike those who were taught in English. Similar findings were also recorded in Ethiopia among Grade 8 learners who were taught subjects such as mathematics, physics, chemistry, and biology in their mother tongue, where the results were 11% higher than those who did not learn in their mother tongue (Trudell, 2016).

2.10 Conclusion

This chapter discussed the language position in South Africa and its impact in the acquisition of knowledge among learners. It further discussed lexicography and possible remedies to elevate the struggle of linguistically disadvantaged learners in the country. An isiZulu-speaking learner is compelled to acquire knowledge in English or Afrikaans for them to graduate high school and be accepted at a university even though resources to equip them for the same in their home languages are not available. Subsequently, this literature review examined concepts that are necessary for practical lexicographic activities for the development of a Life Sciences dictionary. As a means of creating a structured study, the study presents the theoretical considerations for this study in the following chapter.

CHAPTER THREE

THEORETICAL FRAMEWORK AND RESEARCH METHODOLOGY

3.1 Introduction

The notion of lexicographic functions and the academic field of lexical semantics are combined in this chapter to form a theoretical framework. In order to create a new dictionary in this field, the current study concentrated on the terminology used in the field of Life Sciences. To this end, a theoretical framework serving as a foundation for data analysis and interpretation is necessary as it provides knowledge by scholars in the field that will support the study (Kivunja, 2018). This chapter, which is divided into two sections, goes on to explain the research methodology used in the second section and the theoretical framework used in the study in the first.

The research technique employed in data gathering as well as the approach to be taken in data analysis are described. The section introduces the research onion method, which starts with a definition of research methodology and peels away each component of the research method used in the study, including research philosophy, methodical choice, research strategy, time horizon, data collection, data analysis, truthfulness, and ethical considerations.

3.2 The theoretical framework

A research framework is made up of two words, namely theory and framework. According to the Oxford South African Pocket Dictionary (2015), a theory is a collection of concepts used to describe a phenomenon. It also refers to a body of rules that serves as the basis for an activity. Rundell and Fox (2002) explain a framework as a set of ideas used when forming decisions, while the Oxford South African Pocket Dictionary (2015) explains it as a supporting structure. Subsequently, a theoretical framework is developed by compiling related concepts to justify the study being conducted and to explain research findings (LeCompte, Preissle, Tesch, 1993; Caliendo & Kyle, 1996; Radhakrishna, Yoder & Ewing, 2007). This explanation is supported by Kivunga who states the following:

> A theoretical framework comprises the theories expressed by experts in the field into which you plan to research, which you draw upon to provide a theoretical coat hanger for your data analysis and interpretation of results. Put differently, the

> theoretical framework is a structure that summarizes concepts and theories, which you develop from previously tested and published knowledge which you synthesize to help you have a theoretical background, or basis for your data analysis and interpretation of the meaning contained in your research data. Kivunga (2018:46)

Thus, the current study combines semantics, a branch of linguistics that studies word meaning and relationships between words, which forms the basis for research on second-language acquisition and lexicography (Paradis, 2012); and the theory of lexicographic functions, which focuses on developing dictionaries with the satisfaction of dictionary users as the primary consideration (Tarp, 2004). These collections of academic ideas are required for this study because they concentrate on terminology used in the field of Life Sciences, which is examined through the study of semantics. This study also developed a dictionary using that terminology as the lemmata, which it believes will meet user needs when done in accordance with the theory of lexicographic functions. As a result, the theoretical framework used in this study will help it relate to previous research and bring ideas together that will serve as a basis for the analysis and interpretation of data for the goals of this study (Miller, 2007).

3.2.1 The application of semantics as a theory in the analysis of domain specific terminology

Semantics is a subdiscipline of linguistics that studies the meaning of words with the intention of explaining how speakers and listeners interpret and understand the information given. Meaning can be studied through semantics or pragmatics (which is another subdiscipline of linguistics that focuses on meaning of words as used in sentences or phrases) or semiotics (another discipline of linguistics focusing on the interpretation of linguistics and non-linguistic signs). The current study investigated terminology according to semantics, which is the study of how words are used to signify meaning (Stringer, 2019).

The main question examined in semantics is how word meaning can be conceptualised. The conceptualisation of meaning is determined by semantic properties that make up the meaning of words which Rambaud (2012) refers to as different types of meanings. These properties are briefly explained in **Table 3.1** which follows.

Table 3.1: Semantic properties

Semantic Properties	
• **Referential** This is the inferred meaning in a known world. For example, *I am at home*. The referential meaning of the word 'I' refers to 'you' the speaker and 'home' refers to your 29 Jump Street, Centurion which is your residential address.	• **Descriptive** This is the investigation of the meaning of what was said without saying what it is about and provides semantic values to words which gives meaning to what is being said. For example, *the balloon is black*. The colour of the balloon is described.
• **Cognitive** This is the investigation of how meaning is interpreted in the mind based on preserved information from experiences that individuals have pertaining to a phenomenon. For example, *John has a new dog*. To a person who loves dogs, this could be a good thing while a person who has a bad experience with dogs or even the dog John had before the new one would view this as a bad thing.	• **Emotive** The focus here is on words that express emotions and how they are interpreted in the world. For example, the word *awe* was used by people who live in the 1890s to refer to overwhelming 'fear' but nowadays it is interpreted as 'admiration'.
• **Expressive** This is a display of feelings which are only truthful to the person saying them and cannot be disputed because they are based on the feelings of individuals concerned. For example, *Wow!* The person saying that word would be expressing their admiration.	• **Social** This shows elements of social identity of speakers which could include their age, relationship status, ideologies and so forth. For example, *Hey guys*. This is a form of greeting that is used in a casual setting among people of different demographics, such as friends of a young age.

Scholars distinguish between several semantics theories while referring to the same phenomenon with various terms. For instance, Lyons (1995) differentiates between semantics and linguistic semantics with the former referring to the study of meaning and the latter to the study of meaning in terms of how it is written in its grammatical form. Cruse (2000) refers to lexical semantics and grammatical semantics with the former focusing on content words rather than grammatical semantics that deal with words that relate to grammar in terms of syntax and the link between logical and natural language, or semantics. In the same vein, Stringer (2019) articulates these theories of semantics as lexical semantics, which is how meaning is deduced from words and the significance of word meanings in sentences; formal linguistics uses logic to deduce meaning from linguistic expressions, and cognitive semantics which is deducing meaning in language in line with cognitive principles.

Dladla (2020) employed the theory of semantics in studying lemmata in isiZulu dictionaries to study lemmata definitions, stating that words introduced in dictionaries should provide etymological data as well as definitions in a manner that will not confuse the dictionary user. Subsequently, the current study examines dictionary contents to investigate lemma definitions to see if they meet dictionary users' needs. The current study focuses on the theory of lexical semantics in studying Life Sciences terminology to examine challenges faced by learners who speak a different language used to teach this scientific subject. This method will help the study determine whether the lemmata equivalents provided in isiZulu satisfy the needs of users by providing them with isiZulu terms in the language and the relevant definitions in the field of study.

3.2.2 Lexical Semantics

The origins of the theory of lexical semantics can be seen in Katz's work from the 1970s who developed it from Katz and Fodor (1963) from their structure of semantic theory, which focused on the language speakers' ability to understand meaning in new sentences. Theoretical foundations for the study of lexical semantics include cognitive semantics, generativist and neogenerativist semantics, structuralist and neostructuralist semantics, and prestructuralist semantics (Stringer, 2019).

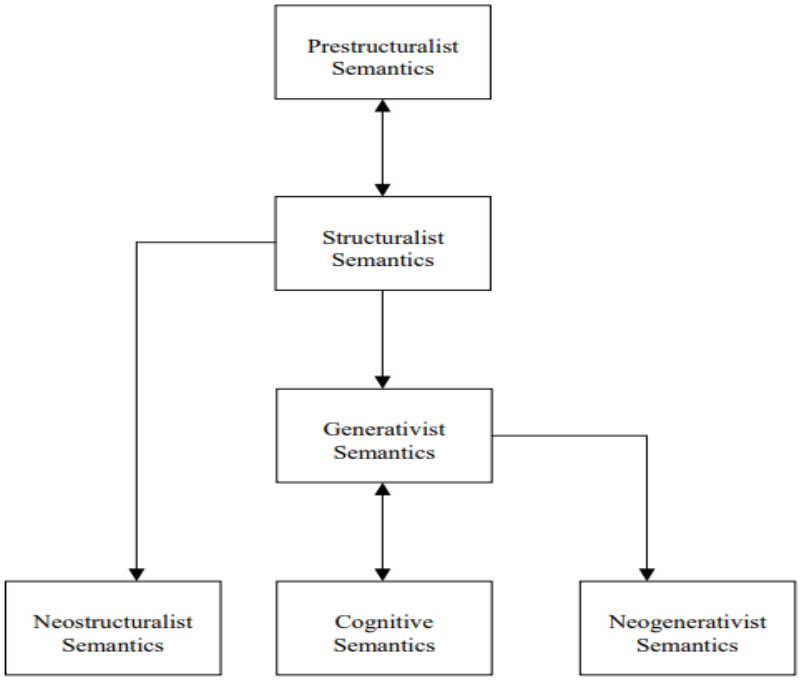


Figure 3.1: Founding theories of lexical semantics

The components of each of these theories and how they contribute to lexical semantics as one of the theories chosen for this study are described below.

- **Prestructuralist semantics**

This type of semantics is estimated to have been prominent between 1870 and 1930 even though there might have been some work in lexical semantics before this period. The study of word meanings did not become a separate field of study until the middle of the 19th century, when linguistics was still a young field of study. The focus of pre-structural lexical semantics was the change in meaning; change of word meaning; and how meanings are conceived from ideas. The results of studies conducted under this approach was the classification of language according to semantic changes such as metaphor, metonymy, generalisation and specialisation (Stringer, 2019).

- **Structuralist semantics and neostructuralist semantics**

Structuralist semantics is often credited to Trier (1931) who produced the first significant descriptive work in structural semantics; the first papers discussing the new strategy that was based on De Saussure's work in terms of theory and methodology in the 1930s, rejecting the historic philological semantics' approach. The structuralist view was that meaning should not be considered independently but should be studied in conjunction with semantic structures;

should focus on how language should be synchronic rather than diachronic and that meaning should be studied in an autonomous linguistic method. The need to develop a structured theory of semantics led to studies of semantic relations which included lexical field analysis, relational semantics, and componential analysis. On the other hand, neostructural semantics was a contemporary approach to lexical semantics founded from structural semantics but following a post-generativist method. It focused on relational descriptions of the semantic structure by integrating linguistics with cognition (Stringer, 2019).

- **Generativist semantics and neogenerativist semantics**

In the latter half of the 1960s and during the 1970s, the neostructuralist generative model of lexical semantic description already mentioned have been developed by Katz and Fodor (1963) and Katz (1972), was a point of reference for lexical semantics. When cognitive semantics was born the generativists also focused on the psychological side of language. Generative semantics also wanted to incorporate the mental side of semantics into grammar which led to questions about the generative period (Stringer, 2019).

- **Cognitive semantics**

This is an approach developed in the 1980s and onward which was cognitive oriented, studying word meaning by prototype theory, conceptual metaphors, and frame semantics. This has been regarded as the most effective framework for contemporary lexical semantics (Stringer, 2019).

Additional contributors to lexical semantics are Dölling (1992), Pustejovsky (1995), Copestake and Briscoe (1995) and Busa (1996) who avoided lexical semantics that only focused on senses but instead built on the deduction of a new meaning that are from existing words (Pustejovsky, 2017).

Lexical semantics has been studied from various approaches and the current study adopted the theory as explained by Stringer (2019) who discussed fundamental concepts in this theory which are reference, sense and lexical relations in relation to translating words from the first language of the speaker or hearer to a second language. The perspective of Stringer (2019) is relevant to the current study as it analyses terminology with a second language learner in mind. Lexical semantics is used to analyse terminology taken from a prescribed learner book in order

to comprehend the terms' meanings in relation to the aforementioned essential ideas that are covered below.

3.2.2.1 Reference

Reference denotes what a speaker intentionally or unintentionally points to in the world which can be seen by other people. One uses words that will direct the hearer to an item that is being denoted. For example, if one describes a chair, the hearer will get a complete idea of what is being referred to. Words are studied to understand how they convey the intended target message (Stringer, 2019).

3.2.2.2 Sense

Sense refers to the idea that one creates in one's mind at the mention of an item. It is how the hearer perceives what is being said in their mind. This perception is determined by the linguistic knowledge that the hearer already has. For example, the word 'stove' when heard by a person who lives in a place where coal is used for energy, the sense they will get is that of a coal stove as compared to a person who uses paraffin who would think of a Primus stove, and the same goes for a person with a gas stove or an electricity stove who would get a sense of what is common to them. Sense can be problematic in translation where the translator has to find equivalents that would be relevant to the target audience which may at times not exist and requires the translator to employ translation strategies that would capture the sense in the target language. A single word may represent many senses which are determined by linguistic relations pertaining to them. For example, table can refer to a coffee table or a dining table. These senses are studied as part of lexical relations (Stringer, 2019).

3.2.2.3 Lexical relations

Lexical relations refer to the entanglement of words on others where one finds a relationship between words as they are used (Rambaud, 2012). This is the structural relationships within words looking at sense relations like synonymy and antonymy. For instance, the relation between aunt and uncle is that they refer to the same genealogical generation even though they are from different genders. The relations between these words are distinguished in terms of different relations that could exist among them which could extend to the hyponymy and hypernymy of the words providing a complete definition of words (Geeraerts, 2017).

Lexical relations are briefly explained below, beginning with symmetric relations and their examples. This is followed by hierarchical relations, to be applied, demonstrated in a diagram that will assist in explaining the relations that will follow. It is important to mention that there are other relations such as homophones and homographs that are not discussed as they will not benefit the study.

a) Symmetric Relations

These relations are explained according to Kroeger (2018).

- **Synonyms**: This refers to words that are totally interchangeable because their meaning is the same or nearly the same. For example: begin, start, commence.
- **Antonyms**: This is a word that is the opposite of another when applied equally which by its nature refutes or disputes all its implications. For example: *She is happy* vs *She is sad*. The words *happy* and *sad* when applied totally negate the meaning of each sentence.
- **Polysemy**: This occurs when lexicons that are formed from the same word have two or more unique but related semantic senses. For example, *bank* can mean a 'financial institution' or a 'stock' of something available when required when used, for example, *blood bank.*

b) Hierarchical Relations

These relations are explained in **Figure 3.2** according to Kroeger (2018).

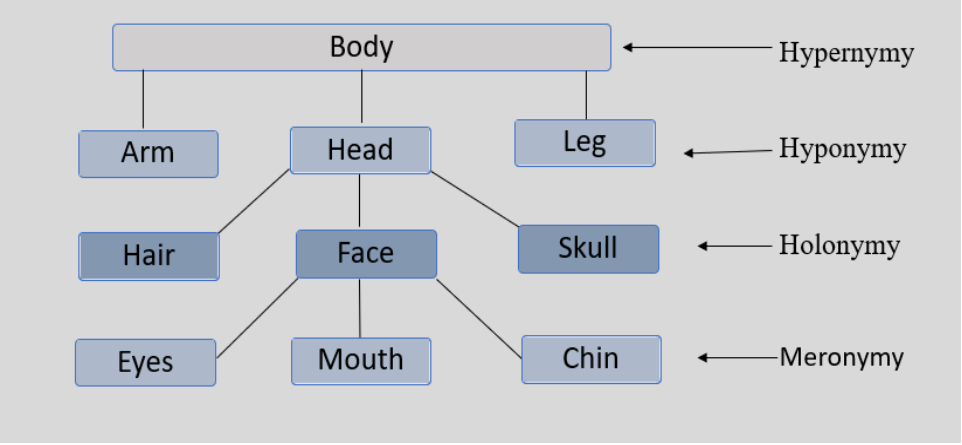


Figure 3.2: Examples of hierarchical lexical relations

- **Hypernymy or superordinate**: These are words that have a broader meaning than others. They are superordinate when compared to related words as can be seen in the diagram; the word ‘body’ is in the highest position because it has a broader meaning and can be used to replace the words in the second row because they are a broader term that refers to the words in the second row.
- **Hyponymy**: The relationship between two words where one includes the meaning of the other one. In the above diagram the word ‘head’ is an example of a hyponymy and so are other words in the same level because they are part of ‘body’.
- **Holonyms**: These are words that name the whole which is part of an item. For example, ‘face’ is part of the ‘head’ which is part of the ‘body’.
- **Meronym**: These are words that name parts of a whole that is part of a given word referring to a larger whole. For example, the parts in the last row are parts of the ‘face’. Therefore, one cannot have a ‘mouth’ without the ‘face’ − that in its own accord is part of a whole.

The meronym can further be broken down and form more hierarchical semantic relations such as the teeth, lip, tongue, etc. The teeth can also be further broken down. This satisfy the position of the never-ending relations of lexical items posed by Purdy (1987) thus making it important for the researcher to know the direction that the partitioning of words is facing a “specific area of emphasis” (Ottenheimer, 2006:18). In the current study, the area of emphasis is Life Sciences, therefore the dictionary terminology is studied according to lexical semantics as defined in that area of focus.

3.2.3 Theory of lexicographic functions

The theory of lexicographic functions is a theory that prioritises user satisfaction which includes extra-lexicographic situations to be taken into consideration when producing dictionaries (Tarp, 2004). This section comprises of the foundation of the theory; lexicography as a science; user profile; user situation; lexicographic functions; and the application lexicographic functions in dictionaries.

3.2.3.1 Foundation of the theory

According to Gouws and Prinsloo (2005), the cornerstone of this theory, which was gradually expanded, was laid by the work of the Russian linguist Scerba (1940) who developed the

general theory of lexicography. The scholar further states that other indirect contributors to this theory were Hausmann (1977; 1986) who came up with the active and passive use theory that focused on source and target users of bilingual dictionaries; and Kromann et al. (1984) who reflected on developing many forms of dictionaries within languages (in the case of bilingual dictionaries) in accordance with the needs of users. These theories, in one way or another, focus on dictionary users and their needs.

Early in the 1990s, the following academics worked with researchers from the Centre for Lexicography at the Aarhus School of Business in Denmark to develop the theory described in these works: Bergenholtz (1996, 1998), Tarp (1992, 1994, 1995, 1998, 2000, 2001, 2002); Bergenholtz and Kaufmann (1997); and Bergenholtz and Tarp (1992, 1994, 1995, 1998, 2000, 2001, 2002, 2003) among others. The present study, however, clarifies the notion of lexicographic functions in accordance with its founders Bergenholtz and Tarp (2003) and Tarp (1999, 2008, 2012).

Despite noting the position of users in lexicographic theories, dictionary researchers did not place the users' needs supreme as the starting point of lexicographic theories and practice. Subsequently, Henning Bergenholtz and Sven Tarp (2003) created a contemporary theory of lexicographic functions to benefit dictionaries created for foreign language education and learners of the same, emphasising that lexicography was a science; and that dictionary users should be the point of departure when developing a dictionary that will satisfy the function of lexicography. (Tono, 2010; Tarp, 2012)

The theory of lexicographic functions makes provision for studying lexicography on its own accord, as a science. Tono (2010) wrote a graphic presentation of the lexicographic functions theory steps for producing successful dictionaries according to this theory (see **Figure 3.3**). Each of these steps are explained briefly below, save for dictionaries as products since that step will be covered by the actual production of a dictionary product.

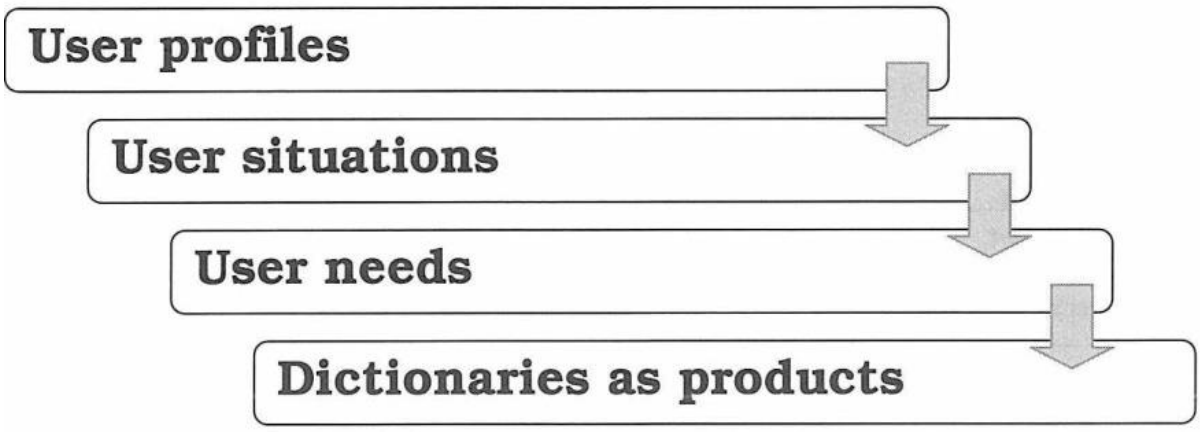


Figure 3.3: Theory of lexicographic function steps for producing dictionaries (Tono, 2010:13)

3.2.3.1.1 An investigation of the user profile

The user is the centre of the theory of lexicographic functions' second aspect. This is based on the idea that dictionaries are created to meet the needs of people; therefore, all theoretical and practical considerations should be focused on these demands in accordance with the traits and environment of that particular group of people. These needs determine the function and need those dictionaries should serve. Given that this study is conducted to develop a dictionary for senior secondary Life Sciences learners, this theory proposes that the needs of that group of users should be considered**.**

This theory requires a lexicographer to create a tool, based on theoretical knowledge that accommodates needs of potential users according to their types which could be in a form of a monofunctional lexicographic resource or a polyfunctional lexicographic resource (Bergenholtz, Bothma & Gouws, 2012). Therefore, lexicographers should profile the characteristics of potential users, their needs and their situations to identify situations that might require lexicographic resources as a solution. This will determine the type of dictionary needed as aligned with the users, function and its genuine purpose.

3.2.3.1.2 An Investigation of the User Characteristics

A dictionary is seen by Yong and Peng (2007) as a tool for interaction between the user and the lexicographer. Therefore, it is crucial for the lexicographer as the person communicating much-needed information to the user to know and understand the user. To this end, Bergenholtz and Tarp (2003) state that being acquainted with the characteristics of users is the first step in lexicography. They further provide a list of questions that should be asked when profiling users.

They do issue a warning that some may not apply in all circumstances and that this list is not all-inclusive of the queries that may be posed depending on the circumstances. The questions are cited and presented in **Table 3.2** below:

Table 3.2: User characteristics (Bergenholtz & Tarp, 2003:173)

1. What is their mother tongue?	5. How well-versed in encyclopaedic knowledge and broad culture are they?
2. How well do they speak their native language?	6. How well do they understand the specialised subject in question?
3. How well do people know foreign languages?	7. What proficiency level do they have in their native tongue's equivalent LSP?
4. What is their level of proficiency in translating between the two languages?	8. What level of the related LSP in the foreign language do they possess?

These questions are relevant as the BLSD-ZU being developed is a dictionary for specific purposes and for a specific group of learners which is a group whose needs and function of their dictionary are identifiable. The initial phase in dictionary building is determining the type of dictionary to be used as well as its purposes. For these elements to be determined, in order for the dictionary function and type to satisfy the users' demands based on the answers to the above questions, there is a larger need to research the wants of the user.

3.2.3.1.3 An investigation of the User Situation

The theory of lexicographic functions provides two types of user situations as users are not expected to be dealing with similar user situations, since their characteristics differ.

- **Cognitive users**

The first one is knowledge based or cognitive users where the user seeks additional information on a subject which could be scientific in nature or a general subject. It could also be a situation where a user wants to use a dictionary as a language study resource. In other words, these users need the dictionary to acquire knowledge and the dictionary provides it. This need of knowledge acquisition from a dictionary can occur in various situations such as those listed in the **Table 3.3** according to Tarp (2008:124).

Table 3.3: Cognitive use (Tarp, 2008:124)

1. The sudden requirement to acquire more encyclopaedic knowledge in order to comprehend the text when reading.	5. When using a dictionary, the urge to learn more about a particular subject.
2. The desire to learn more about a particular subject when writing in order to complete a manuscript	6. When preparing for specialised translation and interpretation duties, it is necessary to become more knowledgeable about the relevant topic area.
3. During conversations with others: the requirement to clarify a certain matter.	7. Concerning a lesson plan: the desire to learn more about a particular subject area.
4. The sudden urge to study something occurs while subconscious processes are taking place.	8. Concerning a course of study: the desire to learn more about a particular topic area.

Reasons stated in **Table 3.3** above provide various reasons for consulting a dictionary. For instance, user 2 and 3 consult a dictionary to fill an immediate need while reading or working on a text. Whereas the last three are sporadically or systematically driven where a user has specific needs that should be filled by the dictionary for them to reach a goal. Systematically driven users often require extensive knowledge that is subject specific highly sophisticated additional knowledge with highly developed cross-references to satisfy their needs.

- **Communication-oriented users**

In this case, users are often faced with a lexicographic conflict and a dictionary is required to resolve such a conflict. The dictionary serves as a written resource that can be consulted in dealing with that problem. These users are detected through a model of communication which can take place between two or more people through the encoding and decoding of texts, or even the translation of texts. This can include the language of the text which could be language A and the language of the text receiver which could be language B and the translator as a mediator.

There are six user situations which are cited and presented in **Table 3.4** below:

Table 3.4: User situation (Bergenholtz & Tarp, 2003:175)

1. Creation of literature in the native language (or first language)	4. Understanding a foreign language text (or second, third language, etc.)
2. Receiving written messages in one's mother tongue (or first language)	5. Text translation into a foreign language from the mother tongue (or first language) (or second, third language etc.)
3. Producing foreign language writings (or second, third language etc.)	6. Translation of writings into the native tongue from a foreign (or second, third, etc.) language (or first language)

An example of a user situation that determines the type of dictionary to be developed as a communication bridge is a bilingualised English dictionary for Catalan speakers called the *Easy English Dictionary with Catalan-English Vocabulary*. This resource was developed for primary and secondary learners to assist them to obtain information from English and Catalan in one dictionary following monolingual and bilingual features. The basis of this dictionary was that monolingual dictionaries had benefits of teaching a language to foreign language learners but frustrated them due to definitions that were difficult to understand. On the other hand, bilingual dictionaries made the users confident but did not provide as much information as the monolingual ones. Subsequently, they developed a newer type of dictionary – a bilingualised dictionary – that provided lemmata in English with definitions translated into Catalan (Corrius & Pujol, 2010).

- **Operation and interpretive situations**

Tarp (2008) and Bothma and Tarp (2012) discussed an operation and interpretive user situation which had not been discussed in lexicographic theory. These scholars refer to texts − such as manuals, handbooks and the how-to books which provide directions on how to act in specific circumstances; and the interpretation of signs, symbols and signals which inform the user about action that has to be taken immediately or later dependent on each situation − as tools that directs a user in a situation that is neither cognitive nor communicative. As much as these

products may not be lexicographic in nature, they share the common function of being designed to help users find information in a particular social context easily and quickly. These products can benefit from lexicographic approaches since they are not designed to be read from cover to cover but for specific consultation, therefore they can introduce new lexicographic tools.

3.2.3.1.4 An investigation of the User Needs

According to Bergenholtz and Tarp's (2003) definition, user needs are what are needed to handle a particular collection of issues that a particular user with a particular set of attributes has in a particular setting. The demands of users can be ascertained once the lexicographer has assessed the circumstances and characteristics of the user. In this regard, there are categories that should be considered as presented in **Table 3.5** below.

Table 3.5: User needs (Bergenholtz & Tarp, 2003:175)

1. Details about the language of origin	6. Comparison of the study subject in the home and foreign cultures
2. Knowledge of a foreign language	7. Knowledge of the native LSP
3. Putting native and foreign languages side by side	8. Knowledge of the foreign LSP
4. Information on the world's cultures and cultures in particular	9. An evaluation of the local and foreign LSP
5. Details regarding the specialty field	

Most dictionaries have been developed without considering specific characteristics of user needs, which makes the user-needs table vital in determining the type of dictionary that will directly satisfy these needs instead of abstract needs. The information in the above table will assist the lexicographer in determining the size, text compound structure, the macro- and microstructure of the dictionary. It also influences the rules for pronunciation, the descriptiveness of the dictionary in presenting the definitions, as well as all other lexical methods required to produce a successful dictionary (Tono, 2010; Schierholz, 2015).

3.2.3.3 Lexicographic functions

The lexicographic function of each dictionary is “to provide assistance to a user group with specific characteristics in order to cover the complex of needs that arise in a specific type of

user situation" (Bergenholtz & Tarp, 2003:176). The function determines the genuine purpose of the dictionary which is to assist specific users to meet their specific needs from a dictionary as required in each situation. A dictionary can have a single function or more than one function which is determined by the user situation. This means the function can be based on knowledge acquisition or it can be communication oriented. The most recognised communication-oriented and knowledge-based functions are listed in **Table 3.6** below.

Table 3.6: Lexicographic functions (Bergenholtz & Tarp, 2003:177)

Communication-oriented function	**Cognitive function**
1. To users in resolving issues with receiving texts in their mother tongue	1. To give users access to encyclopaedic and general culture information
2. To support users in resolving issues with the creation of texts in their native tongue	2. To provide special information about the subject field to the users
3. To help users with issues linked to receiving texts in a foreign language	3. To inform users about the language
4. Assist customers in resolving issues with producing text in a foreign language	
5. To aid users in resolving issues with text translation from a foreign language into their mother tongue	
6. To aid users in resolving issues with text translation from a foreign language into their mother tongue	

The function of developing each dictionary is the basic element of lexicographic theory and practice. This can be seen in Wiegand (1984) who applied a different theory (the general theory of lexicography), and states that:

> The first component is a theory of lexical data collection. This is a theory about how to compile a dictionary base; that is, it concerns, firstly, the collection, composition, representativity, function and typology of lexical corpora relative to

> dictionary types. Thus, it concerns lexical fieldwork as well, e.g., for designing a direct or indirect opinion poll to gather lexical data. (Wiegand1984:16)

Wiegand (1984) placed the function of lexical corpora on the first step of data collection, with other elements which assist in the design of dictionary directly or indirectly. It stands to reason that no lexicographic work can take place without determining the lexicographic function first. Therefore, once this function has been determined, the lexicographer can continue to collect data and prepare it for compiling the dictionary.

3.2.3.4 Application of the theory of lexicographic functions in dictionaries

The function of the dictionary to be met in the current study is to bridge the language gap of users who are learning a scientific language in a second language. The study has two features to be analysed which are published dictionaries and the BLSD-ZU. The former was examined to determine how users were considered or not considered in the development of the dictionary, while the latter, when developed was examined to determine whether or not the researcher, as a lexicographer in the study, succeeded or failed to meet lexicographic functions. For such a dictionary to be developed there is a need to understand the lexicography as a science, the user, and lexicographic function of the dictionary as this will facilitate the determination of dictionary entry definitions that will satisfy the needs of the user.

Tono (2010) considers how the theory of lexicographic functions could improve dictionary studies pertaining to users, noting that most dictionary researchers do mention their target users even though they may not be as specific as stated in the theory. For instance, the *Scholar's ZULU Dictionary* by G.R Dent and C.L.S. Nyembezi (2009) is introduced as a dictionary "intended for those people who find the more comprehensive dictionaries too cumbersome and too detailed for their needs." (Dent & Nyembezi, 2009: iii) and the *Interpreting Terminology, Terminologie Van Het Tolken, Tolkterminologie, Mareo A Botoliki, Amatemu Okulotila* by Marne Pienaar and Eleanor Cornelius (2018) is "aimed at people being trained as interpreters, interpreter trainers, people who work as interpreters, or scholars engaged in research in the field of interpreting and who are looking for interpreting terms either in English, Dutch, Afrikaans, Northern Sotho or Zulu." (Pienaar & Cornelius, 2018: i).

The above dictionaries clarify the target user for the multilingual dictionaries while in monolingual isiZulu dictionaries *Isichazamazwi Samagama Amqondo Ofanayo* (Dictionary of Synonyms*)* by Shabangu (1987) and *Isichazamazwi Sesizulu* by Mbatha (2006), users are profiled according to function in stating that the dictionary is aimed at assisting isiZulu users from all walks of life in their writing at school, university, home and their work functions. They are profiled for general users. Although users may not be specific, they are still profiled, and the theory of lexicographic functions can assist in studying these available products to determine the user situations more explicitly and recognise areas that it needs improvement and the production of more user-specific dictionaries. To this end, a lexicographic function cycle (**Figure 3.4**) can be followed when conducting research for dictionary development which was created by Tono (2010).

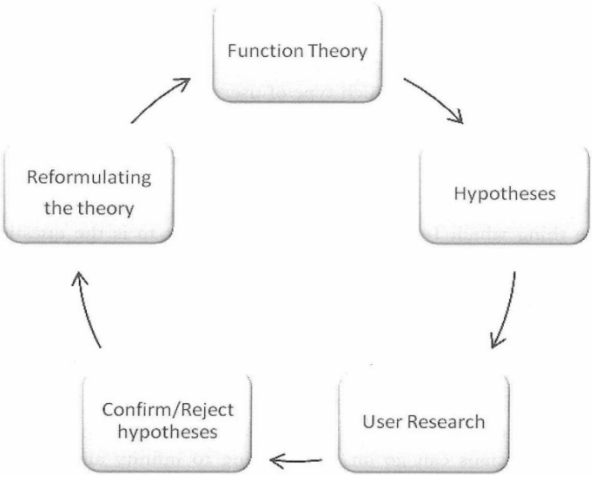


Figure 3.4: Lexicographic functions improvement cycle for dictionary user research (Tono, 2010:2)

The cycle starts with the function theory followed by a hypothesis to be tested that can be formed from the dictionary function and situations, then research can be designed and conducted where the hypothesis will be verified based on findings, then the theory can be modified if necessary. This can serve as a good foundation for developing dictionaries thus the BLSD-ZU is founded on the theory of lexicographic function which was employed by Nkomo (2008) to study Ndebele dictionaries and in developing guidelines for developing a theoretical model for a dictionary of special purposes in the language. He selected this theory because of its thorough consideration of dictionary users, their situation and the functions of dictionaries. For this reason, the current study also selected this research method for its nature and characteristics employed in profiling the user according to their needs and situation when

examining dictionaries to determine their alignment with lexicographic functions of dictionaries.

3.2.4 Combining Lexical Semantics and the Theory of Lexicographic Functions in the study of terminology and pedagogical lexicography

The theory of lexical semantics explains the need for studying meaning and the various types of meaning that exists as informed by lexical relations present in each situation. This theory posed that meaning can be attained by studying words associated with other words and understanding the fine line that exists between them. The application of the theory of lexical semantics in the study of terminology is directly linked to the current study because it will assist the study in analysing terminology and relations that exist in the words plus their contribution in assisting learners to unpack meaning of the content, they have to acquire in a second language.

In the same vein, the theory of lexicographic functions presents arguments supporting the study of lexicography as an independent science from linguistics which provides knowledge required by the study in developing a new lexicographic resource. It also provides the history of the theory and its features, namely the user profile, user situation and the functions of a lexicographic resource. This notion emphasises that in order for a dictionary to serve its intended purpose of being a valuable product for the user, dictionary creators should always start their work by researching the dictionary's intended user. Since the dictionary's goal is to address cognitive learning issues emanating from the user's linguistic difficulties, the user serves as the beginning point for this research and dictionary development.

Some scholars have been contesting the relationship between linguistics and lexicography by arguing that lexicography is part of linguistics and lexicographers arguing for its independence. Wiegand (1984) argues that lexicography requires more than the application of linguistic theories because the study requires more than linguistic knowledge. Subsequently, lexicographers are expected to have theoretical knowledge of the field of lexicography and not only depend on their linguistic knowledge. There appears to be a worrisome relationship between lexicography and linguistics as scholars of linguistics often place their discipline on a different platter and the same is found with lexicography scholars.

Piotrowski (1994) holds that lexicography is independent from linguistics but employs linguistic knowledge in its practice. In the same vein, Burkhanov (1997) poses that lexicography has been argumentatively considered to be part of semantics for academic politics' purposes without a solid foundation. Due to the various methodologies used in lexicography compared to linguistics, it is no longer considered a branch of linguistics or applied lexicology. To this end, Bergenholtz and Gouws (2012) concur by arguing that, the time when dictionary discussion was restricted to linguists and centred solely on the linguistic substance of dictionaries is long gone; and, acknowledge that linguistic content will always be a significant component of some dictionaries, but it's also vital to recognise that many lexicographic practises and theoretical debates transcend the study of linguistics.

As much as dictionary content is linguistic in nature it does not take away or diminish the science employed by lexicographers in the development of the resource. It is common knowledge that some lexicographic theories proposed are founded in linguistics which causes other scholars to place lexicography within linguistics instead of accepting its autonomy (Tarp, 2012). The argued relationship between these disciplines does not have any bearing on the current study which drew knowledge from scholars such as Nkomo (2008), who employed the theory of lexicographic functions when establishing a theoretical model for LSP lexicography in Ndebele, and Ball and Bothma (2018) who employed the same theory for evaluating electronic lexicographic resources. In the same vein, Dladla (2020) employed the theory of semantics to analyse isiZulu dictionaries and combined with a lexicographic theory because of the dependency of these theories on each other in the development and analysis of dictionaries, which in the current study assisted with meeting the objectives of the study. Subsequently, the current study employed both lexical semantics and the theory of lexicographic functions because the researcher had no intention of scrutinising terminology without applying linguistic practices and at the same time would not have been able to develop a dictionary without theoretical knowledge from lexicography.

Kay (2000), a lexicographer and scholar of semantics, expressed his dissatisfaction with the separation of semantics from lexicography stating that he could not find a resource that discussed lexicography and semantics together, while these disciplines are often viewed as interdependent due to their concern with meaning and its expressions. Semantics has a lot to offer lexicographers, as in the current study, where the analysis of terminology requires lexical

semantics for analysis and a theory of lexicographic functions for the study to create a user-need based dictionary with clearly analysed lexical units.

The theory of lexicographic functions posits that lexicography is independent of linguistics and places the user and lexicographic functions as the main points of consideration in practical lexicography. The researcher planned on constructing the dictionary based on the theory of lexicographic functions as the main framework of the project. However, there was a gap pertaining to the interpretation of dictionary entry definitions for translation purposes required for a bilingualised dictionary. Thus, with a full understanding of the independence of lexicography from linguistics, the study employed a feature of linguistics, in particular, semantics in the interpretation and translation of definitions to isiZulu. According to Béjoint (2010), the proximity of lexicography and semantics stands out in practical lexicography but at the same time he does not regard lexicography as a branch of linguistics. This view supports the theory of lexicographic functions with regard to the independency of lexicography as a science but also serves as a foundation for including semantics, particularly lexical semantics, in the interpretation of dictionary entries and their definitions in the current study as a second theory.

The theoretical framework presented in this chapter shows an appreciation of a linguistic theory as well as a lexicographic theory because when lexicographers practice their science they consciously and subconsciously twin the two disciplines to create a well-informed resource. This does not only apply to lexicographers in African languages as is the focus of the current study but the same approach is upheld in all languages because practitioners from both disciplines draw from each other. The choice of the theory of lexical semantics and the theory of lexicographic functions is based on the purpose of the current study which is the expansion of the function of lexicographic resources in African languages through the development of a Life Sciences dictionary in isiZulu. Dictionaries should be developed to meet identifiable needs of users, and to this end, the theory of lexicographic functions and lexical semantics were considered. The current study examines the structure of published dictionaries to enable the study to develop a dictionary that will meet lexicographic functions by placing the needs of users first, the user situation, and the function of the lexicographic resource being developed. Therefore, the study scrutinised the terminology for dictionary development, examined the user profile and treated the terminology in a manner relevant in satisfying the function of the new resource (Chabata, 2009; Schierholz, 2015).

3.3 Research methodology

Research is the process of "defining and redefining problems, formulating hypothesis or suggested solutions; collecting, organizing and evaluating data; making deductions and reaching conclusions; and lastly, carefully testing the conclusions to determine whether they fit the formulating hypothesis." (Mishra & Alok, 2017:1). Research is therefore a systematic and scientific action taken after the identification of a research problem, where the problem is scrutinised then a possible solution is provided through a suggested hypothesis. This is followed by searching and collecting data which are arranged so that deductions can be made and the problem can be resolved which would support or disprove the proposed hypothesis. Thus, methodology refers to a system followed when doing something in a particular field.

A research methodology is a systematic process followed when conducting research. It can also be described as a means of collecting, arranging, and analysing data. In other words, it is a science of studying how to conduct research systematically to resolve a problem in each situation because research methodology is designed to tally with each research problem and is not prescriptive to fit in resolving all research problems. The research methodology applied in the current study for collecting, arranging, and analysing data scientifically is explained (Kothari, 2004).

3.3.1 Research onion

Research can be explained using the metaphor of an onion which has each layer removed until the core of the onion is reached. Each layer of the onion represents the outer elements of research where each part is peeled with the intention of collecting and analysing data. There is a need for a researcher to know each of these elements in order for them to structure research in a workable way (Saunders & Tosey, 2013). **Figure 3.5** presents the illustration of the research onion.

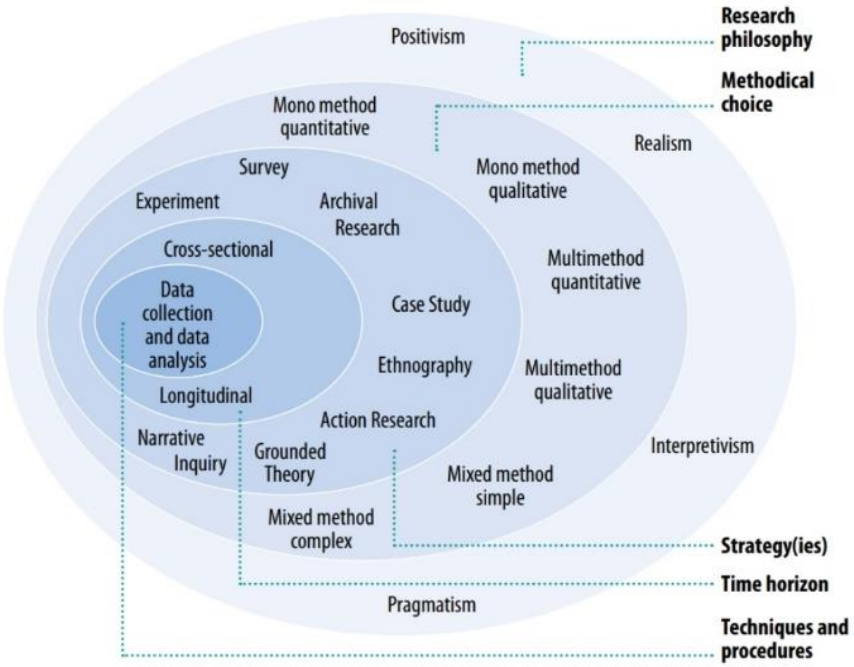


Figure 3.5: Research onion (Saunders, Lewis & Thornhill, 2011)

Shaped like an onion, each ring of the image represents elements of research with the outer layer representing a research philosophy. The researcher selects a philosophy, also known as a paradigm, to state their worldview which was the larger framework of the study. This is followed by the methodical choice, after which the next layer, the research strategies could be employed. This is followed by the time horizon which explains the timeframe for the study as it could take place over a long period or a shorter period. The final layer comprises of techniques and procedures of the research which forms the core of the research onion. The final component is data gathering and analysis. These levels aid in ensuring that the study use the proper methods for information gathering and analysis that will aid in answering the research question (Saunders & Tosey, 2013)

The current study peeled each layer of the onion in establishing a research method to be followed. A research paradigm of pragmatism was selected, the qualitative research strategy was selected, the time-frame that the study should be conducted in was set, and techniques and procedures to be employed were determined. Each of these layers of the research onion is explained in this chapter. This includes the data collection and data analysis procedures that were applied to help the study analyse terminology and expand domain-specific lexicographic

resources that are available in isiZulu. Ethical matters were also taken into consideration and the truthfulness of the study was assessed.

3.3.2 Research paradigm

The word 'paradigm' can be traced back to Khun (1962) who views it as a theoretical means employed by scholars in testing and resolving problems. According to Guba and Lincoln (1994), a paradigm is a belief system or worldview that has been established for a particular person, environment, or set of potential relationships in that environment. A paradigm is a structure founded on a theory that is employed by researchers to examine and resolve world problems (Vosloo, 2014). To this end, the study deduced that a research paradigm is a conceptual system of thought founded on theory that guides research. Thus, having a paradigm as a foundation of a study is imperative in research. A researcher is at liberty to choose from the following forms of research paradigms:

- **Empirical paradigm**

a) **Positivism** – this worldview identifies a problem, finds a scientific methodology to resolve the issue through development of hypotheses that are tested and interpreted as a means of obtaining the truth (Vosloo, 2014).

b) **Post-positivism** – later positivism was transformed to post-positivism which was about falsifying hypotheses rather than expecting it to produce the expected results but instead to understand the broad phenomena that affected the entire study, including theory and practice as key to research results (Vosloo, 2014).

c) **Anti-positivism** – this worldview is against a narrow application of positivism and appreciates the ability of people to interpret knowledge differently and providing multiple findings about a phenomenon (Makombe, 2017).

- **Normative paradigm**

a) **Interpretivism** – this paradigm seeks to understand reasons for people's actions as it helps the study interpret, construct, rationalise, and explain actions of people (Babbie & Mouton, 2008).

b) **Social constructivism** – this is a theory of knowledge about sociology and communication that helps in understanding the world which is defined by social and interpersonal influences (Makombe, 2017).

c) **Criticalism (critical theory)** – this theory criticises the positivism and interpretivism paradigms as it challenges views that restrict human freedom and envisages on changing society in terms of their social and economic positions (Makombe, 2017).
d) **Pragmatism** – this paradigm is founded in the environment which requires human experience (Makombe, 2017).

The current study employed the pragmatism paradigm which is a paradigm that places the emphasis of researchers on meaning and actions that are shared among people based on a belief that theories can be applied according to context and generally be transferred to other situations that require them. With the aid of this paradigm, new concepts like abduction, intersubjectivity, and transferability can be created, as well as connections between induction and deduction, subjectivities and objectivity, context and generality (Makombe, 2017).

Pragmatists reject ideas like truth and reality and instead acknowledge that there can be a variety of non-subjective realities. They hold that knowledge and reality are founded on beliefs and habits that are based on society. In other words, each research can produce a reality that is determined by data and findings of that unique study as long as it can be substantiated with truthful evidence. Further, the paradigm permits the study to benefit from various research methodologies that extend the research's focus and embrace the advantages and disadvantages of both qualitative and quantitative research approaches. (Yefimov, 2004; Creswell, Klassen, Plano Clark & Smith, 2011; Shannon-Baker, 2015).

Pragmatism enables the study to select a research methodology that is most suitable for a study, be it qualitative or quantitative or a mix of the two methods, thus enabling the study to actively develop data and theories. The current study selected the qualitative research method as the data were collected through content analysis and pragmatism enabled the study to apply methodologies that are aligned with the researcher's beliefs, experience, and their socio-political location. The researcher identified the lack of domain-specific dictionaries in African languages as a problem which is part of a real social situation that should be defined and developed using a scientific method to remedy the situation which is directly aligned with the pragmatist's worldview (Kaushik & Walsh, 2019).

Tarp (2000:189) posits that "a great deal of pragmatism is often practised when compiling a concrete specialised dictionary. Lexicographic pragmatism might be necessary, but in order to

be successful it must be guided by theory." This pragmatism in lexicography influences decisions taken by the resource compiler to allow the resource to satisfy the intended function it is being created for, being guided by the compiler's perceptions of what they envisage the new resource to present. The compiler incorporates their belief system, knowledge and researched information in dictionary development, but this should be guided by theoretical knowledge in lexicography. Pragmatism influences the content selection process or even the translation process in a bilingual or multilingual resource such in the current study where the researcher decided to be pragmatic in terminology selection and translation by randomly selecting terms from prescribed books and translating them without developing new terms in isiZulu for words that do not exist in the language. In this study, the researcher applied her knowledge of translation strategies in line with the theoretical framework of this study in developing a functional dictionary.

Pragmatism is a broad research paradigm which covers different areas of conducting a study. To this end, Goldkhul (2008) provides explanations for three types of pragmatism which are presented in a **Table 3.7** below:

Table 3.7: Types of pragmatism (Goldkhul, 2008)

TYPE OF PRAGMATISM	**EXPLANATION**
Functional pragmatism	This type of pragmatism is constructed on understanding a phenomenon as a foundation for the action to be taken as constructive knowledge is believed to have a direct impact on improving a situation and the world in general.
Referential pragmatism	This type of pragmatism refers to knowledge about a phenomenon where the primary phenomenon or people involved in it are studied.
Methodological pragmatism	This type of pragmatism focuses on methods or strategies employed to create knowledge. The researcher is directly involved in the study with the intention of exploring or observing action of other people. This style of learning involves ongoing knowledge production, application, and evaluation.

The current study employs methodological pragmatism in that the study is directly involved in all stages of research and dictionary development. The application of the pragmatistic paradigm in the current study is founded on an observation by Kaushik and Walsh (2019) who presented a five-step model developed by Dewey (1933) and revised by Morgan (2014a) which is summarised by the study in **Figure 3.6** below:

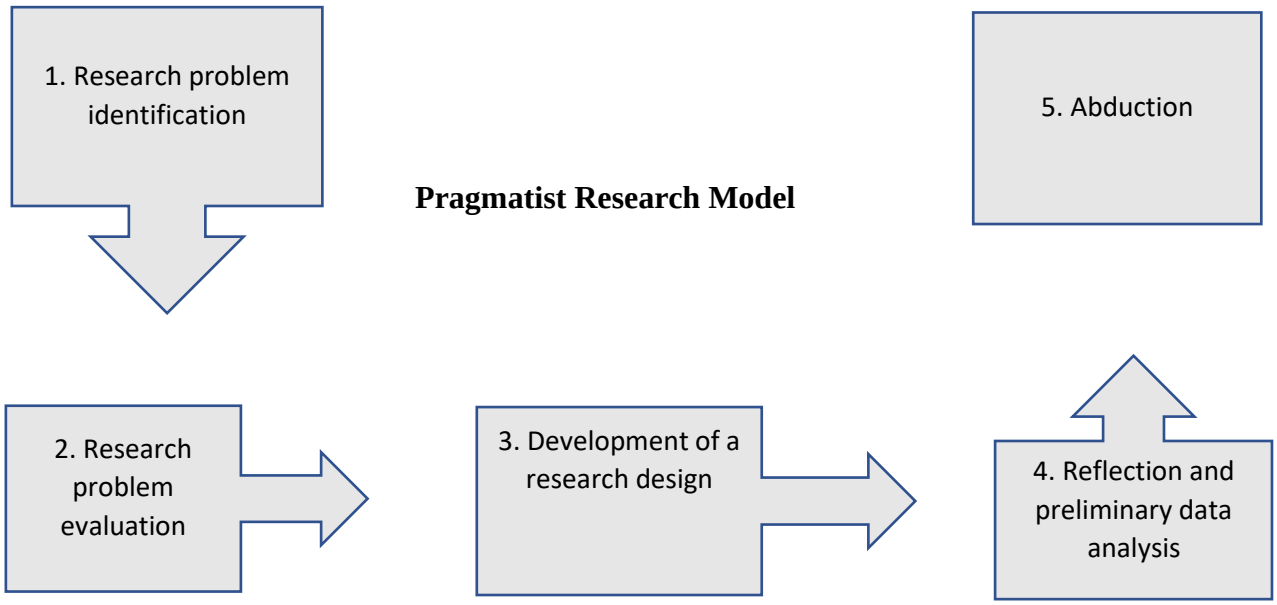


Figure 3.6: Pragmatist Research Model (Dewey, 1993)

The pragmatism paradigm in the current study has been applied as follows:

1. Chapter 1 of the study identified the problem of shortage of lexicographic resources to assist Grade 10 to 12 Life Sciences learners whose home language is isiZulu.
2. The problem was evaluated through a study of literature and theories applicable in the study in Chapter 2 and 3.
3. A research methodology is discussed in the current chapter.
4. Chapters 4, 5 and 6 provide a reflection and analysis of data collected and developed.
5. The last step is the capturing of data analysis in Chapter 7 through the presentation of research findings, conclusion, contributions and recommendation made to resolve the problem identified in Chapter 1.

3.3.3 Research method

This subsection presents research methods employed generally in research beginning with the selected research method for this study which was a qualitative research which promotes an understanding of processes and techniques involved in a particular phenomenon. Other

research methods that could have been employed but were not selected are the quantitative research – a useful method for studying phenomena through statistics, and mixed method – a combination of qualitative and quantitative research methods (Rowlands, 2005).

3.3.3.1 Qualitative research method

The selected method for conducting this research is a qualitative research method. Qualitative research aims at enlightening the study on each detail concerning the development of things in a social setting through a study of people's experiences, beliefs, and knowledge. It enables researchers to explore a multitude of societal matters, including daily life experiences which the current study is interested in, through an array of collected data that is studied to resolve lexicographic challenges faced by learners due to linguistic constraints (Hancock, 1998; Mason, 2002).

This research method promotes an understanding of processes and techniques involved in a particular phenomenon as well as people's actions when faced with different phenomena and it is employed in the interpretation of attitudes, behaviours, and experiences through methods such as action research where the study works with people to improve a situation. The current study does not work with people but work on the resources available and used by people affected in the study and expands the lexicographic resources by adding a user-friendly resource in the mother tongue of the affected people (Kothari, 2004; Rowlands, 2005; Dawson, 2002).

Schierholz (2015) postulates that a qualitative method is a necessity for the analysis of dictionary contents and the logic behind the meanings given to lemmata. This was proven by Hlongwane (2020) who used this approach to study methods for terminology development and by Jauza (2020), who analysed isiZulu dictionaries and employed the qualitative method to study methods of listing synonymous and autonomous lemmata in a dictionary and in determining whether that dictionary satisfied the needs of learners as users of the resource. The current study examined terminology and dictionaries with the ultimate aim of developing a new dictionary. Thus, the qualitative research method has been selected for this study due to its nature of being a method that involves interpreting data to gain more knowledge from the data being analysed. The current study aims at exploring the development of a dictionary as a means of expanding lexicographic resources in isiZulu which is a task that requires examining its contents and further evaluating the resource according to research objectives.

Saunders and Tosey (2013) provide that a researcher can use a mono method qualitative or multimethod qualitative which means that if a researcher chooses a mono method, they will only employ one method technique and if they choose the latter, they will use more than one. For example, a researcher employing one technique will only use interviews for collecting data while one using a multimethod would use interviews and observations to collect data. The current study employed a mono method qualitative method by means of text analysis. This technique is crucial in the study as it resulted in the study extracting data from selected resources which are prescribed textbooks, dictionaries, and by developing a new dictionary which was evaluated.

3.3.3.2 Quantitative research method

According to Kothari (2004), quantitative research method is based on the measurement of quantity through the involvement of an analysis of quantitative data. This method can be further classified as inferential (meaning it is used to form a database to infer features or connections within a population being studied), experimental (meaning that the study works on variables and evaluates their effect on other variables), and simulation (meaning an artificial environment is established to enable the generation of relevant information and data with the intention of observing behaviours of variables in a controlled environment.

Quantitative research allows for the collection of large-scale data through questionnaires or interviews and enables the study to reach more people than qualitative research. Findings of such research are often presented in the form of graphs, pie charts and tables as it is a non-descriptive form as compared to qualitative research where findings are analysed, and re-organised as new results emerge until the end of the study where final findings are reported (Dawson, 2002).

This method can be employed in a mono method quantitative or multimethod quantitative. The mono method quantitative is a research technique where a researcher uses a single technique to collect data. For instance, they can use questionnaires only to collect data. In the same vein, a multimethod quantitative method is a technique that employs more than one data collection method. In this case, the study can, for example, use questionnaires, text analysis and observations to collect data. (Saunders and Torey, 2013).

This method was not selected in the current study because the study did not intend on providing statistical information about the isiZulu dictionary given that reading the entire dictionary to count the lemmata would be an unnecessary and time-consuming task. The researcher only selected a sample of lemmata from dictionaries that was analysed qualitatively (Schierholz, 2015).

3.3.3.3 Mixed research method

A combination of the qualitative and quantitative research methods is called the mixed research method because both methods are utilised to achieve the purpose intended. Below is an explanation of this method, according to Johnson, Onwuegbuzie and Turner:

> Mixed methods research is the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e. g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration. (Johnson et al. 2007:123)

Even though this method combines two distinguished methods, it is a method in its own right, with its own philosophical assumptions and application methods (Creswell et al., 2011). In the same vein, Saunders and Torey (2013) posit that the mixed method approach can be employed as a mixed method simple or mixed method complex. Therefore, a researcher can collect data from participants and use the qualitative approach to study the same data to understand a phenomenon under study thus providing more depth to the research rather than only providing statistical findings (Dawadi, Shrestha & Giri, 2021).

As much as this method is more detailed and provides more data for analysis when conducting a study, it does not apply to the current study. The researcher did not need quantitative data and will thus only employ the qualitative method to study the structure of selected dictionaries as the study did not focus on statistical information of the dictionaries or even of the terminology to be analysed.

3.3.4 Research strategy

Good research is guided by the purpose it is intended as it helps to select the most appropriate method for conducting the research. Further, the design of a study is steered by the research purpose in the process of making decisions when planning the conceptual structure for the

research being undertaken. When selecting a research strategy, a researcher plans how data were collected and analysed to prove or disprove a research hypothesis in line with the intention of the study (Dawson, 2002).

The main purpose of this study was to expand domain-specific lexicographic resources in African languages by developing a bilingualised Life Sciences dictionary for Grade 10 to 12 in isiZulu. This research is conducted to obtain new perceptions and to enhance knowledge about a phenomenon (Burns and Grove, 2001). This type of research requires the study to be impartial and open to different aspects of the study which are aligned with the pragmatists' ideology of neutrality in conducting research by formulating a problem and developing a working hypothesis and testing it to find a solution (Kothari, 2004). The gist of the hypothesis of the current study is that dictionaries can be a solution to terminology problems faced by learners of scientific subjects and this research considered the development of a dictionary by means of providing new insights into the development of lexicographic resources in African languages as well as the enhancement of terminological systems employed in the development of dictionaries in these languages to benefit dictionary users, mostly learners. In proving this hypothesis, the study applied the theory of lexicographic functions, lexical semantics and translation strategies with the intention of developing a dictionary based on theoretical knowledge. Subsequently, the research strategy selected for this study was grounded theory.

3.3.5 Data collection

Data collection is a procedure of gathering and measuring data of interest in a study to meet study objectives. This enables the study to answer research questions, test its hypothesis, and examine its findings. Primary data collection resources are methods of collection data that are being recorded for the first time such as in the form of interviews, questionnaires and voice recordings. This is done by performing experiments and other procedures that are conducted for the very first time as a means of answering research questions. In the same vein, secondary resources refer to data being extracted from literature already studied or other means already produced by other people. Examples of these resources can be books or other forms of literature that is available for scrutiny, of which the study will examine the findings of the presented data (Hoax & Boeijie, 2005; Dawson, 2002; Morgan, 2015).

3.3.5.1 Data collection methods

Paradis, O'Brien, Nimmon, Bandiera, and Martimianakis (2016) explain five key data collection methods and **Table 3.8** below describes their application.

Table 3.8: Five key data collection methods

Data collection method	Definition
Observation	This method involves the use of senses which are touching, hearing, visualising and smelling. When applying this method, the study situates itself in a situation to see what people do and how and why they do that rather than being informed about that.
Questionnaires	This is a method of creating a set of written question in the form of surveys to be asked to respondents. The questions can be open-ended where the respondent can add more information to the responses that they provide. The questions can also be rigid requiring respondents to select a response from a list of provided responses. These are often used when collecting data about people's perceptions or beliefs.
Focus groups	This method is used when one is collecting data about phenomena affecting a group of people which would ideally be made up of eight (8) to ten (10) participants. The questions asked to the participants can be scripted or the moderator, person facilitating the discussion, can ask them randomly as prompted by the discussion with the group. Participants are often put together in one room when their opinions on the phenomena are heard, recorded and transcribed. This method allows the study to capture similar and contrasting opinions from participants.
Interviews	This method is used when collecting data on a one-on-one basis by asking a list of predetermined questions or questions of interest in a research topic. The interview can be structured, meaning that the person asking the questions, called the interviewer, can follow a strict script; or it can be unstructured meaning they can ask questions that they craft as prompted by the responses they receive. Interviews are recorded and transcribed so that there can be a written record of the data collected. Interviews are often used to collect data about a participant's account of a situation, or their opinions about a situation or phenomenon.

Textual or document or content analysis	This method has been selected for the current study. It is a method employed in the examination of written material in order to extract data to answer the research question. Data extracted in this study are terminology from prescribed books and dictionary lemmata. This data collection method can be used to collect data to be used in an investigation of experiences and perspectives of individuals or groups that work with that written material. This method can be the main method of research or be used to put other research findings into context. Any written document can be studied through this method and the coding scheme for analysis was determined by the research question.

Table 3.8 provides a guide for selecting a data collection method, but in order to select a method or methods, research questions have to be considered. It is important to engage each research question at this stage of research rather than assuming that a particular method will work in the study without a foundation for the assumption. The selected method for this study is content analysis where the collected data wereread by the researcher to extract data necessary for the study. This data collection method was employed by Dladla (2020) to study dictionaries as the content of these resources have to be read to extract data that were analysed to satisfy the objectives of the study.

> Document analysis is a systematic procedure for reviewing or evaluating documents – both printed and electronic (computer-based and internet-transmitted) material. Dladla (2020: 14).

Content analysis is helpful in studying the content of dictionaries for purposes of analysis as envisaged in the current study. This data collection method will help the study extract data from selected resources in order to examine isiZulu dictionaries and prescribed Grade 10 to 12 Life Sciences books and dictionaries. These resources were read and analysed in search for data that can contribute to the research questions. To this end, Mason (2002) created a method that can be used for selecting a data collection method which the study applied. This method links research questions to data collection methods to be undertaken.

3.3.5.2. Data collection resources

Data were collected from published isiZulu dictionaries (the *Scholar's Zulu Dictionary* by Dent and Nyembezi (2009) 4th edition, *Oxford Bilingual School Dictionary: IsiZulu & English* by Gilles-Maurice de Schryver (2015) 2nd edition, *English-Zulu / Zulu-English dictionary* by C. M. Doke, D.M. Malcom, J.M.A. Sikhakhane and B. W. Vilakazi (2014)) and the *Multilingual Natural Sciences & Technology Term List* for English, Afrikaans, IsiZulu, IsiXhosa, Siswati and IsiNdebele from the Department of Arts, Culture Science and Technology (2013). Terminology was collected from the prescribed Life Sciences books by *Life Sciences Grade 10 Learner's book, Life Sciences Grade 11 Learner's book,* and *Life Sciences Grade 12 Learner's book* by Chetty et al. (2011, 2012, 2013).

All selected data collection methods for the study comprise of primary resources. Document analysis of prescribed books was undertaken to study and extract terminology. The content of published dictionaries was studied to examine the structure of resources as well as any possible availability of Life Sciences terminology equivalents in isiZulu from these resources. The researcher then developed a dictionary from this terminology learning from the structure of published dictionaries and further evaluated data compiled to develop the new resource according to the theory of lexical semantics and the theory of lexicographic functions.

Document analysis, a data collection method employed for studying dictionaries, is a procedure that uses a systematic procedure to evaluate written material to interpret and understand data to answer research questions. Therefore, the analysis depends on the researcher's interpretation of material instead of having data that have already been analysed by other scholars. When approaching this type of analysis, researchers employ knowledge from available literature; in this case, dictionaries and literature on lexicography to find points that were analysed in the document. Therefore, an analysis of documents can contain quotations, themes, and other categories of analysis that the study seeks to find (Frey, 2018).

3.3.6 Sampling methods

Sampling in its broad definition refers to principles and procedures applied in the identification, selection and accessing of necessary data using the selected data collection method. This is a process of selecting specific data with the intention of addressing a research objective which allows the study to acquire more constructive data by selecting a few people to participate in

the research. A researcher has to carefully select a sampling method applicable to their research given that various methods exist (Mason, 2002; Onwuegbuzie & Leech, 2007; Dawson, 2002).

The study explored the creation of dictionary development guidelines and a dictionary that would expand lexicographic resources in isiZulu. This task required a study of prescribed material for learners and the translation of the selected terms with their definitions, given that the dictionary being developed is bilingual. To this end, an understanding of various sampling methods was necessary hence each sampling technique is explained below, according to Taherdoost (2016).

3.3.6.1 Probability sampling

This refers to a technique that offers any resource affected by the phenomenon to participate in the study. In this case, the study employed a method of selecting any resource without any bias. This type of sampling was divided into different forms which are explained below.

- Simple random probability sampling: This technique affords an equal opportunity to persons interested in participating in the study even though it comes with disadvantages of the daunting task which may take too much time and resources. Also, there are higher standards of making errors when employing this technique.
- Systematic sampling: The researcher chooses participants at regular intervals. For instance, if children in a classroom are being selected, every fifth child in a row can be chosen to be in the study. The benefit of this selection technique is straightforwardness.
- Stratified random sampling: The population is broken down into smaller groups, and a random sample is drawn from each of these groups to create a new, smaller group for the study. This technique is helpful when there is a very large and diverse sample to choose from.
- Cluster sampling: In this case, the whole population is divided into groups accordingly , for example, geographical areas where the random sample is taken from each group and used as a final sample.
- Multistage sampling: This technique requires the study to move from a broad sample to a narrower one where resources are divided until they become small enough to study − saving money and time.

3.3.6.2 Non-probability sampling

This sampling technique applies when a study focuses on small samples in examining real- life situations where a wide population is not required. The selected participants have to be a wide population or randomly selected but must be clearly identified. This method can be applied in various forms as explained below:

- Quota sampling: For the purpose of ensuring that the overall sample is representative of the real population, participants are chosen based on specified features.
- Snowball sampling: In situations where recruiting participants is challenging, this strategy leverages a few cases to persuade other people to participate in a study, which helps to increase the size of the sample.
- Convenience sampling: This method enables the identification of people who are frequently simple to reach. As the study can approach resources, they are already familiar with, this method of data collection is simpler, less constrained, and more practical.
- Purposive or judgemental sampling: Resources are selected deliberately with the intention of extracting data that cannot be obtained by other sampling techniques. The researcher involves participants that they believe to be needed in the study because of their special characteristics.

When a researcher chooses to employ purposive sampling, they acknowledge that the resources they extract data from will add to a body of knowledge that may already exists and also enable them to learn and be able to respond to the research problem. Subsequently, the study selected non-probability sampling and employed the purposive sampling technique as it allowed the study to ensure that the data collected will contribute to the study and provide answers to research questions (Patton & Cochran, 2002).

Ahmed and Shazali (2016) applied purposeful sampling to study two dictionaries to examine selected entries in those resources to investigate presuppositions in dictionary entries. A researcher that already has knowledge of the data they seek are to purposefully select resources that contain the data being sought. To this end, the study identified and selected prescribed books and dictionaries relevant to each subtopic being examined in the study. The data selected in Chapter 4 was for the purpose of terminology analysis and in Chapter 5 the intention was to study the structure of dictionaries. Samples employed in terminology analysis were typed on

the research report and the same manner was applied in dictionary analysis, even though when the microstructure was studied, images from the dictionary were captured, referenced and examined. Other samples were employed in Chapter 6 during guideline formulation and dictionary analysis. These samples were also images and others were typed and referenced.

3.3.7 Data analysis

Data analysis is a method of putting together facts and figures from the collected data to answer a research question or to resolve a problem. In this stage of research, data are coded according to themes, interpreted, and inferences are made thereby leading the study to draw conclusions. This analysis which can be narrative (being told through field texts); descriptive (summarising the observations made while studying the data); and statistical (using statistical figures) thus creating order, structure and understanding of the data being studied (Ashirwadam, 2014).

Marshall and Rossman (1999) state that data analysis can create order, structure and understanding of the data being studied and this process can be exhausting. Data analysis makes up the process of answering the research question through the arrangement of collected data in order to understand the data collected and studying the same to meet research objectives. These scholars created a formula that serves as a framework for analysing data which is made up of organising data, immersing in the data, categorising data according to themes, coding data, interpreting data, searching for alternative interpretations and report writing. Each step of the formula application in relation to the current study is briefly explained below.

Data collected in this chapter were rich in content therefore this research report comprises of three (3) data analysis chapters in Chapters 4, 5 and 6, respectively. Chapter 4 focuses on the analysis of Life Sciences terminology; Chapter 5 is an examination of learner lexicographic resources; and finally, Chapter 6 is the development of guidelines for developing a dictionary which were followed by the study in creating a new lexicographic resource, as well as an evaluation of the dictionary that was developed, which is found in a link in the appendices.

3.3.8 Ethical considerations

Encyclopedia.com explains research ethics as “the application of moral rules and professional codes of conduct to the collection, analysis, reporting, and publication of information about research subjects, in particular active acceptance of subjects' right to privacy, confidentiality, and informed consent.” Thus, an ethical researcher is a person who applies moral rules and

professional principles when conducting their work and this includes all steps of the research methodology from collecting data to its analysis, reporting and publishing information that has been reported. It stands to reason that a researcher is expected to know these rules and codes of conduct when conducting research. The importance of ethics is evident in that researchers at institutions of learning are not permitted to conduct research without an ethics certificate and journals are to require a submission of ethical clearance to prove that there ethical considerations are taken into account when conducting the study (Fleming & Zegwaard, 2018).

In the current study, the following steps were taken to ensure that the study was conducted in an ethical manner:

- The researcher applied for an ethics certificate through the Wits University ethics office which was approved.
- There were no vulnerable people involved in the study as it is only prescribed books of learners that are engaged and not the learners or data directly pertaining to them.
- All research steps were complied with as discussed in this chapter.
- All resources were referenced.

3.3.9 Conclusion

This chapter was divided into two parts and presented the theoretical framework and the research methodology used in the study. The first part focused on the theoretical framework and presented the theory of lexicographic functions and the theory of lexical semantics which are the foundations of this study. The theory of lexicographic functions presented arguments supporting the study of lexicography as an independent science from linguistics; while the theory of lexical semantics explained the need for studying meaning and the various types of meaning that exist as informed by properties applicable in each situation. In a similar manner, the research methodology's second section was based on the research onion. The pragmatic research paradigm used in the study and justifications for its choice were given. This was followed by the research strategy; data collection; data analysis; and ethical considerations as necessitated by the study. The following chapter provides the analysis of terminology described and collected as explained in this chapter.

CHAPTER FOUR

AN ANALYSIS OF LIFE SCIENCES TERMINOLOGY OF PRESCRIBED LIFE SCIENCES BOOKS IN THE FET PHASE OF PUBLIC SCHOOLS IN SOUTH AFRICA

4.1 Introduction

This chapter analyses terminological gaps in the lexical field of Life Sciences for isiZulu mother-tongue speakers. As the theoretical framework comprises of a lexicography theory and the field of semantics, terminology is examined in line with lexical semantics and its various components. The chapter begins by explaining data analysis and continues to present data in terms of the lexical field, lexical relations, defining subject-specific terminology in English-isiZulu dictionaries, and deliberates on terminology analysis in lexicography which then leads to the chapter conclusion.

4.2 Data presentation and analysis

Data analysis is a process of reading and re-reading data to understand it enough for the study to draw themes that can be examined. This is a mandatory and critical stage of research which enables the study to prove or disprove a hypothesis. To this end, Dladla (2020: 103) states the following:

> *Ukwethulwa kolwazi kuyisigaba esisemqoka kakhulu ekuqhutshweni kocwaningo ngoba kunikeza ithuba lokubuyekeza umcabango ongakafakazelwa ukuze kubonakale ukuthi ngabe ulwazi olusha luyawufakazela yini umcabango owethulwe esigabeni esiyisisekelo socwaningo noma luphikisana nawo. Isigaba sokwethulwa nokuqoqwa kolwazi sethula ubufakazi bocwaningo. Isigaba sokwethulwa nokuqoqwa kolwazi senza ucwaningo luhleleke ngoba futhi kube ngolukholwekayo. Lesi sigaba sibamba iqhaza elikhulu ngoba sinikeza umcwaningi ithuba lokwenza izinqumo ezibalulekile ezithinta isihloko.*
>
> Data presentation is an important phase in research as it provides an opportunity to review ideas that can be proven to establish whether new knowledge supports ideas presented in the research methodology chapter. The data presentation and analysis organise research to make it believable. This stage of research is imperative in providing a researcher with an opportunity to make important decisions on the research topic. (English translation)

As stated by this scholar, this chapter is one of three chapters containing terminological data to be analysed in terms of its comprehensibility to an isiZulu mother-tongue high school learner. This study comprises of three chapters of data presentation and analysis where the reviewer presents new ideas about lexicographic practices in isiZulu resources to support the study. The division of data analysis into three chapters lies in the organisation of the data and the desire to present it according to each theme systematically arranged in the interest of this study. This arrangement begins with the analysis of terminology in the Life Sciences field which establishes a basis of developing a new dictionary; the second part of data analysis in Chapter 5 is an examination of published dictionaries with the aim of studying lexicographic practices and identifying gaps in lexicographic practices in the isiZulu language; and Chapter 6 is a presentation of guidelines established for developing a new resource which is then evaluated to determine the contribution of the new resource in expanding the scope of isiZulu dictionaries in subject-specific fields. This stage of the research will provide the study with knowledge to draw conclusions from findings made in the study to prove or disprove the study hypothesis that the establishment of theoretically founded guidelines of developing lexical resources in African languages that concentrate on domain-specific fields can enhance learner performance and help them minimise linguistic challenges in their education experience.

An assessment by the DBE demonstrates that learners are struggling to grasp terminological terms which contribute to their poor results in examinations. They pose that "Poor performance in Q2.1 was due to a lack of knowledge of basic terminology" (DBE, 2020: 147). The DBE acknowledges that learners are faced with challenges in grasping terminology which directly contributes to learner outcomes. It is for this reason that this study creates a resource that will provide this terminology in the mother tongue of learners to help them understand it better. To this end, this chapter examines terminology located in the lexical field of Life Sciences to establish the possible cause of this challenge faced by learners.

4.3 Lexical field

Lexical units refer to words that can have various meanings upon each usage while lexical field refers to the usage of words in a specific field of study. A single lexical unit can have different meanings relevant to each context that it is used in, and in each form of usage, the meaning is determined by the lexical field being referred to (Rambaud, 2012). The researcher assessed terminology and located terms with different meanings when used in the field of Life Sciences and other contexts in general dictionaries. Definitions given to the terms below is from the

prescribed Life Sciences books for Grade 10 to 12 learners, the Oxford South African Pocket Dictionary (2015) (which according to its cover page is suitable for users who are in Grade 10 to 12) and the Scholar's Zulu Dictionary (2009) which is applicable to learners. These dictionaries were selected because of their suitability for users of the prescribed learner material being examined in this study. The definitions from the English dictionary are, however, only for general usage as this research only considers meaning in line with prescribed material for learners.

The tables below compare definitions of terms from the prescribed learner books and the general language dictionary. This comparison shows that definitions from OC contribute to definitions from LS and ZU:

Term 1: Accommodation

Table 4.1: Terminology sample 1: accommodation

Life Sciences (LS)	**English (ENG-GD)**	**IsiZulu (ZU-GD)**
Accommodation: the ability of the lens in the eye to change shape to clarify the view that is aligned with the distance of an object from the eye.	**Accommodation:** 1. A place where someone lives or stays. 2. A settlement or compromise.	**Accommodation:** *Indawo yokuhlala; indawo yokungenela* (A place to stay; a place where one can visit).

The term 'accommodation' is explained in the ENG-GD as a place of abode and as a type of compromise. This definition coincides with the ZU-GD definition which also explains it as a dwelling or lodging place. These definitions are unable to replace the LS definition as it refers to an ability leaning towards the second definition in ENG-GD of a settlement, where the lens of an eye adapts by changing shape to be in line with the distance of an object which enables the person or animal to see clearer. The definition of a dwelling place is not contained in the LS definition and similarly in the ZU-GD. Etymological traits of 'accommodation' show that the word comes from the French word '*accommodationem'* meaning to make something fit for a situation (Etymologyonline.com). This etymological trace complements all meanings as a house is built to have capacity for people to live, and also the definition related to a compromise is suitable because whoever decides on a settlement enables something to cater for another.

Subsequently, the LS definition is within meanings that can be given to this term even though the subject-specific meaning cannot replace the general meaning due to its bias towards the study of Life Sciences and both the ENG-GD and ZU-GD do not cater for the LS at all. The LS definition is tailor-made for the lexical field of the domain of LS.

Term 2: Cell

Table 4.2: Terminology sample 2: Cell

Life Sciences (LS)	**English (ENG-GD)**	**IsiZulu (ZU-GD)**
Cell: the smallest structural and functional unit of living organisms that can live on its own and that makes up all living organisms and the tissues of the body. 2. any small cavity or area, such as the cavity containing pollen in an anther. 3. one of the areas on an insect wing bounded by veins.	**Cell:** 1. A small room for a prisoner, monk or nun. 2. The smallest unit of a living organism that is able to reproduce and perform other functions. 3. A small compartment in a large structure. 4. A small group that is part of a larger political organisation. 5. A device for producing electricity by chemical action or light.	**Cell:** *inhlayiya; inhlayiyakuphila* (a very small element; a life-giving cell).

The term ‘cell’ in ZU-GD is directly aligned to the LS definition as it refers to a very small element and further provides an equivalent of a ‘life-giving cell’ which is precisely the explanation of the LS. The lemma in the resource is entered thrice as different entries in the ZU-GD with the first entry referring to a small item or room; the second entry describes a battery; and the third entry refers to the ‘cell’ in the Life Sciences context. Subsequently, the entry selected and recorded in this table is the latter entry because of its relevance to this research. That definition is not recorded in the above table as there was an entry relevant to this study. The ENG-GD provides one entry with several definitions which all refer to something small that is part of a larger structure. The multitude of definitions in both the LS and the ENG-GD are omitted in the ZU-GD which only offers a domain-specific definition. Despite the

multiple definitions in the ENG-GD none of the definitions accommodate the LS definitions thus making the resource irrelevant when used in a specified domain of Life Sciences.

Term 3: Cholesterol

Table 4.3: Terminology sample 3: cholesterol

Life Sciences (LS)	English (ENG-GD)	IsiZulu (ZU-GD)
Cholesterol: a modified steroid that is synthesised by animal cells to become an essential component of animal cell membranes	**Cholesterol:** A compound which occurs normally in most body tissues and is believed to cause disease of the arteries if present in high concentrations in the blood.	**Cholesterol:** N/A

The LS and the ENG-GD definitions are aligned as the term is from Life Sciences. The difference lies in the simplicity of definitions as the ENG-GD explains it in a simple manner and further adds what cholesterol can do to the body which is absent in the LS that only focuses on its importance. These definitions are beneficial to users speaking English as they are already subject specific. The ZU-GD, on the other hand, does not have the entry in the resource. The researcher investigated other dictionaries in isiZulu but did not find the entry. This means isiZulu mother-tongue learners are not provided for at all when it comes to this term thus creating a lexical gap in the language. The development of a dictionary in this study adds the term to isiZulu lexical resources which ultimately bridges this lexical gap.

Term 4: Consumer

Table 4.4: Terminology sample 4: consumer

Life Sciences (LS)	English (ENG-GD)	IsiZulu (ZU-GD)
Consumer: an organism that eats another for its food because it cannot manufacture its own.	**Consumer:** A person who buys a product or service for personal use.	**Consumer:** *odla noma osebenzisa okuthengiswa ngabanye* (one who eats or uses something sold by others)

‘Consumer’ is defined as a person who obtains a product so that they can use it which is different from the LS definition but if one scrutinises the latter definition, relations can be established. The LS explains it as something that eats another because it cannot produce for itself. This shows a relation in terms of ‘usage’ since both terms refer to using something that is obtained from another resource. Both definitions show the need to find what is being sought and then using it for personal gain. As much as this relation exists in LS this definition is specific to eating because a species cannot produce for itself whereas in the ENG-GD the element of the inability to self-produce is not there. A person can be a consumer who purchases bread by choice and not necessarily because they cannot bake. A general consumer becomes a consumer because of a specific reason and need while the LS consumer is more driven by the lack of ability to produce.

When considering the ZU-GD semantic entry which is a bilingual dictionary, there is no equivalent provided instead there is a meaning which uses the word ‘*ukudla*’ meaning to ‘eat’ and also uses the word ‘*ukusebenzisa*’ meaning to use. The use of these verbs is similar to English in that a consumer is one who uses something; however, the ZU-GD continues to add that they use something ‘sold’ by another. This definition adds an element of not being able to produce an item by yourself as alluded to in the ENG-GD. These definitions are aligned with the LS; however, this does not make the definition explicit for a consumer in LS because a learner explaining a consumer as one or something that purchases and uses something acquired from another would be incorrect because of the element of purchasing. As much as a consumer in LS is something that uses something it is unable to produce; purchasing introduces a human element which is not aligned with the LS definition.

Term 5: Organ

Table 4.5: Terminology sample 5: organ

Life Sciences (LS)	English (ENG-GD)	IsiZulu (ZU-GD)
Organ: a group of tissues in a living organism that have been adapted to perform a specific function.	**Organ:** 1. A part of an animal or plant that has a particular function, for example the heart. 2. A large musical keyboard instrument with rows of pipes supplied	**Organ:** *Ugubhu, iogani* (musical); *isitho somzimba* (biological); into *yomsebenzi, umlomo* (instrument).

	with air from below. 3. Smaller keyboard producing sounds electronically. 4. A newspaper or journal which puts forward the views of a political party or movement.	

The term ‘organ’ has multiple meanings in the ENG-GD, with the first definition as the most relevant to Life Sciences. Other definitions refer to a musical instrument or a component of a musical instrument while the last definition refers to newspaper reports that focus on a specific function. The musical instrument definitions may be outside of the scope of the study but the last definition although outside of Life Sciences focuses on satisfying a function that will promote work of a fraction of the society. The part of the fulfilment of a function is close to the LS definition, although it cannot replace the LS definition which points to a part of the body comprising of a group of tissues performing a specific function in the body. Fortunately, a user of the ENG-GD will not be baffled by other definitions because the first definition is from the Life Sciences’ perspective explaining it as ‘part of an animal or plant that has a particular function’. Thus, one can conclude from the ENG-GD that an organ is something that satisfies a function of another and in Life Sciences it is a part of a living thing that promotes a specific function in the body of that living thing.

On the other hand, the ZU-GD definition provides three (3) equivalents related to music. Additionally, the biology or Life Sciences explanation is provided as ‘*into yomsebenzi’* meaning something for doing work. The explanation is vague in that it can refer to anything in the universe; therefore, should learners try to learn from this definition they would not profit although the element of satisfying a function is found in the English resources. The difference lies therein that not much detail is provided in terms of where this function is conducted. Thus, this resource does not directly assist one to understand the term from the equivalent provided. Another observation is related to orthography even though it is not part of the data analysed in this chapter, is that the word ‘*iogani’* is not updated. The PanSALB 2008 orthography booklet could have been employed in the writing of this term as the resource was developed in 2009. The correct and latest spelling is *i-ogani* as vowels do not follow each other in isiZulu (PanSALB, 2008).

Consulting dictionaries can benefit the user in gaining a general understanding of a term, although due to lexical field differences, terms may not have domain-specific data and at times the term may not be found in the general resource at all. Thus, consulting a general dictionary does not completely benefit the user in finding domain-specific data. However, an understanding of a lexical field of terms is important for a user to consult the correct lexical resource because subject-specific terminology is at times not available in current resources as noted with the term 'cholesterol'. The researcher did not find the lemma even in other resources employed in this study as the entry is not recorded. This is a clear indication of lexicographic gaps in African languages and the necessity of developing domain-specific resources for high school learners to help them be on par with their English-speaking and Afrikaans-speaking classmates who have access to resources in their mother tongue. The development of such resources will help learners obtain lexicographic information in English, the language of schooling. The researcher acknowledges this resource with the reservation that it is an additional English resource for learners and since it was developed in 2001 in South Africa, consideration for indigenous and previously marginalised languages is still missing. Domain-specific dictionaries benefit a lexical field by developing more terms and adding to the knowledge of users of that semantical field by using simple vocabulary that is understood by people in that specific field. Thus, the resource being developed in this study is adding to the simplification of domain-specific knowledge in an African language.

4.4 Defining subject-specific terminology in English-isiZulu dictionaries

The theory of lexicographic functions employed in this study places the user as key to the formation of a lexicographic project because the user of a dictionary determines how a dictionary is to be created and the information to be contained therein. Therefore, subject-specific dictionaries are created with specific users in mind. To this end, Rittner and McCabe (2004) in introducing the Encyclopaedia of Biology, stated that the resource was created as a reference resource to help users understand basic biological concepts and related disciplines. Unfortunately, such a resource is not yet available for isiZulu learners of Life Sciences to assist learners to understand basic terminology in the field. The closest resource found was in the Natural Sciences for Grade 4 to 6 learners. This resource has isiZulu equivalents of basic scientific terms for primary school learners. Given the absence of a resource for Grade 10 to 12 learners in the field of sciences as a whole, the study searched the Grade 4 to 6 dictionary and the general isiZulu dictionaries for dictionary definitions available for terminology from

the lexical field of Life Sciences. The researcher searched for these terms in the following dictionaries:

- *Scholar's Zulu Dictionary* by Dent and Nyembezi (2009) 4th edition, hereafter referred to as the SZD
- *Oxford Bilingual School Dictionary: IsiZulu & English* by Gilles-Maurice de Schryver (2015) 2nd edition, hereafter referred to as the OUPEZ
- *English-Zulu / Zulu-English dictionary* by C. M. Doke, D.M. Malcom, J.M.A. Sikakane and B. W. Vilakazi (2014), hereafter referred to as EZD
- *Multilingual Natural Sciences & Technology Term List* for English, Afrikaans, IsiZulu, IsiXhosa, Siswati and IsiNdebele from the Department of Arts, Culture Science and Technology (2013) hereinafter referred to as the MNST-NGUNI

The researcher randomly selected terminology from the prescribed textbooks for learners and searched for their entries in selected English-isiZulu dictionaries. Searching involved identifying the lemmata in dictionaries and comparing semantic data recorded for each entry to examine how each resource treated each lemma. This was done to determine whether these resources were able to satisfy the needs of users in the field of Life Sciences. Bergenholtz and Tarp (2003) assert that the function of a dictionary guides the lexicographers in creating a resource that will help users gain information about terms in a manner that satisfies their needs in their situation. When learners approach dictionaries, they hope to find elements which could be a part of speech, meaning or even the correct spelling of the word. A dictionary should be able to meet those needs or part thereof. Below are randomly selected terms that the study searched for in each resource. The isiZulu semantic data are translated according to Mbatha (2006).

(a) Anatomy: the study of a specific biological branch in science that deals with the structure and identification of organism's bodies and their different sections.

- *i-anithomi* (anatomy); *ubungcweti bokuhlahla* (the science of analysing); *isayensi yesimo* (the science of a structure); *isimo senhlanganisela* (something that has been put together); *Inhlaziyo* (an analysis) (SZD)
- *Umumo womzimba* (the body structure); *Isayensi yomumo womzimba* (the science of the body structure); *Isimo senhlanganisela* (something that has been put together) (EZD)

- *Isayensi; yomumo womzimba* (the science of the body structure) (MNST-NGUNI)

The term was transliterated in the SZD and then explained as the science of analysing an object as well as the science of a structure and combining of elements. This definition, when compared to the English definition, only focuses on the element of structural analysis of the body. The common element throughout the semantic data provided in SZD is an 'analysis'. In the same vein, the semantic data found in the EZD states that it is the structure of the body which is similar to the MNST-NGUNI.

Semantic properties show different types of meaning that can be found in a lexical item, and the type of meanings offered to the term is a descriptive type of explanation. The term is analysed to describe what it is; thus, providing the sense that is not inferred but vividly recorded. When comparing the descriptions or equivalents provided for the term in lexical resources all resources managed to state that it is a science of studying the structure of the body which is also mentioned in the English definition. Thus, a user of these three resources will be in a position to gain meaning that they are already learning at school, but in this case, the meaning would be learnt in their mother tongue. Therefore, the use of lexicographic resources to find information in a lexical field proves to be a beneficial strategy for languages that lack lexicographic resources in specific domains.

(b) Bronchi: these are the main airways into the lungs.

- *Imithanjana yomoya emaphashini* (small veins in the lungs) (EZD)

This term was only found in one isiZulu resource which is the EZD with a description that is related to the English one save that this resource mentions the word 'vein' while the English refers to it as 'airways'. When searching for the English equivalent of the word '*imithanjana*' (small veins) which is a diminutive form of the word *umthambo*, the study found the following equivalents in English:

thambo (umthambo 2.4.3.9, *imithambo*) (n)

1. Vein, artery (of the body), blood-vessel; tendon.

2. Rib of a leaf.

3. Fibre, fibrous material, string (as in sweet potato, bean)

4. Real essence (of a matter) (Dent and Nyembezi, 2014:1140)

Given that the above semantic data explain *imithanjana* with many equivalents, the user would have to determine which semantic data belong to the lexical field being described. The closest equivalent to the lexical field is the first equivalent. However, the Merriam Webster online dictionary defines 'airways' as a space that enables air to pass through and the 'vein' is described as a blood vessel. This means that the first equivalent does not adequately fit in the definition of the term in English. The better equivalent is the third one in that 'fibre' when referring to a 'string' can be closely associated with the Merriam Webster explanation of airways. Another issue with this definition is that the isiZulu semantic data do not state that these are airways leading to the lungs but only states that they are found in the lungs. The connection with the parts they are attached to is absent in the equivalent.

The study translated the equivalence as 'small veins in the lungs' or 'fibre in the lungs' because that was the sense found when approaching the term. It can mean both unless one has knowledge of the English definition then conclusion can be drawn to detach the equivalent from the 'vein'. Stringer (2019) holds that sense is the idea that is created in the mind when a person encounters a word. This demands clarity in lexicographic resources to help users decontextualise lemmata easily upon searching for semantic data in resources. The temptation to take *imithanjana* as veins cannot be ignored as this is a Life Sciences term which includes knowledge of 'veins' due to cognitive semantic properties that have already been created in the mind of users. Cognitive semantics enables language speakers to quickly align words with something they mostly acquainted with. In this case, '*imithanjana*' is a commonly used term therefore users can easily associate the EZD equivalent to that meaning. Subsequently, a user defining 'bronchi' according to the EZD, will not obtain a complete definition as a user using the English resource because of different senses that may be drawn from the semantic data.

(c) Embryo: an organism in its early stage of development that develops from the unicellular zygote by repeated mitotic divisions.

- *Umbungu* (an unborn offspring of a human or animal that is still in the womb); *isibindi sembewu* (a portion of the seed that develops to a plant*); i-embriyo* (an embryo). (OUPEZ)

- *Umbungu* (an unborn offspring of a human or animal that is still in the womb); in embryo: *ngakalungiswa* (that which has not been fixed), *-ngakakhuliswa* (that which has not been developed) (EZD)
- *Umbungu* (an unborn offspring of a human or animal that is still in the womb); *Umqumbe* (a flower that has developed to a stage where it is about to bloom); *isibindi sembewu* (a portion of the seed that develops to a plant) (SZD)
- *Umqumbe* (a flower that has developed to a stage where it is about to bloom) (MST-NGUNI)

The description given to this entry is similar in all resources, including the English resource. This lemma has been described as an offspring in three resources save for the MST-NGUNI which only provided the agricultural meaning while the other three resources refer to the latter meaning as secondary to an offspring of a human or animal. The English definition is inclusive in that it refers to the early stage of development for any living thing inclusive of human, animals and agricultural items. The semantic property of reference in the isiZulu equivalents allow the user to select a meaning that occurs in their mind when the lemma is mentioned. These resources provided two definitions stemming from one sense of early-stage development but in different objects. Reference directs a user to a particular meaning and these meanings point a user to the world of human and animal birth plus the development of plants and seeds. Users of isiZulu lexicographic resources would get a sense and referential information of the term and they would have to use their personal knowledge that an embryo is still developing which then completes the English definition. Bearing in mind that bilingual dictionaries often provide equivalents instead of definitions, these resources successfully presented semantic data that would place the user at the same level as a user of the English resource.

(d) Mammal: endothermic vertebrates belonging to class Mammalia identified by having three middle ear bones, lower bones jaw made of single bone, and four chambered hearts.

- *isilwane esincelisayo*. (An animal that breastfeeds) (OUPEZ)
- *isilwane esincelisayo*. (An animal that breastfeeds) (EZD)
- *Isilwane esincelisayo*. (An animal that breastfeeds); *-ncelisayo* (that which breastfeeds) (SZD)
- *-ncelisayo* (that which breastfeeds) (MNST-NGUNI)

Equivalences given to this lemma in isiZulu all refer to one element about this type of animal which is that it provides its young with food from the breast. This is unfortunate because the English resource provides much more information describing it from the type of bones it has and elements of its heart. None of this information is available in the isiZulu dictionaries. Cognitive data provided in the bilingual dictionaries only create one element of this type of animal which limits the information given to the user. However, the dictionaries being explored are for general use and the cognitive function of dictionaries, according to the theory of lexicographic functions is, to provide cultural and generally available data about the term. The Merriam Webster online dictionary as a general language resource also includes the characteristic of breastfeeding and omits the scientific information provided in the English resource. The general sense that it is common among mammals to feed their young makes the provided equivalents relevant although they would not benefit the user much due to their shortage of scientific information.

The lexicographic functions of general dictionaries are to provide general information; however, some terms belonging to certain lexical field are also found in these dictionaries. The availability of these terms as lemmata in general language dictionaries can be beneficial to users who do not have scientific dictionaries in their languages. The problem identified in general language dictionaries is that the definitions provided therein are general and not scientific. This limits the knowledge users are able to obtain from these resources. Subsequently, dictionaries that comprise of field-specific terms are necessary as they provide definitions that are specific to that semantic field. Terms from Life Sciences textbooks examined in this study indicate a gap in lexicographic resources in isiZulu which the current study bridges through developing a subject-specific dictionary in the language.

4.5 Lexical relations in Life Sciences Terminology

A common way of determining word meaning is the examination of relations that exist between them. Various senses of words are studied with regard to terms that have a similar meaning (synonyms), words that have opposite meanings (antonymy), and related words (Kroeger, 2018).

Alameh (2018) posits that lexical relations can help learners of a foreign language in their acquisition of vocabulary and to learn more about the language. This will not only help them

identify words but they can stretch themselves to learn meanings that exist between words once they are aware of how they relate to each other. Subsequently, lexical relations that exist in Life Sciences terminology are examined in this subsection, and they are presented below according to types of relations that exist among them.

4.5.1 Antonyms

Table 4.6 provides examples of antonyms that were identified:

Table 4.6: Antonyms

LIFE SCIENCES ANTONYMS	
Abiotic factor: A non-living chemical or physical factor in the environment, such as soil, *ph*, forest fire, etc.	**Biotic factor:** Living components or factors that affect an ecosystem or other organisms living in that ecosystem.
Herbivore: Organisms that eat plant material only.	**Carnivore:** Flesh-eating organism.
Indigenous species: A plant or animal originally occurring in that country.	**Alien species:** Species of living organisms that do not naturally live in a particular habitat.
Vasodilation: Widening of the blood vessels in the skin in humans, which increases the amount of blood flowing to the skin when the environmental temperature is high.	**Vasoconstriction**: Narrowing of the blood vessels in the skin in humans, which decreases the amount of blood flowing to the skin when the environmental temperature is low.
Long-sightedness: A defective condition of the eye that means that a person can see distant objects clearly while nearby objects are blurred.	**Short-sightedness:** A defective condition of the eye which means that a person can see nearby objects clearly while distant objects are blurred.
Vertebrate: animal with a backbone	**Invertebrate:** animals without a backbone.

The definitions of words in the above table distinguish them from each other thus qualifying them as antonyms. Words in **Table 4.6** are antonyms in that they mean the opposite of each other. Shakzoda (2021) posits that there are different types of negations, namely lexical, semantic, clausal and phrasal negations. Since this study is a study of terminology it considers lexical, semantic and clausal relations through a lexical semantics perspective where whole words are being studied and not phrases.

- Lexical negations

Lexical negations are created by adding an infix to a positive word which changes a positive meaning to a negative one. In **Table 4.6**, the entries 'abiotic factor' and 'invertebrate' are samples of lexical negations. Abiotic factor has the prefix 'a-' which changes its meaning from 'biotic factor' to 'not biotic factor' which provides an opposite meaning of the former. Similarly, the word invertebrate has the prefix 'in-' which changes the 'vertebrate' to 'not a vertebrate' which is the opposite meaning. A learner with a knowledge of English lexical negations will be in a position to assume the meaning of any of these two antonyms is the opposite of another.

- Semantic negations

Semantic negations are words with opposite meanings by nature and not because affixes were added to them to change their meanings. These words are completely different but related in that they mean the opposite of each other. Semantic negations in the table are herbivore vs carnivore, indigenous species vs alien species, and vasodilation vs vasoconstriction. These terms are opposite in terms of their definition which means the opposite of each other, as can be seen in the table. The relationship between these terms is not created by the words themselves but by their natural meaning as independent lexical units.

- Clausal negations

Clausal negations are changes in meaning created by denying the truth of another. The words on their own contain their own truth but one has the power to remove the truth of another. Therefore, they cannot be used to refer to one item. This can be seen in the sample 'short-sightedness' and 'long-sightedness'. The adjectives 'short' and 'long' are words with opposite meanings and their addition to the word 'sightedness' give opposite meanings to the word. As stated in their definitions, a short-sighted person can see nearby items clearer as compared to a long-sighted person who cannot see nearby items clearly.

Antonyms identified in this terminology show different construction methods that create opposite meanings which when known by a learner can help them presuppose the meaning of a word when they encounter it. Syntactical knowledge of the English language structure adds to the vocabulary knowledge of learners of a foreign language; therefore, these lexical relations can benefit learners in understanding terminology. The identification of lexical relations in words can help learners improve their language knowledge. The terms 'biotic factor' and

‘abiotic factor’ are identifiable by looking at the words as related in that the only difference between them is the negation ‘a-’. This negation means ‘not’ therefore an ‘abiotic factor’ can also be regarded as a ‘not biotic factor’. Lexical negations and clausal negations are glaring and can be identifiable much easier than semantic negations that require a definition in order to identify this relation.

This study considers second language learners as foreign language learners in that the language they are learning in is not their mother tongue. Subsequently, knowledge of the framing of antonyms in the English language would benefit them in their understanding of Life Sciences terminology. English negations are different from isiZulu antonyms even though the structure is similar. Therefore, linguistic knowledge of the English language can benefit learners in understanding terminology in various lexical fields.

4.5.2 Hierarchical lexical relations

These relations show words to be related to each other in terms of hierarchy from a superordinate word (a word that is highest in the rank compared to others listed with it) and hyponymy (part of what is being referred to) and meronymy (a type of that which is being referred to). In explaining these relations, the study begins by describing hierarchical levels of lexical relations according to Kroeger (2018).

- Superordinate/hyperonyms: These are words at the highest level for a term at a given time. For example, **animalia**: the arrangement of the kingdom of all animals. This term refers to all animals and when placed at the highest level of the hierarchy can have different types of animals and different parts of animals under it in lower levels.
- Hyponyms: These are words that are part of a superordinate. For example, chromosome (a string-like structure found in the nucleus of dividing cells that contain hereditary material DNA) can be the superordinate and **chromatid** (half of a chromosome) is a hyponym because it is part of the whole.
- Meronymy: These are words that are part of a term that is in a level higher than it. Examples are types is the hyponymy of diseases which contains various types that form part of what a ‘disease’ is, such as epiglottis or dwarfism.

Adamska-Salaciak (2012) asserts that lexical relations can be used by lexicographers when forming semantic data for lemmata such as the provision of hyponyms in defining a lemma that is from a higher level (hypernomy). Defining a term can at times require words that users

can easily associate with the lemma being described. For example, the SZD provides in its entry for ‘frog’ a meronym which is a type of frog.

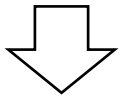
> Frog (n) *isele; iselesele, ingxangxa, ixoxo; ijunguju* (f.spawn) (Dent & Nyembezi, 2009:119)

The semantic data ‘*isele, iselesele and ixoxo’* are synonymous while ‘*ingxangxa*’ is a type of frog that has a green line (Mbatha, 2006). The lexical relations in this example have been used to explain the lemma as they belong to the world where the term is applied which adds value to the term. Below are two hierarchical lists of lexical relations.

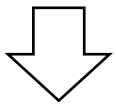
a)

Table 4.7: Lexical relations

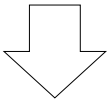
vegetation (all the plants or plant life of a place, taken as a whole)
izimili (zonke izitshalo noma impilo yezitshalo yendawo, ebalwa isiyonke)



flora (all the plant populations present in a certain habitat)
izitshalo. (yonke imiphakathi yezitshalo ekhona endaweni yokuhlala ethize)



alien plant (plants that do not naturally belong in a particular habitat)
isitshalo sokufika (izitshalo okungezona ezasendaweni yokuhlala ethile ngokwemvelo)



variegated leaf (a leaf with a variety of colours.)
iqabunga elimibalaminingi (iqabunga elinemibala eminingi.)

The term ‘vegetation’ pertains to all plant life that exists and ever existed which makes the word superordinate, this is followed by the hyponymy ‘flora’. ‘Flora’ is a hyponymy as it is

more specific making reference to a specifically defined vegetation; in the next level is a holonomy 'alien plant' which is a whole word which is part of something, in this case 'flora' that can contains parts that it can be broken down to, in this case, 'variegated leaf' which is a type of leaf and word types in lexical semantics is called a meronymy. **Table 4.8** provides another example below.

Table 4.8: Lexical relations

blood circulation system: a network that moves blood to different parts of the body ***umgudu wegazi:*** *unxanxathela ohambisa igazi ezingxenyeni ezahlukene zomzimba.*			
Artery: a vessel that carries blood high in oxygen content away from the heart to the farthest reaches of the body. ***umthambo wegazi elihlanzekile:*** *umthambo othwala igazi eliqukethe i-oksijini eningi ulisusa enhliziyweni liya ezindaweni zomzimba ezikude kunazo zonke.*		**Vein**: one of the systems of branching vessel or tubes converting blood from various parts of the body to the heart. ***umthambo wegazi elingcolile:*** *olulodwa lwezinhlelo zemithambo eba amagatsha noma amashubhu ahambisa igazi elisuka ezindaweni ezahlukene emzimbeni eliya enhliziyweni.*	
pulmonary artery: blood vessel transporting oxygenated blood from the lungs to the heart. ***umthambo osuka emaphashini:*** *imithambo yegazi ehambisa igazi eline-oksijini omningi ukusuka emaphashini ukuya enhliziyweni.*	**renal artery:** blood vessel carrying oxygenated blood with nitrogenous wastes to the kidney. ***umthambo oya ensweni:*** *umthambo wegazi othwala igazi eline-oksijini eningi elinodoti onenayithrojini liya ensweni.*	**pulmonary vein:** blood vessel transporting oxygenated blood from the heart to the lungs. ***umthambo oya ephashini****:imithambo yegazi ehambisa igazi eline-oksijini elisuka enhliziyweni liya emaphashini*	**renal vein:** blood vessel carrying de-oxygenated blood with very little nitrogenous wastes away from the kidney. ***umthambo osuka ensweni:*** *umthambo wegazi othwala igazi eline-oksijini encane elinodoti omncane kakhulu onenayithrojini lisuka ensweni*

The superordinate term is ‘blood circulatory system’ which has two examples of hyponyms that are part of the blood circulation system — ‘artery’ and ‘vein’. These hyponyms can be further divided into types (meronyms) which are shown in different boxes because their relations at that level only pertains to either artery or vein. In other words, ‘renal vein’ cannot be substituted for ‘renal artery’. The word used for ‘artery’ and ‘vein’ is recorded as *umthambo othumelayo and umthambo obuyisayo* (Nyembezi, 2015), respectively. This can confuse the learner because it doesn’t specifically state where the blood flows to or from. English dictionaries provide lemmata with definitions that clearly distinguish between the two. IsiZulu dictionaries do not provide this because they are bilingual – only providing equivalents. Subsequently, this study differentiated between these two terms in their translations by adding where the organ the blood is being transported to or from. As a result, the pulmonary artery has been translated as a ‘vein’ that transports blood from the lungs and pulmonary vein as a ‘vein’ that transports blood to the lungs. The same practice was applied to renal vein/artery.

4.5.3 Cross-referencing

Purdy (1987) describes cross-referencing as identifying lexical units that belong to the same group. These lexical units need not mean the same thing but they can be identified through a common lexical unit. **Table 4.9** provides examples of cross referencing from the terms ‘animalia’ and ‘hormone’.

Table 4.9: Cross referencing: Flora

Flora: all the plant populations present in a certain habitat **Izitshalo:** *yonke imiphakathi yezitshalo ekhona endaweni yokuhlala ethize*		
Mesophyte: plant living in areas with normal amount of water which do not show any adaptation to wet or dry environments**. imesofayithi**. *isitshalo esihlala ezindaweni ezinomthamo wamanzi ojwayelekile ezingakhombisi noma yikuphi ukuvumelana nesimo sezindawo zokuhlala ezimanzi noma ezomile.*	**Angiosperm**: a plant that produces flowers. **izikhiqizambali**. *isitshalo esikhiqiza izimbali*	**Hydrophyte:** plants with special adaptations to live in or around water. **isitshalo esiphila emanzini**. *izitshalo ezinezakhiwo ezikhethekile ezivumelana nesimo ukuze zihlale emanzini noma eduze kwamanzi*

The lexical units in the three bottom boxes are all related to flower and can be replaced by the word 'flora' because they are part of the plant population. These words can be cross-referenced with the top lexical unit.

Table 4.10: Cross-referencing: Hormone

Hormone: chemical messengers which are protein in nature secreted by endocrine glands. **isigqa**. *izithunywa ezingamakhemikhali ezingamaphrotheni ngokwakhiwa kwazo ezikhishwa izindlala zohlelo lwamahomoni*		
Insulin: a hormone that stimulates the conversion of excess glucose to glycogen. ***i-insulini***. *ihomoni ekhuthaza ukuguqulwa kweglukhosi ibe i-glycogen*	**Testosterone:** a male sex hormone produced by testes that stimulates the maturing of sperms and stimulates puberty in males. ***isigqa sabesilisa.*** *ihomoni yobulili yabesilisa ekhiqizwa amasende ekhuthaza ukuvuthwa kwesidoda futhi ikhuthaze ukuthomba kwabesilisa*	**Oestrogen:** a hormone that causes thickening of the endometrium and is produced by the Graafian follicle. ***isigqa sabesifazane***. *isigqa esibanga ukuba ugqinsi kolwelwesi lwesibeletho olungaphakathi futhi ekhiqizwa i-graafian follicle*

The three relations in the bottom boxes can be substituted for the lexical unit 'hormone' as they are types of hormones. This makes cross-referencing a simpler way of understanding the item being referred to, in the general sense, and when one gets technical, one can differentiate between the lexical units. The difference in meaning of the lexical units is identifiable in the definitions provided for each of them.

4.5.4 Partitioning

This is the division of a lexical unit to smaller lexical units that can form from the main lexical unit. Purdy (1987) poses that this type of lexical units requires the decomposition of lexical

units to smaller units and this can be limitless as relations between words can be limitless. **Table 4.11** provides examples of partitioned lexical units.

Table 4.11: Partitioning: cell

<table>
<tr><td rowspan="2">cell. 1. the smallest structural and functional unit of living organisms that can live on its own and that makes up all living organisms and the tissues of the body
inhlayiya. 1. iyunithi encane kunazo zonke yesakhiwo sezinto eziphilayo esebenzayo engaziphilela yodwa futhi eyakha zonke izinto eziphilayo kanye namathishu omzimba</td><td>cell cycle: the series of events that take place during the lifetime of a cell.
impilomjikelezo yenhlayiya. uchungechunge lwezehlakalo ezenzeka ngesikhathi sokuphila kwenhlayiya</td></tr>
<tr><td>cell wall: a semi-rigid thick protective structure that surrounds the cell membrane of some types of cells for protection
isembozanhlayiya. isakhiwo esiqine ngokungaphelele futhi esiwugqinsi esizungeze ulwelwesi lwenhlayiya lwezinye izinhlobo zezinhlayiya zokuvikela nokunika izinhlayiya umumo wawo</td></tr>
</table>

The lexical unit ‘cell cycle’ and ‘cell wall’ are decomposed from the lexical unit ‘cell’. The bottom lexical units can be further broken down to more words that would come out of each of them and those words too can be further broken down. This partitioning can lead a learner to associating and grouping terms according to their lexical relations which would show a better understanding of the terms. **Table 4.12** provides another example of partitioning from the term.

Table 4.12: Partitioning: eye

<table>
<tr><td rowspan="2">Eye: animal organ that enables them to see.
Iso. Isitho somzimba sesilwane owenza ukuba sikwazi ukubona</td><td>Iris: the coloured part of the eye which regulates pupil size and subsequently controlling the amount of light entering the eye.
isiyingi seso. indawo enombala yehlo elawula ubungako benhlamvu yehlo bese ngokulandelana ilawule ubungako bokukhanya obungena ehlweni</td></tr>
<tr><td>Lens: a structure in the eye that focuses light rays onto the retina for clear vision.
ilensi. isakhiwo ehlweni esiqoqela imisebe yokukhanya ku-retina ukuze kubonakale ngokucacile</td></tr>
</table>

The ‘iris’ and the ‘lens’ as reflected in their definitions are parts of the eye and these parts have their own parts and can be further divided thus making partitioning and lexical relations unending for lexical units.

Rambaud (2012) explains that lexical relations can vary according to the intended meaning in each context and this is supported by Purdy (1987) who states that the meaning of a lexical unit should be examined according to each context. This helps language users understand what is meant by a word as used in each instant. This chapter presented lexical units and lexical relations that demonstrated the dependency of words on other words. For example, one cannot speak of the ‘iris’ without using the word ‘eye’ because of the type of relations that exist between these words. The same can be said about antonyms such as ‘carnivore’ and ‘herbivore’ that can make one wonder what word would refer to an animal that feeds on both meat and plants; thus, arousing interest in the learner to learn more about the types of animals.

4.6 Terminology analysis in lexicography

Terminology examined in this chapter demonstrated the need for the development of Life Sciences terminology in isiZulu. General language dictionaries provide limited data for learners because they do not define terms or provide equivalents that have been designed for the specific field of study. Terminology development is currently of interest in South Africa as universities are developing terminology for their learners. Should high school learners be privileged to have terminology resources in their mother tongue, their transition to higher education would be facilitated because they would enter with knowledge that was provided to them in their mother tongue (Trudell, 2016).

Terminology development is a multistage process that requires a team to perform the project and submit developed terms for approval to the PanSALB. The current study does not focus on terminology development but studied terminology for dictionary development purposes. Béjoint (2010) states that lexicography and linguistics have a relationship in that lexical items have to be examined using semantical knowledge and then being created into dictionary lemmata. For this reason, the current study examined terminology in order to translate terms in a manner befitting the lexicographic function of the dictionary being developed, which is to place isiZulu learners at the same level of understanding Life Sciences terms as their peers. Diko (2018) states that learners who learn in their mother tongue perform better; therefore, the dictionary developed in this study aims to assist learners to understand terminology better and hopefully, obtain better outcomes in their learning experience.

In translating terminology to be incorporated in the dictionary, the study examined bilingual isiZulu dictionaries and further studied relations that exist among terminology. Understanding lexical relations contributed to consistency in translation of terms. It assisted the study in differentiating between related words by interrogating their meanings in lexicographic resources and prescribed learner textbooks. This contributed to the provision of correct definitions.

Superordinates are employed when there is a lexical gap in a language (Kroeger, 2018). This means that where a dictionary developer does not have an equivalent term, they can examine lexical relations that exist in a word and use a word in a higher level that will contain the meaning of the term within the superordinate. An example of this approach was found in one of the dictionaries examined in this study (EZD) in their treatment of 'womb' and 'ovary'. The Oxford South African Pocket Dictionary (2015:1004) provides 'uterus' as a synonym for 'womb' (2015: 1050) and the current study considers the entry 'uterus' as an entry in the Life Sciences terminology to be synonymous to 'womb' as the former dictionary does not have 'uterus' as entry but has 'womb'. The terms are treated as follows:

Womb: *isizalo, inimba* (EZD, page 409)
Ovary: *Isizalo* (EZD, page 238)
Womb: *isizalo* (EZD, page 1236)

The definitions of these words are completely different, yet they are given the same equivalents. There is no equivalent for '*inimba*' in the same resource, however the SZD (2009:488) has an equivalent for the lemma as 'birth pain'. Now birth pains are something completely different and may have served a better purpose under a different entry. When considering entries for the same lemmata in the SZD, 'uterus' is an entry and 'ovary' is entered with the following semantic data.

Uterus: *isibeletho, isizalo, isisu* (SZD, page 330)
Ovary: *isizalo, indlala yamaqanda, isizalo sembewu* (SZD, page 208)
Womb: *isizalo, inimba* (SZD, page 342)

The treatment of these terms in these resources have only ***isizalo*** which literally means 'of birth' as a related term which is a superordinate and not specifically identifying the part of the female reproductive system being referred to. The closest equivalents in these entries with their equivalents are uterus – *isibeletho*, ovary – *indlala yamaqanda*; 'womb' could have taken the equivalent 'isibeletho' as it is synonymous with 'uterus'. An understanding of the relationship between these parts of the female reproductive system is important for lexicographers to make a distinction when creating entries.

Figure 4.1 below provides a picture of the female reproductive system and illustrates the distinction of these lexical items from each other.

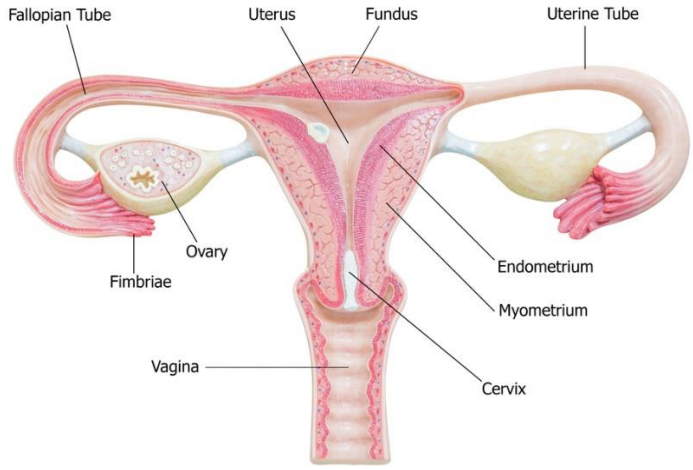


Figure 4.1: Image of female reproductive system (https://www.livescience.com/58862-ovary-facts.html)

This image clearly shows that these two terms are hyponyms of the female reproductive systems and not synonyms as reflected in the dictionary. However, due to terminological gaps a polysemy was used. A lexicographer should have in-depth knowledge about the world, inclusive of factual information and terminological information about many different things (Geeraerts, 2010).

It stands to reason that the task of developing a dictionary demands an extensive knowledge of terminology and its meaning in the world generally as well as in a specific lexical field that it belongs to. Therefore, lexicographers of specialised resources should consider developing lexical resources that will provide meaningful meanings in the lexical field the dictionary is situated in. The lexicographic functions of dictionaries should be based on assessing user needs,

their situation and the function that the dictionary intends on satisfying. This does not only require the examination of the user but the terminology itself through an understanding of the meaning given to lexical items in existing resources, lexical relations and alignment of terminology with the field of study.

The non-availability of an isiZulu Life Sciences dictionary hinders learners from grasping terminology meanings or equivalents in their mother tongue. Therefore, lexicography and lexical semantics, as distinct fields of study are necessary for practical lexicography, especially in domain-specific dictionary development, as lexicography is concerned with producing dictionaries and semantics, by providing explanations of words. Lexicography requires its practitioners to have substantial knowledge of the world and the domain in which the resource they are developing is situated. Studying terminology through lexical semantics in lexicography will assist lexicographers and translators to produce functional lexicographic resources for learners of Life Sciences in their mother tongue.

4.7 Conclusion

This chapter explained data presentation and analysis. It further examined Life Sciences terminology considering the lexical field, defined subject-specific terminology in English-isiZulu dictionaries, explained the importance of understanding lexical relations and finally, analysed the importance of terminology analysis in lexicography. This was done by studying the terminology that learners have to understand in order to grasp the subject knowledge. To this end, the first concept that was investigated was the lexical field of terminology usage where the study concentrated on the interpretation of lexical units when used in the specific field – Life Sciences. This investigation involved the extraction of terminology and studying them in reference to selected isiZulu dictionaries. As much as these dictionaries were mostly dictionaries of general usage, they proved to be useful because they showed different results upon the examination of the selected terms.

One of the selected examples is a lexical unit which is used in general language and the lexical field of Life Sciences – ‘accommodations’ (**Table 4.1**) –the English general dictionary only refers to a place of settlement or a compromise. The same was found in isiZulu dictionaries where only the general usage of the word was found. The Life Sciences meaning given to the term is the ability of the eye to change shape in line with an object, which when considered in line with the terminological traits of the term is not too far-fetched. The general understanding

of the term from its etymology means ‘to make something fit for something’ therefore, when a person is accommodated in a hotel, the hotel is being made fit for usage by the person. In the same vein, when the eye moves in line with the object the eye adjust itself to view the object.

Studying etymological traits of this term clarified the selection of this lexical unit to obtain this meaning in the lexical field of Life Sciences. Terminological knowledge is not readily available for learners and at the same time the general use dictionaries cannot accommodate the usage of the word in all lexical fields. This provides no recourse for learners in class when they are being taught as there is no isiZulu resource to help them clarify the meaning.

Ten Hacken (2018) posits that etymology recognises the motivation behind the employment of a lexical unit in a lexical field. This study realised the need for wide linguistic knowledge of a language as an assistive characteristic for basic interpretation of a word or at least an idea that the word can be associated with. This knowledge is not readily available in isiZulu resources and leaves learners having to fumble to draw from the second language knowledge of the subject. It is for this reason, that this study saw the need to develop subject field-specific dictionaries in isiZulu. This would require the lexicographer to study etymological traits of lexical units and demonstrate the re-employment of lexical units in specific fields, in isiZulu. In this way, leaners will have a resource that they can use to better understand terminology in subject fields. These dictionaries will not only provide the interpretation of words but linguistic gaps in the subject field in isiZulu can be field. Words that do not exist in a language can also be coined through an understanding of etymological traits of the words. The study understands that terminology development in South Africa, according to the DSAC, is not the work of a lexicographer; therefore, a lexicographer is able to work with a terminology unit, provide them with terms that do not have equivalents in isiZulu and terms can be created. Once terms are coined, the lexicographer can record them in dictionaries with their definitions.

Definitions of terms in bilingual dictionaries are often absent, which is why the current study considered a bilingualised dictionary. Bilingual dictionaries provide lemmata equivalents and in cases where they are not readily available, descriptive translation methods are employed leading to what seems more like an explanation of what the term entails. One of the subject specific lemmata ‘anatomy’ was in all isiZulu dictionaries described as the study of the body structure, which is not distant from the definition. Therefore, leaners using a general language dictionary can be in a position to understand this term. This, however, is not the position for

all terms, as in some instances, for example, the term ‘bronchi’, which was only found in one of the selected dictionaries, described as a small vein/artery in the lungs while prescribed books refer to airways that go the lungs. These airways are not veins/arteries which may be problematic to the resource user who would misinterpret the term because of the non-specific description. For this reason, a dictionary with a direct definition of a term in line with definitions provided in the subject field are sorely needed in isiZulu to provide learners with resources that will help them associate terms with words that can be related to them in their mother tongue, leading to a better understanding of the subject.

Relations between words were also considered in this chapter in relation to subject-specific terminology. The research considered terms that are related to words with the opposite meaning (antonyms); hierarchal relations where words are related to others because of their position in relation to other word meanings; cross-referencing where words form a lexical unit that binds the words in their formation and meaning; and partitioning where a single lexical unit can be joined with other words to form a new word that will be related to the main word. An understanding of relations that exist within a lexical field can benefit language users in terms of association of words as a lack of understanding of one lexical unit can lead to the misinterpretation of a term. For instance, if one does not understand what ‘cell’ means but understands ‘wall’ there will be a gap in interpreting the meaning of ‘cell wall’. In this example, one will have to find out what a ‘cell’ entails otherwise one will keep wondering what the second part of the word refers to. Subsequently, an analysis of terminology in their lexical fields is necessary for lexicographers to create resources that will benefit mother-tongue learners who are inundated with field-specific terminology being taught to them in a second language. The study finds it unfair for learners to not be provided with linguistic resources for subject-specific content as this is a continuation of the legacy of linguistic marginalisation of the African child. English-speaking learners have the advantage of basic terminology comprehension while isiZulu language speakers may not have a similar level of such terminology.

Bergbauer, van Staden and Bosker (2016) conducted a study on the achievement of learners when being tested in their mother tongue and English. They learnt that learners require a mother-tongue base and continuation of learning in their mother tongue, or at least an association with a language related to their mother tongue, for them to understand what they

are learning. This shows that content provided to learners should build on what learners already know as this would make understanding the new content less difficult to interpret.

> The exposure and testing of learners in languages other than home languages results in nothing more than what Desai (2001) refers to as 'incomprehensible education'. While the development of African languages should be paramount in the implementation of the LiEP, success can only follow if greater currency is afforded to African languages in society, business and government and when speakers of African languages assert their rights and greater currency for their languages (Bergbauer, et al., 2016:10).

To avoid incomprehensible education for learners more investment should be made in developing African languages and language comprehension resources in their language. Providing what may be considered as quality educational content is not enough because learners are unable to reap the benefit. Terminology in lexical fields should be made available for usage in all spheres of society as this will not only expose learners to these fields in their languages but it will also store knowledge that they can apply when faced with lexical field content in their time of learning.

The investigation conducted in this chapter shows the need for the Life Sciences dictionary developed in this study as terminology was examined which was then listed as part of lemmata for the developed dictionary. The dictionary user, as the starting point of dictionary development, should not be put in a position of having to find a resource in another language for them to understand terminology, but an investment into the examination of terminology, their coinage (if absent in the target language), and translation should urgently be considered by language practitioners and the DBE as an aid to elevate linguistic challenges faced by learners. This will also demand a greater investment in lexicographic practices in previously marginalised languages, such as isiZulu. The next chapter investigates pedagogical lexicography in English-isiZulu dictionaries.

CHAPTER FIVE

PEDAGOGICAL LEXICOGRAPHY IN ENGLISH-ISIZULU DICTIONARIES

5.1. Introduction

This chapter presents the data and the analysis of data collected in the study to investigate the structure of published pedagogical English-IsiZulu lexicographic resources, and to analyse domain-specific terminology for learners as a foundation for developing a new dictionary, respectively. The chapter begins with a presentation and analysis of data; it then investigates the typology of published lexicographic resources in English-IsiZulu, and evaluates the structure of the same.

This chapter investigates strategies employed in practical lexicography with the intention of establishing knowledge that can be adopted in developing a new dictionary. To this end, the study follows a formula by Marshall and Rossman (1999) who emphasise the importance of following a framework when studying data. The selected framework for this study was explained in Chapter 3.

5.2. Selected dictionaries

One of the characteristics of the theory of lexicographic functions is concerned with the ability of dictionaries to satisfy the function it was intended for. These functions are founded on the acquisition of knowledge where the user consults a dictionary to collect information such as the correct spelling of the word or most commonly the definition of a word. Another function could be to facilitate communication needs of the user. To this end, this study analysed the outer, middle, and back matter of three bilingual dictionaries selected for analysis, namely the *Scholar's Zulu Dictionary* by G. R. Dent and C.L.S. Nyembezi (2009) 4th edition, hereafter referred to as the SZD; *Oxford Bilingual School Dictionary: IsiZulu & English* by Gilles-Maurice de Schryver (2015) 2nd edition, hereafter referred to as the OUPEZ; *English-Zulu / Zulu-English dictionary* by C.M. Doke, D.M. Malcom, J.M.A. Sikakana and B.W. Vilakazi (2014), hereafter referred to as EZD. Further, the *Multilingual Natural Sciences & Technology Term List* for English, Afrikaans, IsiZulu, IsiXhosa, Siswati and IsiNdebele from the Department of Arts, Culture Science and Technology (2013), hereinafter referred to as the MNST-NGUNI was examined. This dictionary was selected because learners at primary school

level do not study Life Sciences as a standalone subject but the subject is incorporated in Natural Sciences. At primary school Natural Sciences incorporates Life Sciences.

Lexicography researchers (Dladla, 2020; Jauza, 2020) studied bilingual English-isiZulu dictionaries through textual analysis which allowed them to study the megastructure of dictionaries. Two of the dictionaries (*Oxford Bilingual School Dictionary: IsiZulu & English* by Gilles-Maurice de Schryver (2015), *English-Zulu / Zulu-English dictionary* by C.M. Doke, D.M. Malcom, J.M.A. Sikakane and B.W. Vilakazi (2014) selected for this study were scrutinised by these scholars.

The main objective of the current study differs from that of the abovementioned one, as it is to expand the function of lexicographic resources in African languages through the development of a new dictionary. Thus, as a pragmatist, the researcher conducted her independent study without any influence of findings of previous studies in lexicography such as Simelane (2000), Dladla (2020) and Jauza (2020). This required the study to explore new ideas that will enhance knowledge about dictionaries.

The study draws on the employment of document analysis from previous studies on lexicography and scrutinised the megastructure as they did, not with the intention to criticise, but rather for learning purposes to establish the foundation for the dictionary being developed. This separated the study from findings of other researchers and enabled the study to determine new findings based on data collected to meet the purpose of this study (Sebastian, 2019).

5.3 Typology of bilingual dictionaries

Typology refers to the classification of items according to categories (Merriam-Webster.com), and in the current study the typology of dictionaries is used to describe lexicographic tools from a specific point of view; each new dictionary concept is founded on a purpose-driven typology which is the lexicographic function of a dictionary (Bergenholtz & Agerbo, 2018).

The typology of the dictionaries under examination in this chapter is bilingual and multilingual. Bilingual dictionaries have already been described as dictionaries that consist of two languages and multilingual dictionaries as those which comprise of many languages. The combination of focus in these dictionaries are English and isiZulu. According to Atkins (1996), a bilingual dictionary should consider the following:

- Function of dictionary information;
- Mode of expression;
- Source and target language speakers; and
- Purpose of use.

The objective of the current study was to develope a comprehensive bilingualised dictionary which is a resource that is not available at the moment. As a foundation to developing this resource, the study through textual analysis examined the typology of selected dictionaries to determine the above considerations in light of the importance of meeting lexicographic functions, according to the theory of lexicographic functions, which is one of the founding theories of this study.

While reading the front matter of these dictionaries, it was observed that these resources provide similar information and they meet the requirements of traditional bilingual dictionaries, namely the equivalence mode and the bilingual browsing mode. The equivalence mode is evident in that they provide equivalents that help the user perform specific tasks such as translation, comprehension, or the ability to express themselves as required in each reason for consulting the resource. It also provides information for the bilingual browsing mode when users use a dictionary to compare information in two languages (Atkins, 1996).

According to Laufer and Levitzky-Aviad (2006), dictionary users consult bilingual dictionaries using the foreign language as a lemma to find meanings for words in source languages. In other words, an isiZulu speaker consults a bilingual dictionary to find the meaning of an isiZulu word in English. The absence of definitions in bilingual dictionaries, especially domain-specific ones, was also criticised by Nkomo (2019) who held that the typology of domain-specific South African dictionaries leaves much to be desired as they do not completely satisfy the needs of users. Learner dictionaries developed by the DSAC are called dictionaries even though they offer minimal lexicographic information with only the translation of the lemmata into official languages. These multilingual dictionaries do not provide any definitions or any other data in the resource which can be problematic for mother- tongue users who have limited competence in English as domain-specific terms are at times not found in general language dictionaries which may leave users still hoping for an explanation of terms in those languages.

Lemmata are not defined but only given an equivalent in another language – isiZulu or English depending on the resource. According to the DSAC (2013: iv), "The meaning of the terms as set out in the definitions formed the basis according to which collaborators found or coined equivalents in the target languages." From this statement, it was noted that compilers had definitions in the source language but decided not to add them to the target resource. The resolution for users seeking definitions of terms in the source or target language is stated by Atkins (1996:8) as follows:

> People often turn to a monolingual dictionary during a bilingual search. The ideal dictionary should offer monolingual functions (definitions, etymologies, usage notes) to the bilingual dictionary user. It should cater for the dictionary browser, as well as the user intent upon one task.

For a user who seeks to define a word they would need to consult a secondary resource to find more information in another language, especially in domain-specific terminology, when it would be convenient to translate definitions into isiZulu. This is a common challenge in bilingual dictionaries as it was observed by Klapicová, (2005:62) that:

> Monolingual specialized dictionaries offer a definition of each lexical item, in many cases enriched by an encyclopaedic extension and illustrations. Bilingual and multilingual specialized dictionaries, on the other hand, present the equivalents of the terms in one or more languages. It would be wonderful to have bilingual and multilingual specialized dictionaries which would offer also a definition of each term, at least, in the source language, which is the only possibility to confirm whether the equivalents in the target language(s) truly correspond with the term of the source language.

To remedy the situation, Laufer (1995) proposed the development of resources that will incorporate definitions in the foreign language. This resource would provide definitions in the language of users thus producing a dictionary that will have English lemmata, isiZulu lemma translations and isiZulu lemma definitions which would be easier for users to get the information they seek. To this end, he asserted that an entry in such a dictionary would include four elements:

(1) L1-L2 translations.

(2) L2 information (definitions, examples, etc.) about each translation option.

(3) Thesaurus-like information, i.e., semantically related words to each

translation option.

(4) Additional L1 meanings of the L2 translations.

This resource would provide definitions in the language of users thus producing a dictionary that would have a basic structure as follows: English lemma > IsiZulu lemma translations > isiZulu lemma definitions + additional information. The dictionary developed in the current study is a bilingualised dictionary because of its comprehensiveness, which is a dictionary that combines information from a monolingual and a bilingual dictionary into one resource by including data types that are often omitted in traditional bilingual dictionaries. This type of resource applies translation by following a translation brief (Hartmann, 1994; Laufer & Hader, 1997; Laufer and Hill, 2000; Gauton, 2008).

Subsequently, the dictionary developed in this study is bilingualised providing English lemmata > IsiZulu lemma translations > isiZulu lemma definitions > additional information about the lemmata in isiZulu. The typology of this new lexicographic resource is drawn according to Atkins (1996) where the function of information contained in the resource is considered, as well as the mode of expression, source and target language of speakers, and the purpose of the resource. This is presented in **Table 5.1** below.

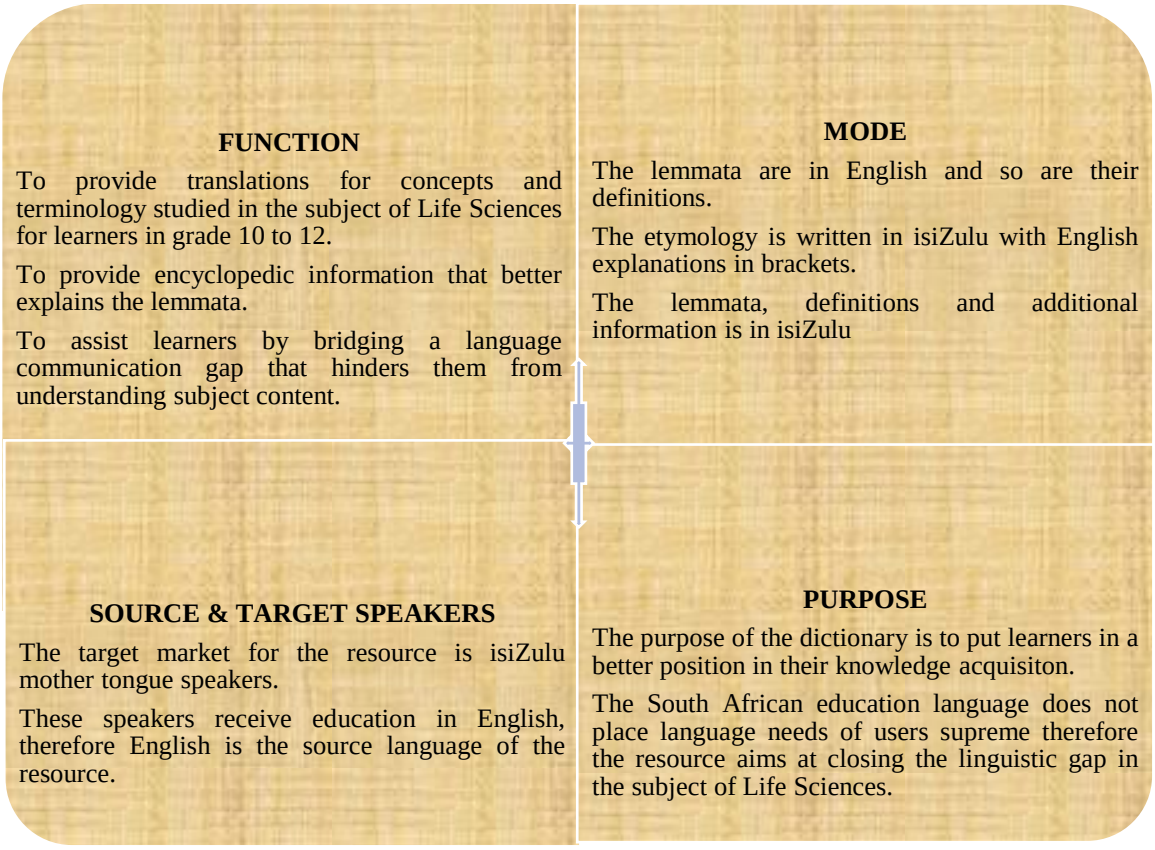


Figure 5.1: Typology of the ISY-LSD

As a bilingualised and domain-specific resource, this type of dictionary requires the services of professional translators, or monitoring by them, who receives a translation brief as the translation stage of dictionary development is regarded as an assignment on its own. This translation was conducted by following a translation brief which according to Gauton (2008), should (a) be commissioned by a client; (b) have a specified target audience in mind; (c) make the translator aware of the purpose the translation is intended to serve; and (d) meet fairly rigid timeframes.

The researcher is a professional translator; therefore, she translated the dictionary content according to the above brief. The specific group of prospective users were learners of Life Sciences in the FET phase of school. The researcher was aware of the function of the dictionary text which is to bridge the language challenges of learners in a scientific subject; and as the dictionary is to be submitted as part of this research report, the deadline had to be adhered to so that the study could also analyse the developed resource.

5.4 The megastructure of learner dictionaries

The megastructure of dictionaries has two main components which are the main body of the dictionary and the outer parts of the dictionary. The outer parts refer to the dictionary front, middle and back matter of the dictionary; while the main body is the middle part which is further divided into the microstructure and the macrostructure. Each of these components were explained in Chapter 2 and more clarity was provided when analysing data collected from each of the components. The megastructure of published dictionaries was examined in the current study as this would help the user in developing the megastructure of the new lexicographic resource which is discussed in the next chapter (Chapter 6).

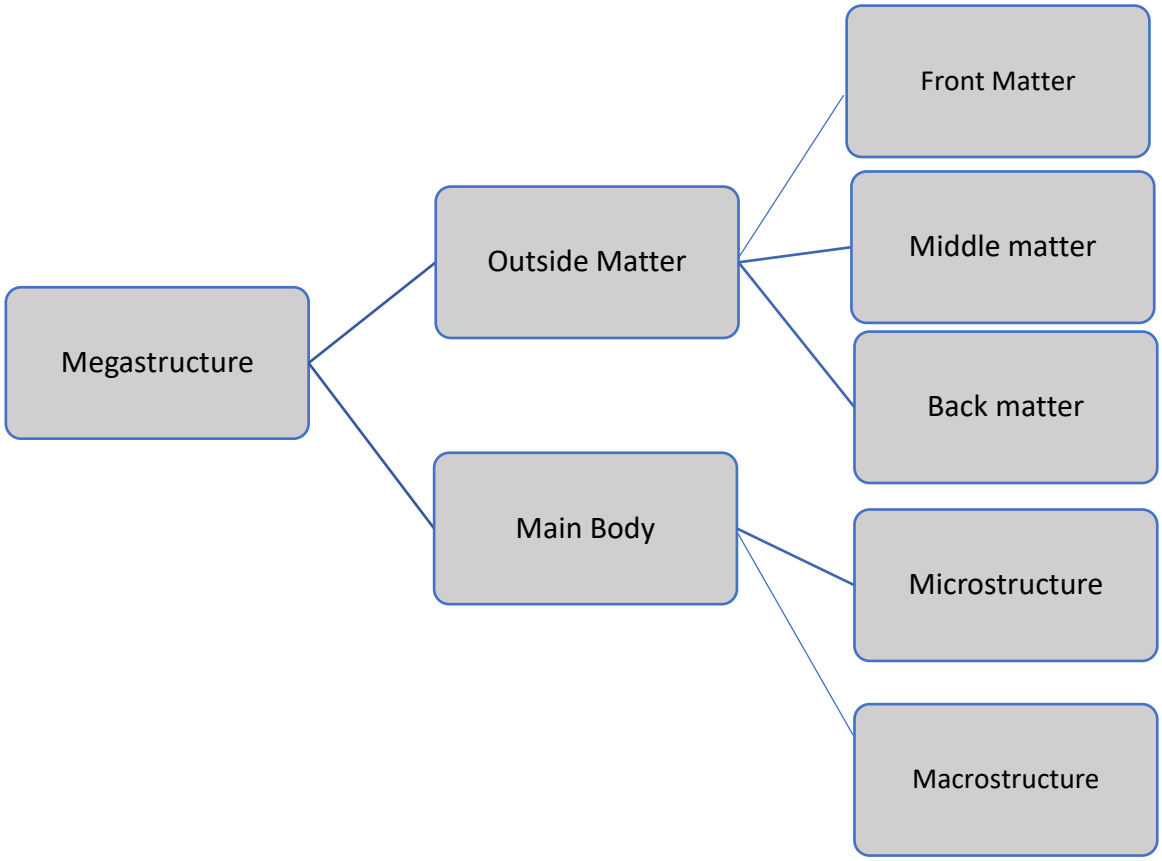


Figure 5.2: Megastructure

5.4.1 The Outside Matter

The outside matter comprises of parts of the dictionary that provide information about the dictionary with the intention of enabling more efficient use of lexicographic resources. To this end, Assam (2006) states the following:

> The components of the textbook structure of a dictionary are the following: The front matter, central list and the back matter, not all of which are compulsory components. The central list is a compulsory component because it contains the lexicographic treatment. According to Hausmann and Wiegand (1989:331), only one other obligatory component exists besides the central list, namely the text in which the central list and its uses are explained to the dictionary user. It is usually presented in the front matter of a dictionary. Other texts in the front matter and the back matter have to be regarded as optional parts of a dictionary. (Assam, 2006:120)

This is one of the reasons that makes reviewers of dictionaries ignore the outside matter stating that it is consulted less in comparison with the main body of dictionaries (Nielsen, 2009).

Contrary to the latter, a study conducted by Wolf (1992) as stated by Nielsen (2009) showed that more than 50% of dictionary users found the outside matter to be an important part of the dictionary because it provided users with important guidelines that were helpful in achieving dictionary functions. Subsequently, the current study examines each component of the outside matter of selected dictionaries in its entirety to evaluate its impact on the dictionary development process and the dictionary as a product on its own accord.

> It is proposed that the separate sections of dictionaries should not only be examined independently but that their relationship to each other should also be evaluated so as to represent faithfully the lexicographic elements, i.e., wordlist, front, middle and back matter, their organisation and presentation, as well as three underlying elements: the function(s), data types and structures of the dictionary. Focus on all these elements may result in dictionary reviews that are academically sound because they treat the dictionary as a true research object. (Nielsen 2009:207)

Subsequently, this subsection evaluates components of the outside matter, beginning with the front matter.

5.4.1.1 The Front Matter

The front matter refers to components that precede the central wordlist section of a dictionary and examples of these components are “title page, copyright page and imprint, acknowledgements and dedication, foreword or preface, table of contents, list of contributors,

list of abbreviations and/or illustrations used, pronunciation key, user's notes, notes on the nature, history and structure of the language, dictionary grammar" (Hartmann and James, 2002:60). Given that three dictionaries were investigated, the front matter of each of them was examined.

5.4.1.1.1 The Front Matter of the SZD

- The front matter is presented in English.
- The target audience is stated to be "people who find the more comprehensive dictionaries too cumbersome and too detailed for their needs." (Dent & Nyembezi, 2009: iii).
- Dictionaries consulted are acknowledged.
- The isiZulu word structure is explained briefly as the Zulu lemmata are to be listed according to the stem and not the first letter of the word.
- This is followed by isiZulu pronunciation of words, providing how the entire alphabet is pronounced.
- The abbreviations used are in isiZulu and states that the dictionary will employ English abbreviation which are also listed as they will appear in lemmata in the main body.

5.4.1.1.2 The Front Matter of the OUPEZ

- Languages used in the presentation of the front matter are isiZulu and English.
- It begins with a contents page.
- Dictionary features are presented, beginning with describing the function of the dictionary which is to help users read and write English or isiZulu better depending on the language the user wants to learn.
- A page copied from the main body is presented and each feature of the lemmata explains how to interpret and use the dictionary.
- The introduction to the dictionary explains that the dictionary was developed specifically for South African schools with the intention of assisting learners in reading, writing, hearing and speaking these languages as additional languages; making the dictionary easy to use; addressing current usage and concerns; making the dictionary useful to learners; and providing extra information for teachers and learners.
- The dictionary is explained to be a new type of dictionary, and the microstructure of the dictionary is explained.

- The middle and back matter of the dictionary are briefly explained as study and reference sections.
- There are questions and answers to assist the user about word senses, headwords, examples and spelling.
- An acknowledgement of people who were involved in the dictionary project is provided.

5.4.1.1.3 The Front Matter of the EZD

- The front matter is presented in English.
- The contents page is provided.
- The history of the dictionary is provided in the preparatory note as there have been three editions (Zulu-English Dictionary by Doke and Vilakazi (1948), English and Zulu Dictionary by Doke, Malcom, Sikakana and Vilakazi (1958), and a combined version of the latter two dictionaries (1990), and now a new publication under examination was authored by Doke, Malcom, Sikakane and Vilakazi (2014) prior to the one under examination and the target users are stated as learners of isiZulu, isiZulu-speaking learners learning English, and isiZulu linguists.
- Preface to the 4th edition is provided beginning with the revised orthography by PanSALB (2008).
- Preface to the combined edition of the dictionary where the orthography is explained; the interpretation of Doke et al. (2014) tone marking system is discussed; the preparatory note to part one of the two-fold dictionary is provided; key pronunciations are provided; note on Zulu orthography; abbreviations used in part one; the introduction to part one of the dictionary comprising of preparation, method of lemma entry, orthography, indication of tone, publications consulted and acknowledgements. Prefatory notes to the second edition of the combined version are provided, comprising of the classification of the Zulu language; the alphabet and phonetic system of Zulu; parts of speech in Zulu; noun classes in Zulu; concord in Zulu; palatalisation in Zulu; nasalization and nasal changes in Zulu; definitions; abbreviations and signs.

5.4.1.1.4 The Front Matter of the MNST-NGUNI

- The front matter is in English.

- Information about downloading the resource from the internet is stated. This information reserves copyright to the DSAC and no corrections and issuing for financial gain are permitted.
- Information about the Natural Sciences curriculum of 2005 is reported.
- Terminology harvesting details are recorded.
- Terminology treatment information is provided.
- Target user information is provided as stated in **Figure 4.4** above.
- The number of words that make up the term list is recorded to be 2896.
- Acknowledgements are made and all collaborators in the dictionary development project are listed.
- Explanatory notes on how to use the resource is provided and examples of dictionary entries are provided with indicators of the source terms, target terms, parts of speech, synonyms, additional information related to context for some terms, and treatment of abbreviations and acronyms.

The front matter of selected resources explains the contents of the dictionaries and explains how the resources are to be used. The general language resources also provide language-related matters as their general function is to provide users with language knowledge to help them in their daily conversations. Most of the information in the front matter is the same save for the OUPEZ which presents a different structure explained in both languages. The difference in the structure lies in that the lemmata are listed as complete words instead of the stem format which is common in isiZulu dictionaries. Further, the resource starts with isiZulu as a source language and only presents the English source lemmata after the middle matter.

Another front matter with a difference is found in the MNST-NGUNI, which like other dictionaries, states the target users but additionally, reveals the resources used for terminology harvesting. It further explains the entire process undertaken in the development of the resource, even naming experts and collaborators who were involved in the resource creation. The confidence of the developers is noted in their statement below:

> The compilers of this product do not claim that it is comprehensive or entirely without errors and scope for improvement. Feedback, especially on the layout, the accuracy of the equivalents and the comprehensiveness of the dictionary, will be welcomed. (Department of Arts, Culture Science and Technology, 2013: iv)

The compilers welcome users to inform the DSAC of errors or suggestions they may have on the resource which is not a common trend in the other three resources. The researcher does not view this statement as a weakness but as boldness of the confidence they have in the resource. Additionally, front matter of all examined resources was found to be insightful and educational to users who are in the education space.

5.4.1.2 An Investigation of the User Profile

Busane (1990) states that dictionary users do not engage with the outside matter which subsequently relates to the front matter. Nevertheless, when a lexicographer embarks on a dictionary creation project their intentions should be clearly stated in the front matter to show that the lexicographer did not embark on the project because they had nothing else to do but took on the project to satisfy the identified needs of users (Jauza, 2020). Therefore, regardless of the assumption that users lack interest in the front matter, lexicographers ensure that it is rich in much-needed information for users to gain the confidence of the same users who by reading the explanatory information in the front matter will realise the science and art that were incorporated in the development of the resource. To this end, the profile of users should be examined to identify user needs and user situations for which the dictionary was used. Information about the users of the three dictionaries was identified in the front matter.

5.4.1.2.1 An Investigation of the User Characteristics

The education level of the SZD is not indicated but the expectation is that they are users with knowledge of the English language given that the front matter is written in English. In the same vein, the education level of EZD users is that of a university level which is clearly stated in the front matter, while the OUPEZ indicated the education level of users as school learners. Additionally, the MNST-NGUNI has a combination user profile with learners from Grade 4 to 6 and education experts such as teachers and subject specialists, among others.

There is no indication of the mother-tongue users of the SZD in the front matter; the EZD indicates that it is for mother-tongue speakers of isiZulu and English which is similarly indicated in the OUPEZ. The MNST-NGUNI, however, has a mixed language readership as it is a multilingual resource. The sisterly relationship between users of this resource enables users to understand the target term in other Nguni languages and at times the languages may share equivalents.

The users of the MNST-NGUNI, SZD and the EZD were identified as users who already have knowledge of English as the front matter is written in English with no translation. Whereas the front matter of the OUPEZ is equally available in isiZulu and English and begins with IsiZulu wording followed by the English version.

The knowledge of isiZulu grammar is extended in the EZD and the SZD with the former providing more detailed educational knowledge about the language. The EZD provides thorough knowledge of isiZulu, arming the user with all important features to grasp knowledge of the language.

The MNST-NGUNI is a domain-specific list of resources engaged in terminology harvesting and dictionaries consulted during the treatment of terminology. Names of language and subject specialists who were involved in the development of the resource are also provided.

5.4.1.2.2 An Investigation of the User Situation

Users differ according to their characteristics which influences the situation that may require them to use the dictionary. User situations extracted from the front matter are provided in **Table 5.1** below.

Table 5.1: User situation in accordance with Bergenholtz and Tarp (2003)

Communication-oriented function	**Cognitive function**
1. All dictionaries provide communication in English and isiZulu.	1. EZD explains the isiZulu language structure providing grammatical information.
2. All dictionaries are intended to help the user be able to receive texts in English and/or isiZulu.	2. EZD provides the orthography of isiZulu as updated in 2008.
3. All dictionaries are intended to help the user to be able to produce texts in English and/or isiZulu.	3. EZD provides encyclopaedic information, where the history of dictionary development explained dates from 1937.
4. The EZD indicates that it is also intended for linguists. This resource provides for the	4. OUPEZ explains how the dictionary is to be navigated while the SZD

translation of texts from English to isiZulu and vice versa by mother-tongue speakers and speakers who are not mother-tongue speakers of these languages of the source document in each situation. As much as the other dictionaries did not indicate the use of the resource by linguists or translators, the availability of the language resource for language needs for each situation can assist users when translating between these languages.	explains the composition of nouns in the resource to assist the user in finding words guided by knowledge of how lemmata are presented in isiZulu.
	5. Information about word senses is provided in the OUPEZ.
	6. The pronunciation of words in the isiZulu language is provided in the SZD and the EZD.
	7. Abbreviations are provided and explained in the EZD and the SZD.
	8. Information about the type of dictionary is provided in the OUPEZ, as this is a new type of dictionary which presents lemmata differently as compared to the SZD and the EZD that lists words according to stems while the newer dictionary lists them in their complete form.
	9. The MNST-NGUNI only provides equivalents in African languages, including Afrikaans and the function of the resource which is to assist learners, teachers and interested parties in their engagement with the subject.

5.4.1.2.1 Investigating of the needs of users

Once the characteristics and situation of the user has been identified, their needs can be deduced. The lexicographer considers language of target users of the dictionary and creates a resource that they will be able to understand. They align user language abilities with the language level used in definitions and examples. This also guides the lexicographers in terms of the dictionary size, text structure, and dictionary structure. This also serves as a guideline for the level of pronunciation and other lexicographic methods to be employed (Bergenholtz & Tarp, 2003; Tono, 2010; Schierholz, 2015).

The needs indicated in all three dictionaries are to assist users in communication, language learning, and teaching. More specifically, the OUPEZ listed the purpose for its creation which would cater for the needs of users, as follows.

1. Giving learners the ability to read, write, hear, and talk in their second language effectively and competently.
2. Making this dictionary incredibly simple to use.
3. Making sure that this dictionary accurately reflects current concerns and usage.
4. Creating this dictionary in a way that is equally applicable to and practical for English and isiZulu learners.
5. Including a special selection of helpful extras in the Study and References section for learners and teachers. (De Schryver, 2015)

The importance of the front matter cannot be over emphasised as Gouws (2005) regards it as the most important feature of the outer text given that it serves as a guideline for dictionary users. This is clearly visible in all three dictionaries where the lexicographers profiled users, the situation that requires them to use the dictionaries, and the needs of these users with the most common being to empower users in their communication abilities in English and isiZulu.

5.4.1.3 The Middle Matter

The middle matter is a part of the outside matter which is found in-between dictionary entries that responds to extra-lexicographic information such as the provision of illustrations and cross-reference information (Assam, 2006; Brangel, 2015). The middle matter is a section of the dictionary that provides subtexts necessary for users of bilingual dictionaries. An example of this is the *Oxford Bilingual School Dictionary: Northern Sotho and English / Pukuntsu ya Polopedi ya Sekolo: Sesotho sa Leboa le Seisimane* (2007) which provides sub-texts necessary

to assist users to produce correct oral and written texts in various forms of written communication (Chabata and Nkomo, 2010).

In the current study, the only dictionary with the middle matter in the dictionaries under examination is the OUPEZ. This part of the dictionary comes after the last isiZulu lemmata in the isiZulu-English A-Z side of the dictionary and is titled as the study section and lists its contents in the contents page. The middle matter is provided in isiZulu and English just like the front matter. It comprises of a dictionary activity where users are being taught how to create their own dictionaries in groups by listing words that are to be sorted alphabetically. Users are provided with information about nouns and translating of words into another language by using other dictionaries to cross-reference.

Extra information that is important for users in their communication needs is provided, namely knowledge about how to write a business email, formal letter, informal letter, and electronic messages on cellular phones. There is a brief explanation of how to use a dictionary that comes with isiZulu 'mini-grammar'. Similar to the EZD (in the front matter), the entire isiZulu grammar is presented. There is also a short guide to pronunciation in isiZulu, irregular verb forms in English, English pronunciation, English spelling, everyday conversations and the user is provided with space to create their own bilingual dictionary.

5.4.1.4 The Back Matter

The back matter is the last part of the dictionary found after the last lemma of the main body of the dictionary providing extra information that the lexicographer finds important to the user. For instance, the back matter of the Oxford Primary Dictionary (2011) has spelling tips, common irregular verbs, common prefixes and suffixes, and etymology (Brangel, 2015).

The back matter is regarded as an additional component of the dictionary because it provides bonus information such as the bibliography in the Dictionary of South African English on Historical Principles (Silva,1996). This section can be regarded as a secondary front matter as it provides unique information about the dictionary contents and reference material that provide users with more information that they can cross-reference should they wish to know more about the development of the dictionary (Gouws, 1999).

The only resources with the back matter among the selected dictionaries are the MNST-NGUNI and the OUPEZ. The former only has a list of lexicographic references from which the resource data were harvested, and consulted in the development of the resource. This information is found in the front matter of the SZD where all referenced resources are acknowledged in the introduction. In the same vein, the OUPEZ has a more complex back matter. This back matter is referred to as the reference section because it contains information for users to use for referential purposes and not necessarily as a bibliographic reference. The section contains its own table of contents and consists of illustrations and names (in both languages) of domestic animals, small creatures, fruits and vegetables. This is followed by a map of South Africa and names of provinces. Statistical information on South African languages and education level of the country are also included. Useful information included months of the year, time, days, dates, seasons, fractions, mathematic symbols, the solar system, and South African public holidays. It concludes with numbers, weights and measurements, and lastly, answers to activities and questions from the middle section.

It is the lexicographer who identifies language use and knowledge acquisition issues and plans a dictionary in a manner that will address the problems (Bergenholtz & Tarp, 2013). The researcher finds the back matter of these dictionaries important in that they satisfy the dictionary purpose stated in the front matter which is to produce an easy-to-use resource tailor-made for South African schools to facilitate communication and extra-linguistic knowledge of learners, teachers and other users. For instance, the illustrations enhance communication where users may know animals in their mother tongue but have trouble in making reference to them in the second language.

All parts of the outside matter are equally important and should be analysed, described examined and evaluated based on their direct impact on each dictionary being studied (Nielsen, 2009). Dictionaries studied in this research demonstrated a rich outside matter stating who the dictionary users are, the situation they find themselves in, and the needs that the resources are developed to satisfy. Although the ESZ and the SZD do not have the middle and back matter, their front matter addressed common features found in the middle matter of the OUPEZ which also served as a teaching tool to users on how to create and use dictionaries; and provides useful information for simple communication and general knowledge in the back matter given that users are learners.

5.4.2 The Main Body

The main body of the dictionary, referred to as the central list by Gouws (1999) or the textual wordlist structure (Assam, 2006), comprises of the macrostructure and the microstructure with the former referring to the selection of lemmata and its selected form of arrangement, and the latter, the number and sequence of items such as pronunciation rules, definitions and so forth which differ in each type of dictionary (Schierholz, 2015).

5.4.2.1 The Macrostructure

Gouws and Prinsloo (2005) define the macrostructure as the ordering of selected lexical items that were included in a dictionary as lemma identifiers which are the root of explaining each dictionary entry. These lemmata found can be in the form of lexical lemmata (whole words), sub-lexical lemmata (dependent words) or multi-lexical lemmata (words made up of more than one word) and these lemmata with their various characteristics help the compiler and the user in locating information in the resource (Assam, 2006).

The macrostructure in the current study is considered from the perspective of both languages of the selected dictionaries, starting with an examination of isiZulu lemmata and English lemmata followed by the consideration of how it is arranged in the resources. As stated in the introduction of this subsection, there are various forms of lemmata, and their differences are accompanied by various forms of selection and treatments. Below is an explanation of how lemmata are selected, followed by their treatment and finally their arrangement.

5.4.2.1.1 Lemma Selection

According to Geeraerts (1984), lemmata can be selected based on the following:

- **Geography** – where dialects can be narrowed down to one that can be understood generally unless the resource is specifically written for people who live in a certain area. An example of this can be a dictionary written in Ndebele spoken in Zimbabwe as compared to Ndebele spoken in South Africa.
- **Sociolinguistics** – this is when the lemmata are selected to cater for people belonging to an identified social group.
- **Temporality** – a dictionary designed for a specific period like a historical or new dictionary with new words.

- **Interlingual** – this dictionary comprises of lemma from one language but the treatment of the lemmata may include other languages too in explaining the words, such as the case with bilingualised dictionaries.
- **Etymology** – this refers to dictionaries that select words that will be explained according to their historic origins.
- **Formal and grammatical** – this considers lemma that will be treated according to their grammatical categories, spelling and pronunciation. This can be found in linguistic dictionaries.
- **Style** – this dictionary focuses on lemmata that are used according to a particular style. Simelane (2000) developed an isiZulu slang dictionary as part of his study of lexicography. Such a dictionary presents a particular style of talking by specific people in a less formal situation.
- **Pedagogy** – these are lemmata selected for school learner resources and will contain words that users are already acquainted with for them to be able to use the resource effectively as tailored for each age group or school grade. IsiZulu dictionaries are categorised under this group but the content to be discussed in the macrostructure treatment leaves much to desire. The researcher found the OUPEZ a more user-friendly pedagogical dictionary.
- **Semantic** – refers to lemmata selected according to a specific domain they fall under. An example can be a domain-specific dictionary like a dictionary for business.
- **Encyclopaedic** – refers to expressions referring to individual items. Often lemmata in a resource with this lemmata has more nouns than verbs.
- **Idiolectic** – focuses on lemmata that deal with one person or restricted texts, for example, lemma particular to Jesus from the Bible.

  Frequency – records lemmata that are frequently used in different dictionaries. An example of a resource of this nature in isiZulu is the *Frequency Dictionary Zulu: Isichazamazwi Sokuphindaphinda SesiZulu* by Quasthoff (2020).

As general language dictionaries the OUPEZ, SZD and the EZD have a wide range of lemmata selected from general words used daily. The EZD is a new publication of the English-Zulu dictionary by Doke, Malcom and Sikakana (1958), therefore, the lemmata included in the examined resource was a re-publication of a list compiled by these scholars. To this end, Doke et al. (2014: xvii) states the following:

> Advantage was taken of the additional words included by Samuelson [1923] in his dictionary, of lists submitted by several correspondents, of words incorporated into Zulu from outside the sources, particularly from English and Afrikaans, in order to meet the growing needs of modem conditions.

Subsequently, the EZD lemmata has been selected from literature, words submitted through correspondents, words from English and Afrikaans, and from previously published dictionaries. This explains the thickness of the resource as it has 1251 pages. As the SZD acknowledged the EZD and the work of A. T. Byrant in its introduction, it stands to reason that the lemma selection of the SZD was influenced by work of predecessors.

The MNST-NGUNI as a domain-specific resource harvested lemmata from specific resources relevant to the subject field. To this end, the Department of Arts, Culture Science and Technology (2013: iv) states the following:

> The primary school Natural Sciences and Technology term list for Curriculum 2005 has been completed on the Multiterm database by a team from the Terminology Coordination Section of the National Language Service. The list is based on the learning material for Grades 4 to 6 initially obtained from the Your Pal Study Skills and the Brainline electronic study guide for science and technology.

This list was selected from reference material for learner education which makes the terminology relatable for users. Once terms were identified they were selected and several dictionaries listed in the back matter were used to determine meaning and equivalents were coined.

5.4.2.1.2 Lemmata Arrangement

The most influential factor in lemma arrangement of isiZulu dictionaries is lemmatisation. Lemmatisation is the process of analysing the vocabulary and morphology of words with the aim of determining the dictionary form of the word called the lemma (Manning, Raghavan & Schütze, 2008). Prinsloo and De Schryver (1999) assert that there are two forms of lemmatization in Bantu languages, namely a lemma entry of a full word and a lemma entry of a stem.

According to De Schryver and Wikes (2008), isiZulu as a language belonging to Bantu languages is agglutinative in nature like +-500 other languages in this language family. This means nouns have different noun classes prefixes and when a noun is substituted for another in a sentence, the sentence sounds completely different, and the meaning changes too. Subsequently, lexicographers employ many approaches when arranging lemmata. One example is the comparison of the arrangement of entries in the EZD and *Isichazamazwi SesiZulu* by Mbatha (2006) where the EZD shortens the words and removed their prefixes while Mbatha retained the full word. Both dictionaries arranged headwords alphabetically according to the first letter of the stem although Mbatha added the prefix in italics and the part from the stem in regular font.

The latter scholars also posit that the stem arrangement of lemmata to require linguistic and grammatical knowledge from the user which may not be readily available to a user who is not a speaker of isiZulu. For example, the word *-hlela* when provided as such in the EZD with other words that can come from it, and the SZD only gave it the equivalent. The OUPEZ, however, opted to provide lemmata in some of its completed forms as *ukuhleleka* and *ukuhlelwa* as a lemma in its own right which is similar to the MNST-NGUNI that uses English lemmata and only provides equivalents in the target language. However, a different approach was undertaken in the EZD, for example, in **Figure 5.3** the lemma *-hlelwa* is part of *-hlela* because the user has the word as it is without the extralinguistic knowledge requirement while the EZD and the SZD only provided the stem.

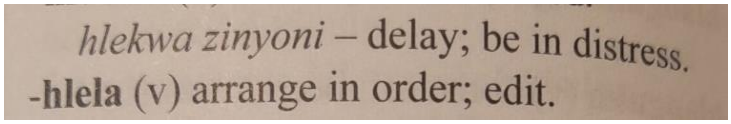

hlekwa zinyoni – delay; be in distress.
-hlela (v) arrange in order; edit.

Figure 5.3: Dent and Nyembezi (2009:426)

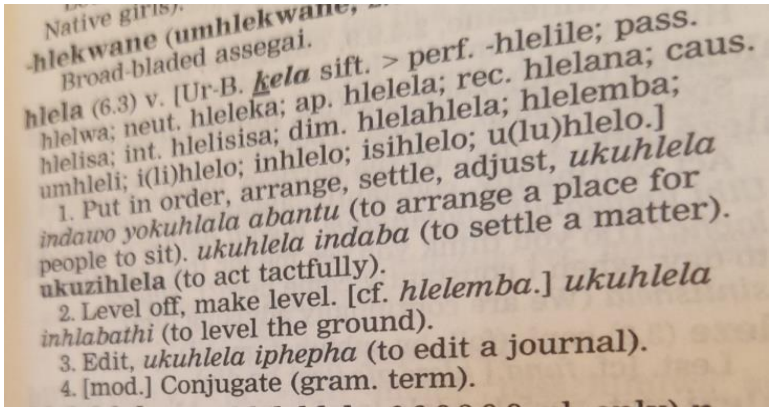

Native girls).
-hlekwane (umhlekwane,
Broad-bladed assegai.
hlela (6.3) v. [Ur-B. ***kela*** sift. > perf. -hlelile; pass. hlelwa; neut. hleleka; ap. hlelela; rec. hlelana; caus. hlelisa; int. hlelisisa; dim. hlelahlela; hlelemba; umhleli; i(li)hlelo; inhlelo; isihlelo; u(lu)hlelo.]
1. Put in order, arrange, settle, adjust, *ukuhlela indawo yokuhlala abantu* (to arrange a place for people to sit). *ukuhlela indaba* (to settle a matter). **ukuzihlela** (to act tactfully).
2. Level off, make level. [cf. *hlelemba*.] *ukuhlela inhlabathi* (to level the ground).
3. Edit, *ukuhlela iphepha* (to edit a journal).
4. [mod.] Conjugate (gram. term).

Figure 5.4: Doke et al. (2014:77)

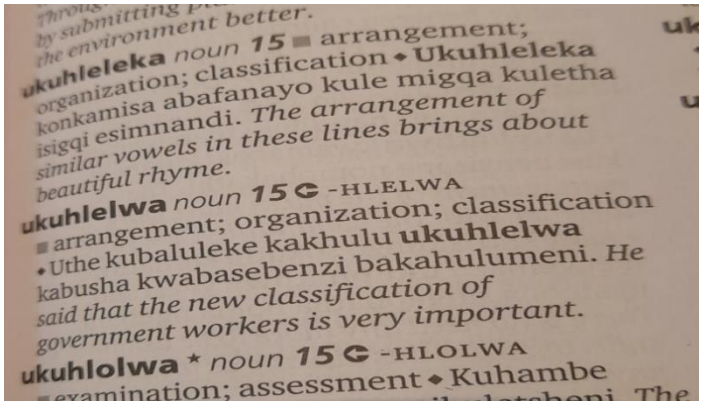

by submitting
the environment better.
ukuhleleka *noun* **15** ■ arrangement;
organization; classification ◆ **Ukuhleleka**
konkamisa abafanayo kule migqa kuletha
isigqi esimnandi. *The arrangement of*
similar vowels in these lines brings about
beautiful rhyme.
ukuhlelwa *noun* **15** ↻ -HLELWA
■ arrangement; organization; classification
◆ Uthe kubaluleke kakhulu **ukuhlelwa**
kabusha kwabasebenzi bakahulumeni. *He*
said that the new classification of
government workers is very important.
ukuhlolwa * *noun* **15** ↻ -HLOLWA
examination; assessment ◆ Kuhambe

Figure 5.5: De Schryver (2015: 221

simultaneous	
Afrikaans	**tegelykertyd**
Afrikaans	**terselfdertyd**
IsiZulu	**kanye kanye**
IsiXhosa	**ngaxeshanye**
Siswati	**kanyekanye**
Siswati	**sikhatsi sinye**
IsiNdebele	**kanyekanye**
single	
Afrikaans	**enkel**
IsiZulu	**-nye**
IsiXhosa	**enye**
IsiXhosa	**umnqongo**
Siswati	**-dvwa**
Siswati	**kunye**
IsiNdebele	**-dwa**
sink v.	
Afrikaans	**afsak**
IsiZulu	**-zika**
IsiXhosa	**ukuzika**
IsiXhosa	**ukutshona**
Siswati	**cwila**
IsiNdebele	**tjhingela**
IsiNdebele	**cwila**
sisal	
Afrikaans	**sisal**
IsiZulu	**uhalibhoma**
IsiXhosa	**umsonto wesisali**
Siswati	**ihalibhoma**
Siswati	**sikwenge**
Siswati	**isayizi**
IsiNdebele	**ikghokhgopha**

Figure 5.6: Department of Arts, Culture Science and Technology (2013: 205)

The bilingual dictionaries examined in the current study employed the alphabetical arrangement of headwords. The EZD and the SZD follow the lemmatisation method in the alphabetical arrangement of their entries where headwords are recorded without their prefixes as can be seen in **Figure 5.6**, and **Figure 5.7** above. The lexical items in the above figures from the EZD and the SZD are under the letter *h*, while in the OUPEZ they are under the letter *u*. The OUPEZ which was edited by De Schryver deviated from the 'one-size-fits-all' approach because it does not contribute to user-friendly dictionaries universally (De Schryver, 2010). Thus, the arrangement of lemmata in the OUPEZ is new to isiZulu lexicography as the common

stem structure method is not beneficial to young users who are target users of the resource (Ntuli & Mollema, 2015).

5.4.2.1.3 Lemma Treatment

There are lemmata that have limited treatment and those that receive complete treatment. Limited treatment of lemmata refers to variant and synonym lemmata, and self-explanatory lemmata. On the other hand, complete treatment is offered to lexical lemmata, sub-lexical lemmata and the multi-lexical lemmata. These types are explained below according to Tshikota (2001) and Assam (2006).

A. Lemmata with limited treatment in selected dictionaries

- **Variant and synonym lemmata**

These are lemmata inclusive of other lexical items and the other words are made part of the headword's explanatory notes. They are regarded as a cross-reference while the headword is treated fully because it is the most frequently used synonym or variant for the entry.

The treatment of synonyms of the selected dictionaries is similar for the SZD and the EZD because they are bilingual dictionaries and only provide equivalents of the headwords in either isiZulu or English dependent on the entry. For example, the entries **chastise** has been given equivalents which are ***shaya, jezisa, qondisa*** and **punish** has been given the same equivalents ***shaya, jezisa, hlawulisa*** instead of being limiting their treatment (Doke et al., 2014: 53 and 274). In the EZD the same entry has been given a similar treatment with equivalents ***shaya, lungisa, jezisa, qondisa*** for **chastise** and for **punish - *shaya, jezisa, hlawulisa*** (Dent & Nyembezi, 2009:43 and 240). There are similar equivalents in these entries which could have employed a referral system thereby limiting the treatment of the lemmata, but the lexicographers did not do so. The main difference between these dictionaries is that the EZD provides the pronunciation of the word while the SZD does not.

The OUPEZ as a bilingualised dictionary treats entries differently from the aforementioned dictionaries, providing definitions and examples of usage for each entry in both languages. For example, the sub-lexical lemma ***nxa*** has been treated completely as a conjunction with its translation and usage examples as shown in **Figure 5.7** below.

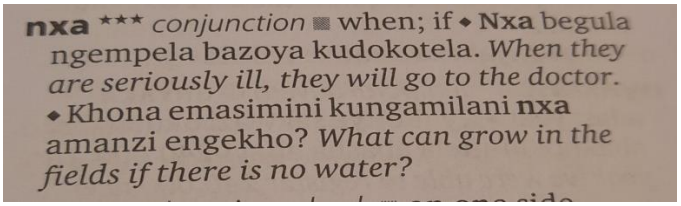
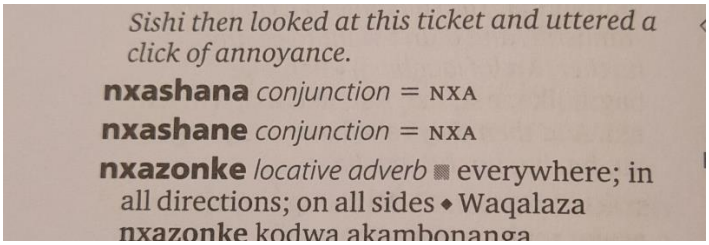

nxa *** *conjunction* ■ when; if ◆ **Nxa** begula ngempela bazoya kudokotela. *When they are seriously ill, they will go to the doctor.* ◆ Khona emasimini kungamilani **nxa** amanzi engekho? *What can grow in the fields if there is no water?*

Figure 5.7: De Schryver (2015: 179)

While ***inxa***, ***nxashana***, and ***nxashane*** have all been entered as entries but given very limited treatment and users are referred to the entry ***nxa*** for their explanation.


Sishi then looked at this ticket and uttered a click of annoyance.

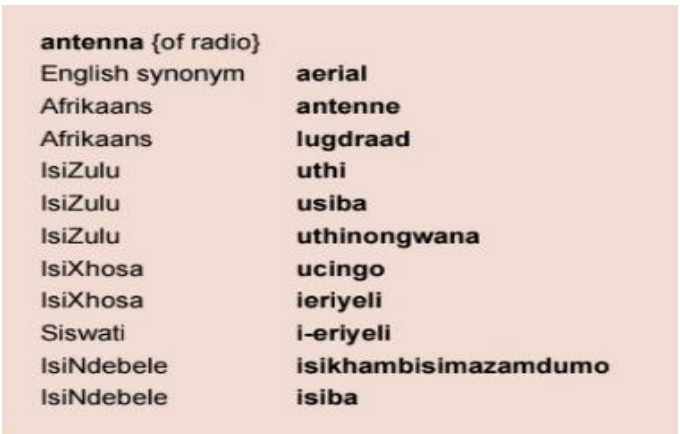
nxashana *conjunction* = NXA

nxashane *conjunction* = NXA

nxazonke *locative adverb* ■ everywhere; in all directions; on all sides ◆ Waqalaza **nxazonke** kodwa akambonanga

Figure 5.8: De Schryver (2015: 180)

The MNST-NGUNI treats synonyms by listing the lemmata synonym below the original entry and stating that it is a synonym. The equivalents then follow with their various equivalences in each language. **Figure 5.8** shows an image of the lemma 'antenna (of radio)', the synonym 'aerial' is provided and 3 synonyms which are *uthi, usiba* and *uthinongwana* are provided in English. Unlike in other resources where the microstructure is documented in a sentence form, this resource documents entries in the form of a list so make languages stand out as shown in **Figure 5.10** below where each equivalent is listed next to a corresponding language.


antenna {of radio}

English synonym	**aerial**
Afrikaans	**antenne**
Afrikaans	**lugdraad**
IsiZulu	**uthi**
IsiZulu	**usiba**
IsiZulu	**uthinongwana**
IsiXhosa	**ucingo**
IsiXhosa	**ieriyeli**
Siswati	**i-eriyeli**
IsiNdebele	**isikhambisimazamdumo**
IsiNdebele	**isiba**

Figure 5.9: Department of Arts, Culture Science and Technology (2013:7)

- **Self-explanatory lemmata**

Lemmata that is transparent in its meaning can be grouped together in an internal alphabetical order and the user is able to capture meaning by looking at the meaning of its components. Self-explanatory lemmata could not be found in the dictionaries because they are bilingual dictionaries and all entries were translated into the target languages as that is the purpose of these resources.

B. Lemmata with complete treatment in selected dictionaries

- **Lexical lemmata**

These are words that dominate the macrostructure of dictionaries made up of simple and complex singular entries determined by the typology of the dictionary. Below are examples of two lemmata with full treatment in each selected dictionary showing how they were treated in each resource. English lemmata are treated fully as whole words in all dictionaries and their equivalents are also entered as whole words. However, isiZulu lemmata in the EZD and the SZD are written from the stem of the words with their prefixes in brackets for nouns and the equivalent as a full word – for example, ***-thatha*** (take) (Dent & Nyembezi, 2009:554) (Doke et al., 2014:1143) in both dictionaries. Lemmata with other parts of speech are also listed from the stem but do not have prefixes provided in brackets. As much as these words are entered from the stem, they are whole words but written as such because of the language structure. The OUPEZ, however, handles isiZulu lemmata like the English – providing the full word with its equivalent also as a full word. Headwords are entered in full (not from the stem), such as ideophones and are identified by not having dashes before the words like those that start with stems.

- **Sub-lexical lemmata**

These lemmata entries cannot stand on their own in application at communication level which are added as individual entries in dictionaries. An example is the definite article **a**, the first entry in the OUPEZ and the EZD in the section with English lemmata, and this is an example of sub-lexical lemma as it cannot stand on its own but is an important part of a sentence. In the isiZulu lemmata of the same dictionary, the conjunction ***nxashana*** is an example of an entry already presented in **Figure 5.8** above that cannot stand independently in a sentence and is thus entered as a sub-lexical lemma in the SZD, EZD, and the OUPEZ.

- **Multi-lexical lemmata**

These are entries made up of more than one word. They can range from compound words, loanwords (words borrowed from other languages), idioms, expression, etc. which are recognised as single items because they carry meaning when used together. For example, penknife (pen + knife) in the SZD and the EZD as an English compound word, and -*khulumandla* in the EZD which is also a compound word made up of *khulu* and *mandla*.

5.4.2.2 The Microstructure

The microstructure of a dictionary is a structure of dictionary entries that focuses on the arrangement of data categories (which are sometimes called microstructural elements) given to lemmata entries (Tshikota, 2001; Hlongwane, 2021). The microstructure comprises of elements pertaining to the lemma which can be semantic information, lexicographic labels; examples, and idioms – which are ordered according to an arrangement structure.

Below is an examination of microstructural elements and definitions of the selected dictionaries. These are explained from the isiZulu lemmata side of these dictionaries as the study is more focused on isiZulu lemmata than English.

5.4.2.2.1 Microstructural elements

Below are references from the three dictionaries demonstrating the main body of the resources. The researcher selected the English lemma '**fly'** and the isiZulu lemma '***thatha'*** in all general language dictionaries to exhibit how each resource handles the macro and microstructure of the same lemmata. These lemmata were randomly selected among lemmata that have been given full treatment in dictionaries. The lemmata are not presented in this research report as it will take up too much space when reference can be easily directed to the dictionaries directly. The isiZulu lemma '***thatha***' is found in Dent and Nyembezi (2009:554); De Schryver (2015: 206); and Doke et al. (2014:1143). The lemma '**fly**' is found in Dent and Nyembezi (2009:114); De Schryver (2015: 359); and Doke et al. (2014:131).

The lemma 'fly' has been given a part of speech as a noun with the following details: (a) equivalents of the term as an insect are provided. (b) Other lemmata that have parts of the lemma 'fly' for example 'fire<u>fly</u>' in them are given with their equivalents of isiZulu equivalents. The researcher notes these entries under the equivalent as space saving because they could have been entered as separate headwords and treated individually. (c) The lemma

details also provide equivalents of a different type of fly that is not an insect 'fly on trousers' which provides an insight into another form of usage of the headword. (d) The lemma is also labelled as a verb with equivalents for the verb form. (e) Forms of usage of the word in a verb form are provided.

The researcher looked up the same headwords as in the SZD and found 'fly' to be treated in a higher level in the ESD. The pronunciation of the word is given, then the lemma is given four types of parts of speech and each of them has definite equivalents and forms of usage as a verb infinite, a verb tense, noun and a colloquial artful. There is also an idiom provided which is not found in the SZD or the OUPEZ.

The OUPEZ also provides two parts of speech for the headword which are the noun and verb like the other dictionaries. The verbal form is given in English with four tenses of the word and there is one equivalent provided which is in the same tense as the headword. An example of usage is then provided. A second definition of the word is provided with its example of usage. The noun form is also provided with an equivalent and an example of usage. This equivalent referring to an insect only provides one insect as compared to the SZD which provided examples of other insects with the word '**fly**' as part of the body of the word.

The SZD lemma '***thatha***' has been provided with its part of speech which is a verb. Equivalents are provided in English for the term. They are followed by the usage of the headword in the form of idioms with many idioms provided for the headword. The treatment of the lemma in the EZD is similar to the SZD with various forms of usage. Idioms are also listed with their equivalents even though not as many as those listed in the SZD.

The OUPEZ provides two separate entries for the word '***thatha***'. Both entries regard the word as a verb and provide one equivalent each, with examples. The first entry provides two different equivalents and examples of usage with their translations into English. The second entry only has one equivalent with an example and a translation into English.

The MNST-NGUNI has a very simple microstructure compared to the general language dictionaries as its microstructure comprises of only equivalents in each language. These equivalents are provided with synonyms, where they exist and in other circumstances, they

only have one equivalent. There are no data categories that can be identified save for synonyms in this resource.

There is no definite order for presenting elements of the microstructure, however, Tshikota (2001) posits that meaning may not necessarily be the first feature of the lemma but instead it can be phonetic, grammar, etymology and other data which would then be followed by the meaning. The arrangement of the meaning is also a point of consideration on its own as definitions can be presented according to the oldest meaning first or it can take the most frequently used sense, or a combination of both forms. Subsequently, elements that are often found in the microstructure are as follows, according to Tshikota (2001) who draws explanations from Geeraerts (1984):

a. Orthographical data: This data refers to the spelling of words which should be uniformly tailored throughout the dictionary. Other spellings may be provided as extra information if they exist. IsiZulu orthography has been revised over the years and the EZD and SZD as revised resources state that they have revised the orthography and employ the same as the OUPEZ which is a new resource. Therefore, all selected isiZulu dictionaries follow the revised orthography of 2008 by PanSALB.

b. Phonetic data: This is data about the pronunciation of words which has to be selected in a manner that will be understandable to the target user. The OUPEZ does not provide phonetic data in its microstructure, however, the middle matter has a detailed page explaining the pronunciation of isiZulu words which is almost similar to how the SZD handles pronunciation in the front matter where a list of all letters of the isiZulu alphabet is explained. The EZD, however, had a related but advance approach in that the alphabet pronunciation is explained in the front matter and then the microstructure of English words is given phonetic data for the lemmata. **Figure 5.10** presents a sample from the EZD as it is the only resource with phonetic data.

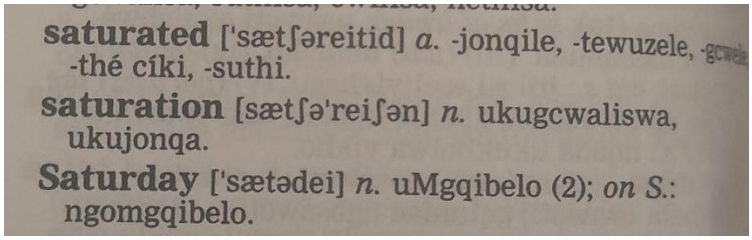
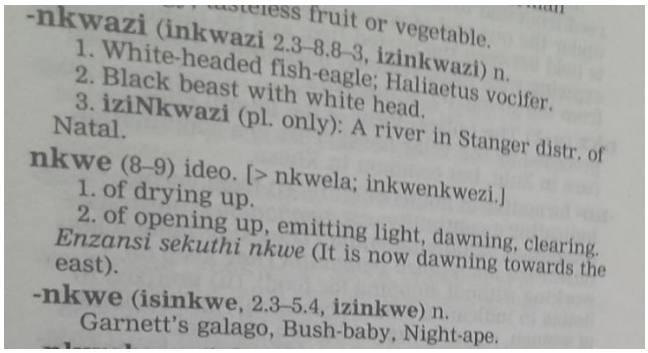

saturated ['sætʃəreitid] *a.* -jonqile, -tewuzele, -gcwa
-thé cíki, -suthi.
saturation [sætʃə'reiʃən] *n.* ukugcwaliswa, ukujonqa.
Saturday ['sætədei] *n.* uMgqibelo (2); *on S.*: ngomgqibelo.

Figure 5.10: Doke et al. (2014:304)

The entries ‘saturated’, saturation, and Saturday in this image are given phonetical data to show the reader how it can be pronounced. The absence of pronunciation data or phonetic transcriptions in dictionaries in African languages is common and lexicographers who attempted to add them did not manage to do so efficiently. In the same vein, Arabic language dictionaries have phonetic transcriptions, however, they were found to not be effective enough for learners since the user’s mother tongue has a major influence on word pronunciation in the second language (Uguru & Okeke, 2020).

c. Grammatical data: This is data about the grammar of the language which can include parts of speech, idiomatic information, morphological information and many other features of grammar that may be necessary in explaining the lemma. In all the dictionaries under examination the part of speech is the first item entered next to the lemma. In cases where there are idiomatic expressions, they are entered. Further, the OUPEZ made sure that there was an example of how to use the lemmata in sentences as part of their explanations. **Figure 5.11** presents samples from the three resources showing grammatical data. Only the isiZulu lemmata are taken because the study is bias towards the language as the study aims at expanding isiZulu lexicographic resources.


-nkwazi (inkwazi 2.3–8.8–3, izinkwazi) n.
1. White-headed fish-eagle; Haliaetus vocifer.
2. Black beast with white head.
3. iziNkwazi (pl. only): A river in Stanger distr. of Natal.

nkwe (8–9) ideo. [> nkwela; inkwenkwezi.]
1. of drying up.
2. of opening up, emitting light, dawning, clearing. *Enzansi sekuthi nkwe* (It is now dawning towards the east).

-nkwe (isinkwe, 2.3–5.4, izinkwe) n.
Garnett’s galago, Bush-baby, Night-ape.

Figure 5.11: Grammatical data on entry -nkwazi. Doke et al. (2014:953)

The lemma ‘*-nkwazi*’ is listed as a ‘noun’ represented by the abbreviation ‘n’. Information about the usage of the lemmata in plural form is also provided with the abbreviation for ‘plural’ in brackets. The pattern on abbreviating parts of speech is also found in the SZD where parts of speech are in brackets in all entries in the image in **Figure 5.12** below.

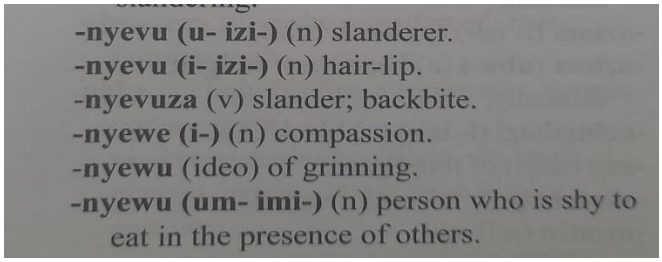


Figure 5.12: Dent and Nyembezi (2009: 503)

The OUPEZ, however, completed the name of the part of speech but provided an abbreviation for the plurality of the lemmata, as can be seen in the image in **Figure 5.13** below.

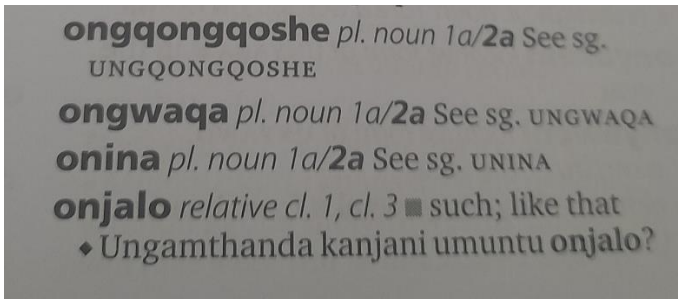


Figure 5.13: De Schryver (2015: 187)

d. Stylistic data: This is data informing the situation the lemma would be used, such as in euphemism or humour. An example of this usage is found in the ESZ where the lemma ***-khanyiso*** is entered three times as a lemma (see image in **Figure 5.14** below). In the third entry it is given its part of speech (noun) and two definitions (torch, lamp, light) and another entry of the same lemma is entered and explained as a *hlonipha* word for ***umlilo*** (fire). *Hlonipha* words are common in isiZulu dictionaries as *hlonipha* is part of the Zulu culture that is the substituting of words for others in order to respect certain members of the family or society.

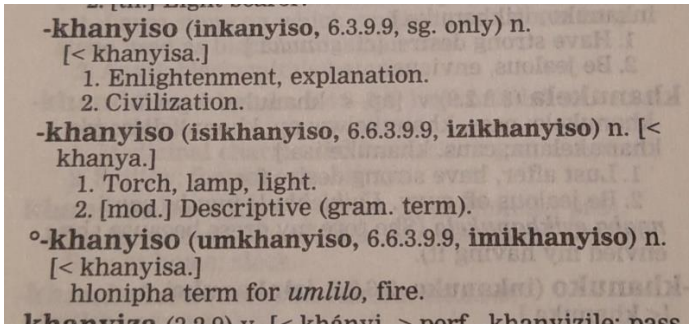


Figure 5.14: Doke et al. (2014:768)

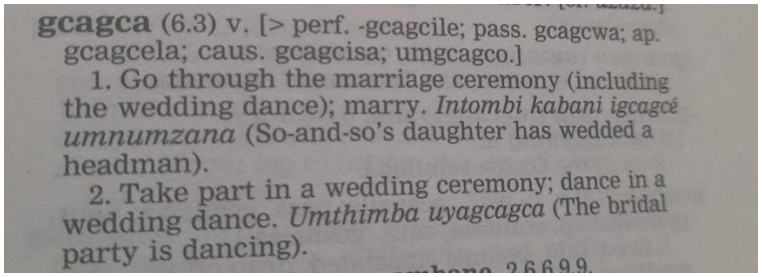
e. Distributional data: This is data that show that the lemma belongs to one or more socio-linguistically differentiated languages, by means of the word frequency or corpus spread. The general language dictionaries under examination do not have this element. However, the MNST-NGUNI as a multilingual resource has lemmata with equivalences in other Nguni languages. The image in **Figure 5.15** is an example of the entry 'body' which has the equivalent '*umzimba*' in isiZulu, isiXhosa and isiNdebele with Siswati having a similar equivalent '*umtimba*' as the language sometimes takes the letter '**t**' for a word that would take a '**z**' in other Nguni languages.

body	
Afrikaans	**liggaam**
IsiZulu	**umzimba**
IsiXhosa	**umzimba**
Siswati	**umtimba**
IsiNdebele	**umzimba**

Figure 5.15: Department of Arts, Culture Science and Technology (2013:18)

f. Etymological data: This data refer to the origin of the word, which can be derived from another language and can show historical and semantical change of words. Such data could not be found in the dictionaries under examination.

g. Interlingual data: This is the translation of data in multilingual dictionaries. Given that the dictionaries under examination are bilingual and multilingual, data are provided in more than one language for each entry. Interlingual information found in these dictionaries are the equivalents of the lemmata which are translated to either isiZulu or English depending on the language of the lemmata. The microstructure of all lemmata is translated, therefore, a randomly selected sample from the EZD is provided in the image in **Figure 5.16** below.



gcagca (6.3) v. [> perf. -gcagcile; pass. gcagcwa; ap. gcagcela; caus. gcagcisa; umgcagco.]
1. Go through the marriage ceremony (including the wedding dance); marry. *Intombi kabani igcagcé umnumzana* (So-and-so's daughter has wedded a headman).
2. Take part in a wedding ceremony; dance in a wedding dance. *Umthimba uyagcagca* (The bridal party is dancing).

Figure 5.16: Doke et al. (2014:631)

In **Figure 5.16**, two translations are provided for the lemma '*gcagca*' as the lemma has two meanings. These translations also have examples of the usage of the lemma which are in isiZulu with the translation of the usage translated to English in brackets. The additional information forms part of illustrated data which are explained below.

The approach of the MNST-NGUNI in translation provides an equivalent and synonyms where they exist for words. Some lemmata have more than one meaning. In those cases, different meanings of the lemmata are provided in brackets and entered as different entries with relevant equivalents. Some of these lemmata also take on different translation equivalents in the target language when they are in a different part of speech. **Figure 5.17** below provides an example of the entry 'balance' that has been entered three times with equivalents provided for each entry.

balance n. {apparatus}

Afrikaans	**massameter**
IsiZulu	**isilinganisi**
IsiZulu	**isikali**
IsiXhosa	**isikali**
Siswati	**silinganiso**
Siswati	**sikalo**
IsiNdebele	**isilinganisi**

balance n. {equilibrium}

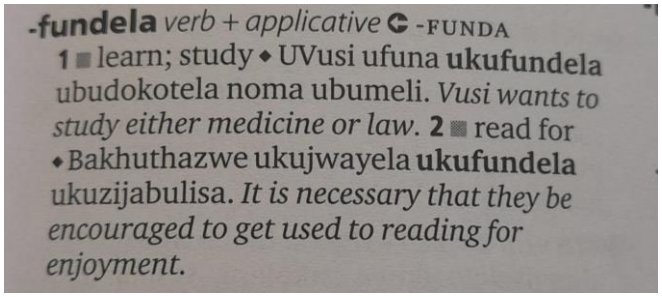
Afrikaans	**balans**
IsiZulu	**uzinzo**
IsiXhosa	**ukuzinza**
Siswati	**kusimama**
Siswati	**kutinta**
IsiNdebele	**ukulingana**

balance v.

Afrikaans	**balanseer**
IsiZulu	**-linganisa**
IsiZulu	**-kala**
IsiXhosa	**lungelelanisa**
Siswati	**kala**
Siswati	**linganisa**
IsiNdebele	**linganisa**
IsiNdebele	**nzinzisa**
IsiNdebele	**dzimelelisa**

Figure 5.17: Department of Arts, Culture Science and Technology (2013:12)

h. Illustrative data: This type of data can be verbal or non-verbal and necessary when the definition is not sufficient in explaining the lemma. Verbal illustrations can be in the form of examples, quotations or citations and non-verbal can be pictures, charts, or fables. The dictionaries under examination use non-verbal illustrations but examples of lemma usage in some entries are available. Further, the OUPEZ has examples for each lemma recorded.



-fundela *verb + applicative* ⓒ -FUNDA
1 ■ learn; study ◆ UVusi ufuna **ukufundela** ubudokotela noma ubumeli. *Vusi wants to study either medicine or law.* **2** ■ read for ◆ Bakhuthazwe ukujwayela **ukufundela** ukuzijabulisa. *It is necessary that they be encouraged to get used to reading for enjoyment.*

Figure 5.18: De Schryver (2015: 59)

Figure 5.18 above provides a lemma '*-fundela*' with an example, '*UVusi ufuna ukufundela ubudokotela noma ubumeli*.' The translation of the example is also provided next to the illustrative data as 'Vusi wants to study either medicine or law.' Another example of usage is provided, a different form of lemmata usage as '*ukufundela*' meaning to 'read for'. The example provided is '*Bakhuthazwe ukujwayela ukufundela ukuzijabulisa*. It is necessary that they be encouraged to get used to reading for enjoyment.' The isiZulu usage is immediately followed by the English translation.

g. Semantic data: This refers to the meaning of the word which can include synonyms or encyclopaedic elements, among other, features. The amount of data recorded is determined by the dictionary function. Semantic data provided in the dictionaries are mostly lemmata equivalents which can vary if the lemma has various meanings. Dictionary definitions are often the main reason for consulting lexicographic resources where users want to understand the meaning of words (Tarp, 2008). As stated by Tshikota (2021:10), "Lexicographical definitions can be divided into two major groups, namely descriptive definitions and synonymy definitions. Descriptive definitions include three sub-groups, namely: generally descriptive definitions, genus differentia definitions and circular definitions."

The dictionaries under examination are not monolingual which means that their data entries take a different language the moment one moves from the macrostructure to the microstructure and this eliminates the possibility of finding synonymous meanings; instead, one finds equivalents in the target language. Descriptive meanings are, however, available for terms that do not have direct equivalents where compilers had to describe the term. The entry in F**igure 5.19** below from the SZD provides four English entries that were described in isiZulu.

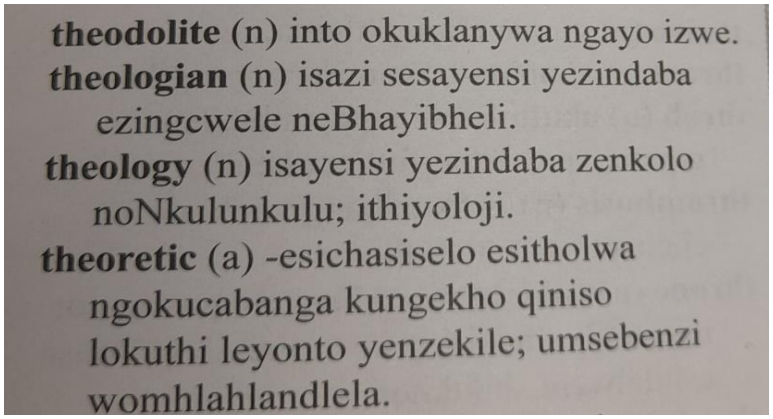


Figure 5.19: Dent & Nyembezi (2009:309)

In **Figure 5.19** entries are described as follows:

- Theodolite: something used for measuring a country.
- Theologian: An expert in the scientific study of divine stories and the Bible.
- Theology: The science of religious matters and God.
- Theoretical: An explanation discovered through thought without proof of the occurrence of a phenomenon.

5.5 Pedagogical lexicography in English-isiZulu resources

Resources examined in this chapter for the analysis of the megastructure of leaners' dictionaries that are for general language use and a domain-specific one for Natural Sciences and Technology for Grade 4 to 6 learners demonstrated developments in the production of lexicographic resources in isiZulu with English serving as a foundation for the development. These resources are designed to satisfy the communication and language educational needs of users who are first language speakers and those who are learning the language as an additional language as suggested by the theory of lexicographic functions. This was evident when considering the typology, structure and semantic data of the resources.

- Dictionary Typology

The researcher found the typology of the examined dictionaries similar and user oriented as posed by Tarp (2003) in the theory of lexicographic functions which states that the development of dictionaries should consider extra-lexicographic aspects that place the user at the forefront. The profile, user situation, user needs, lexicographic functions proposed by this theory were considered in the development of the dictionaries. These considerations determined the typology of dictionaries thus they were structured as bilingual dictionaries

because the needs that they are meant to satisfy were needs of users who seek to find equivalents of lexical items in another language, which were already known in one language. As an example, the blurb on the back cover of the SZD records the following:

> The Scholars Zulu/English bilingual and explanatory dictionary is a comprehensive dictionary compiled to meet the needs of IsiZulu and English Home language, First Additional and Second Additional Language learners, learners as well as speakers of other languages who need knowledge and understanding of IsiZulu words and phrases and their English equivalences. (Dent & Nyembezi, 2019)

As indicated in this blurb, user needs were considered as the resource meets categories of user needs set by Bergenholtz and Tarp (2003), which is information about the native language of the native and foreign languages, and information about the culture and world in general, which was seen in the content of SZD and the other dictionaries. A similar pattern was also found in the EZD where the resource is regarded as an "invaluable resource for learners of isiZulu, for isiZulu-speaking learners of English, and for linguists working in the isiZulu language." (Doke et al., 2014: vii); and the OUPEZ which states that "This dictionary has been designed to help you read and write isiZulu better, if you are a learner of isiZulu, or read and write English better, if you are a learner of English." (De Schryver, 2015:vi).

Atkins (1996) suggests that bilingual dictionaries should consider the function of the dictionary information, mode of expression, source and target language speakers, and the purpose of the dictionary. This information was well expressed in the outside matter of all dictionaries under examination, and also found in the main body of the resources, where the needs of pedagogical users were placed supreme.

- Dictionary Structures

The structure and usage guidelines of all resources are provided in the front matter to help users learn how to navigate the resources which made the main body of dictionaries more comprehensible even without reading the guidelines provided in the front matter. The examined resources successfully created simple structures that facilitated navigation in these printed dictionaries in determining the meaning of words, although the EZD and the SZD only provided the root of the word. This is common in isiZulu as an agglutinative language even though it may pose challenges for users who do not have grammatical knowledge of the

language. The commonality of writing isiZulu words from the stem was also seen in the MNST-NGUNI where some equivalents were written in that fashion. **Figure 5.20** provides a sample where the equivalents for 'absorb' are written from the stem which is noted by the hyphen at the beginning of the word:

absorb	
Afrikaans	**absorbeer**
IsiZulu	**-munca**
IsiZulu	**-donsa**
IsiZulu	**-habula**
IsiXhosa	**ukufunxa**
IsiXhosa	**ukutsala**
Siswati	**munya**
IsiNdebele	**ginya**
IsiNdebele	**munya**

Figure 5.20: Department of Arts, Culture Science and Technology (2013:1)

The agglutinative nature of isiZulu and other Bantu languages led to dictionaries opting to record lemmata according to their stem instead of entering the whole word. The challenge with this form of lemmata presentation is that nouns have different noun classes prefixes, and when a noun is substituted for another in a sentence, the sentence sounds completely different, and the meaning changes too (De Schryver & Wikes, 2008). A person who does not have the benefit of being a first language user might struggle to satisfy their lexicographic needs in these resources. Subsequently, the OUPEZ was created with a new form structure in isiZulu lexicography where whole words are recorded as the lemmata are recorded. This limits the extralinguistic knowledge requirement from users where they are expected to know how to apply the prefix and sometimes the suffix of a lemma presented in stem form. Most lexicographers have been loyal to the lemmatisation approach, however, the new approach is also worth examining in modern lexicography, especially in pedagogical lexicography because learners, depending on their age group and/or grade may have limited linguistic knowledge and not easily understand dictionary contents. This may hinder the lexicographic function of pedagogical dictionaries.

- Semantic data

All dictionaries provided a microstructure with equivalents and not necessarily definitions save for instances where direct equivalents or simple translations were not available and the

compilers had to define the lemmata. Tarp (2008) holds that dictionaries are often consulted for definitions and given that the examined dictionaries are not monolingual, one of the most important features of a dictionary is lacking. Nevertheless, dictionary definitions can take various forms such as descriptive definitions and synonymous definitions (Tshikota, 2021). The form of definitions provided in all selected published resources are descriptive. Lemmata are not described but only given an equivalent in another language – isiZulu or English depending on the language of the lemmata. This is supported by Atkins (1996:8) who states the following:

> People often turn to a monolingual dictionary during a bilingual search. The ideal dictionary should offer monolingual functions (definitions, etymologies, usage notes) to the bilingual dictionary user. It should cater for the dictionary browser, as well as the user intent upon one task.

For a user who seeks to define a word they would need to consult a secondary resource to find more information in another language, especially in domain-specific terminology, when it would be convenient to translate definitions into isiZulu. This is a common challenge in bilingual dictionaries as it was observed by Klapicová (2005:62) that:

> Monolingual specialized dictionaries offer a definition of each lexical item, in many cases enriched by an encyclopaedic extension and illustrations. Bilingual and multilingual specialized dictionaries, on the other hand, present the equivalents of the terms in one or more languages. It would be wonderful to have bilingual and multilingual specialized dictionaries which would offer also a definition of each term, at least, in the source language, which is the only possibility to confirm whether the equivalents in the target language(s) truly correspond with the term of the source language.

At the moment, a bilingual dictionary that provides thorough definitions as monolingual dictionaries is not available in isiZulu as a target language. As a user of isiZulu dictionaries, the study depends on monolingual English dictionaries for definitions. This can be frustrating and time consuming. Additionally, a user who is not well conversant in English would not benefit as much from a bilingual dictionary that lacks definitions because they would get an equivalent in isiZulu but still be short of a description of the same word. To this end, Nkomo (2019:108) posits that dictionaries should have information that is "relevant, sufficient and accurate" for them to adequately satisfy the needs of users. Therefore, lexicographers should

consider developing dictionaries that will have definitions, as already stated, because most users consult a dictionary to define terms and, as determined in the EZD and the SZD that have additional information in the form of examples of usage and idioms provided in these resources.

Although the outside matter of the dictionaries was somewhat different (the SZD and the EZD only had the front matter; the MNST-NGUNI had the front and back matter; and the OUPEZ had the front, middle and back matter), the dictionary structures corresponded in all resources and their treatment was aligned with the target users of each resource. The major difference between these resources was the structure of the lemma where the OUPEZ and the MNST-NGUNI entered some of the entries fully and the SZD and EZD entered them from the stem. It stands to reason that users were considered in the development of the dictionaries as required by the theory of lexicographic functions because the users are learners of the isiZulu language and are expected to know isiZulu morphology which is also explained briefly in all selected resources. Published resources examined in the current study do assist learners in elevating their general pedagogical language comprehension challenges as they do provide lexicographic data that enhance knowledge about the lemma. However, the absence of descriptive definitions limits the usage of these resources by learners and other users interested in learning the language.

5.6 Conclusion

This chapter presented the analysis of data collected from selected dictionaries to examine their structure for learning purposes for this research to enhance practical lexicography through the development of the new resource. Subsequently, the chapter examined the megastructure of dictionaries and determined that the outside matter of most English-isiZulu dictionaries only has the front matter, while the OUPEZ has the front matter, middle matter and the back matter.

The front matter of English-isiZulu dictionaries explains the target users for the resource and provides brief linguistic information about the isiZulu language. The EZD also contains historic information about the resource because it has had previous publications with different orthographies in line with the development of the language. In the same vein, the OUPEZ, in explaining its front matter, further presents information about a new type of dictionary and explains the new features included in the resource in two languages, which is not done by the other resources. The research found the front matter of the OUPEZ most interesting, because of how it was presented, and its bilingual form which is not enjoyed in any other dictionary. The inclusion of both languages shows that the resource is targeting users who are mainly

English speakers and those who are mainly isiZulu speakers as it speaks to both of them in both languages. Nevertheless, this method was not adopted in the developed resource because this resource only targets isiZulu mother-tongue speakers.

As already mentioned, the OUPEZ was the only resource with middle matter and this part provides linguistic information for users and details about creating a list of words for the users' personal dictionary. It was recognised that the OUPEZ is a learner dictionary and found that this information may be of benefit to them in their learning and English class lessons. However, as learners targeted by the current study are in the FET phase of learning, this information is not necessary, thus the dictionary developed in this study does not have a middle matter.

The back matter is however available to provide reference details as an acknowledgement of resources consulted during the development of the resource. This is a feature learnt from the MNST-NGUNI which also lists references consulted during its development as compared to the OUPEZ which provides detailed information about language statistics, animals, the South African map and so forth. As much as the information provided by the latter resource is important, it is not relevant to the Life Sciences dictionary and is not part of the features of interest to this study.

The main body of selected dictionaries consists of the macrostructure and the microstructure. Features contained in the macrostructure of this research are lemma selection, lemma arrangement and lemma treatment. The study determined that the selected dictionaries selected data from words that are used generally in everyday language because the resources are for general language use. The MNST-NGUNI, however, selected its lemmata from prescribed school material from the DBE. This research followed the latter resource and extracted data from the prescribed Life Sciences books from the DBE as the data contained in those resources are most relevant to the target user of the developed dictionary.

Selected dictionaries are divided into two parts; a section of English lemmata and a section of isiZulu lemmata. They are all arranged alphabetically as this is the most common arrangement in dictionaries. The arrangement, however, differs in the isiZulu section as compared to the English because of the lemmatisation feature of the isiZulu language. Thus, lemmata are arranged from the stem of the word. Information about how one can use the dictionary arranged in this manner is provided in the front matter of these resources. The OUPEZ, however, deviated from this method and provided a complete form of each isiZulu lemma. Deviation in lemmata arrangement and the division thereof according to languages are also found in the

developed resource in that it followed the MNST-NGUNI and arranged lemmata according to the English headword and provided the isiZulu equivalent in the microstructure. Thus, the arrangement of the developed dictionary does not begin from the stem as other English-isiZulu dictionaries.

The study also considered how these lemmata were treated in the dictionaries and found that each lemmata was given a part of speech and they were given equivalents in isiZulu from the English section and English equivalents from the isiZulu section. These dictionaries are bilingual and only provide equivalents instead of definitions, which could be a problematic feature for dictionary users seeking to understand the words. Therefore, this study created a bilingualised dictionary to cater for definitions of terms thus extending the boundaries of isiZulu dictionaries.

This research analysed Life Sciences terminology with the intention of developing a comprehensive English-isiZulu dictionary and in order to consider it as comprehensive, it should contain definitions and explanatory information for the lemmata. This treatment method expands the function of lexicographic resources in African languages through the development of this dictionary, which is ultimately the main aim of this research. This forms part of the microstructure of dictionaries which looks at the features that come after each lemma. This information includes grammatical data, the pronunciation of the lemma, etymology, and others relevant to each dictionary type. Most English-isiZulu dictionaries contain a part of speech and the equivalent of the term in the target language. The developed dictionary is a scientific dictionary focusing on providing scientific information to users; therefore, its focus is only on explaining the terms featured as lemmata entries. Thus, the developed dictionary has some etymological features providing clarity on the formation of the word and further defines each term in isiZulu which is the target language. The lemmata of the developed resource are in English which is the language of education as explained earlier; therefore, definitions are provided in English firstly, to enable the user to relate what they are learning in class with what is in the dictionary as the expectation in their examinations will be to write in English. Subsequently, etymological and semantic information are provided in both languages, with additional information only provided in isiZulu.

The typology of the new dictionary (to be deliberated on in the next chapter) was developed from studying the typology of dictionaries examined in this chapter. The resources examined were from general language dictionaries and a domain-specific resource and they demonstrated

a gap in English-isiZulu dictionaries, which was the absence of definitions in all resources with descriptions only applied on lemmata that lacked equivalents. This, however, is not caused by a fault of lexicographers of those resources, but is resultant from their type as bilingual general language dictionaries. Subsequently, the resource developed in the next chapter brings a new structure for the development of a new lexicographic resource that is bilingualised and subject specific.

CHAPTER SIX

EXPANSION OF PRACTICAL LEXICOGRAPHY IN AFRICAN LANGUAGES THROUGH THE DEVELOPMENT OF A BILINGUALISED LIFE SCIENCES DICTIONARY

6.1 Introduction

This chapter presents guidelines created during the development of the ISY-LSD and evaluates the developed resource which is in an electronic form. This is done to determine the alignment of the resource with user needs, subsequently expanding lexicographic resources in African languages is the main objective of this study. In establishing whether the developed resource meets lexicographic functions, the dictionary evaluation criteria by Ball and Bothma (2018) are considered. Sections in this chapter are made up of guidelines for the development of the ISY-LSD; the dictionary structure, and an evaluation of the ISY-LSD, respectively.

6.2 Guidelines for the development of the ISY-LSD

The researcher developed guidelines to guide her in developing the ISY-LSD as a novel domain-specific dictionary in an African language. Below is a diagram of the same which is followed by an explanation.

Table 6.1: ISY-LSD Development guidelines

DOMAIN-SPECIFIC AFRICAN DICTIONARY DEVELOPMENT GUIDELINES

1. PLANNING

- User profile
- User needs
- User situation
- Lexicographic function
- Dictionary type
- Dictionary form

2. MACROSTRUCTURE

- Lemma selection
- Lexical relations
- Lemma arrangement

3. MICROSTRUCTURE

- Etymology
- Semantic data
- Additional information

4. TRANSLATION

Translation strategies for lemmata and definitions

5. DEVELOPMENT

- Dictionary structure
- Dictionary content
- Dictionary

6.2.1. Planning

The theory of lexicographic functions states the importance of considering the user as a starting point of dictionary development. To this end, the user profile, user situation, and user needs are considered as they guide the lexicographer on the type of dictionary required by the user. Examining the user is the first step of dictionary development as it influences the type of dictionary required, lemma selection, dictionary structure and form. Subsequently, the first step of creating a dictionary required the study to plan how the practical lexicographic process will unfold. In the same vein, the researcher took it upon herself to harvest domain-specific terminology and also decided on the form that she would like the resource to be published in based on the user characteristics; and incorporated dictionary form in the planning process for this resource. The researcher applied this knowledge to create a plan for the dictionary being developed in this study which has five components - User profile, User needs, User situation, Lexicographic function and the Dictionary form. Each of the components of the planning components are explained below.

6.2.1.1. User profile

Nkomo (2008) regards language competency of the user as the first step for the lexicographer; this is followed by distinguishing between the user's first language and another language that might be needed in the dictionary development project. Language data determine the source language and the level of the language to be used as users of the same language can have different levels of linguistic knowledge depending on their age and level of education. The current study developed a bilingualised dictionary, therefore, elements such as the linguistic competence of users in both languages were considered as a starting point; followed by their age group; and their expertise in the subject. These elements are explained below:

a) User language proficiency

The target users of the ISY-LSD are high school learners from Grade 10 to 12 whose mother tongue is isiZulu. The resource is intended to assist them in understanding scientific material, which is in English − an acquired language. Taljard and Gauton (2001), when examining the quadrilingual Explanatory Dictionary of Chemistry (English, Afrikaans, isiZulu, Sepedi) stated that most users are subjected to learning in English which was not their mother tongue, and this puts them at a disadvantage as compared to their English and Afrikaans mother-tongue peers.

Language has been found as a hindrance to the process of learning (Mji & Makgato, 2006; Charamba, 2017; Gudula, 2017; Diko, 2018) and methods such as code-switching have been applied by teachers to assist users. As a means of assisting learners, teachers of their own accord create bilingual classrooms to ease the English burden on the shoulders of learners (Mohohlwane, 2020), thus the ISY-LSD can serve as a resource promoting education that considers the language gap of learners in educational resources.

The Language in Education Policy (1997) posits that learners can choose a language of teaching upon their registration at a school, however, an annual survey of schools from 2007 to 2011 by the Department of Basic Education found that learners whose mother tongues are indigenous languages, and who make up 79.1% of South African learners, still have to grapple with problems that emanate from the apartheid era of the country (Taylor & Coetzee, 2013). Furthermore, Mohohlwane (2020) states that there are no educational resources to support language choices of learner after Grade 4. This unavailability of resources makes linguistic choices of learners impractical to attain as the South African education system is more advantageous to learners with available resources, which are English and Afrikaans mother-tongue learners.

Rollnick and Rutherford (1993) determined that it was not only learners who grappled with understanding scientific terminology in a study conducted in the Eastern Cape, but teachers were also not completely clear in their explanations. Charamba (2017) found that learner results were influenced by the language of knowledge acquisition. Subsequently, the translated macrostructure and microstructure of the ISY-LSD are envisaged to be beneficial to users – making the language of science available in their mother tongue. Kranebitter (2021) who examined terminology development of legal texts in German established that translating Italian legal terms to German aided in the development of the language and provided for better comprehension of the material among speakers of the target language, making them to be on par with their Italian counterparts. The Constitution of the Republic of South Africa requires the government to provide for linguistic needs of all South Africans (Beukes, 2010) and this includes the translation of material to facilitate communication and education. Thus, the linguistic abilities of users are the main reason for the development of the ISY-LSD, more especially, because the subject of the dictionary is scientific, and science has a language of its own that is not readily available in general isiZulu dictionaries.

b) User age

According to the South African Schools Act (1996), the age requirement for entry into Grade 9 is 15 and Grade 12 is 18. This means that learners who are the target market of this dictionary are between the age of 16 to 18 and above, given that 18 is the entry and not necessarily the exit age. These learners are teenagers who have various interests in life and interests in the current age are mostly influenced by technological developments which influence the medium of delivering information to these users. Dictionaries and other learner material developed when created with a user in mind will be delivered in a form that is most relevant to them.

Taljard and Gauton (2001), when examining the quadrilingual Explanatory Dictionary of Chemistry (English, Afrikaans, isiZulu, Sepedi) for high school learners from Grade 10 to 12 and pre-graduate tertiary learners, stated that most users were subjected to learning in English which was not their mother tongue and had fragmented knowledge of the subject. In the same vein Taljard, Gauton and Gauton (2007), in their paper on examining the planning and design of the bilingual (English-Northern Sotho) explanatory dictionary for industrial electronics, found that it catered for users between the age of 15 to 21 who were neither good in English nor Northern Sotho because they were taught in English as a medium of instruction, and not much academic attention was given to their mother tongue. The language of education has a direct impact on the level of language expertise of learners which makes learners who speak indigenous languages as their mother tongue lack adequate linguistic knowledge required for their age.

The ISY-LSD is aimed at Grade 10 to 12 users which Maddock and Maroun (2018) consider as adolescent users and explain the term ‘adolescents’ as a broad term in the Western society that covers people from the age of 12 or 13 up to the early 20’s, which is a crucial age for learners where decisions made have a direct and indirect impact on their quality of life. The importance of this stage in life demands that learners be provided with supporting learner material to promote the development of this age group. However, the availability of resources that accommodate language needs of these users are lacking. On the contrary, there have been subject-specific lexicographic resources developed by the South African government via the DSAC for young users up to Grade 7 which provide terminology equivalents for all official languages of the country. Unfortunately, learners in the senior phase of high school have not been catered for.

c) User expertise

The expertise or the encyclopaedic competence of users is the final stage of characterisation when planning a dictionary, and this grouping of users is determined by their experience and exposure to information. The expertise of users can be that of layman, semi-expert, or expert as differentiated in **Figure 6.1** below.

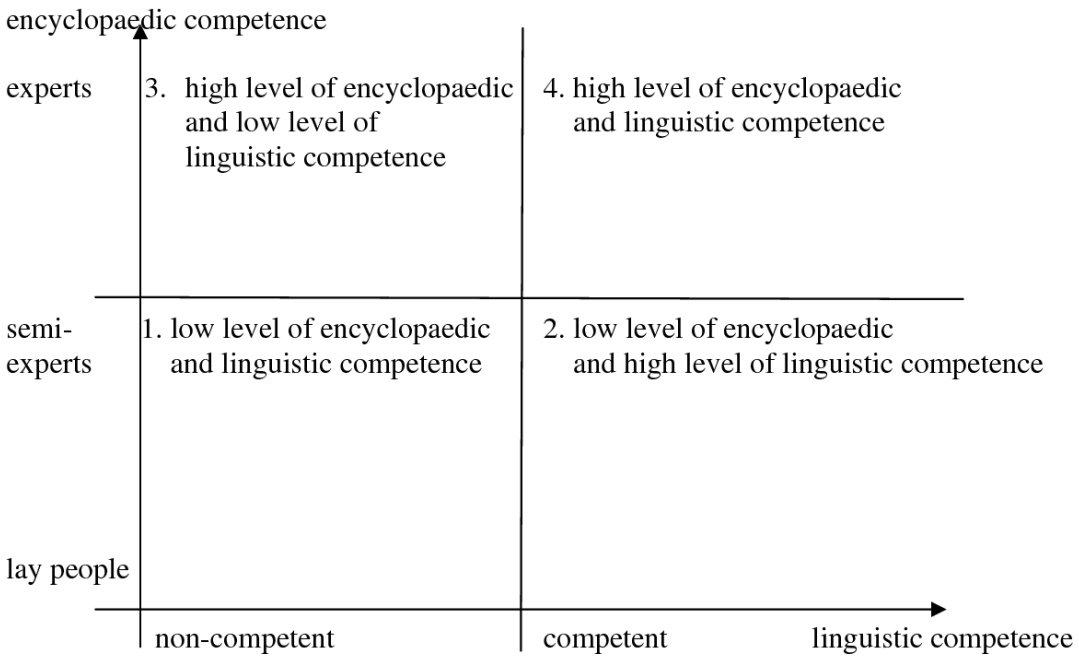


Figure 6.1: User profile (Tarp, 1995:21)

Users with a high level of knowledge on the subject are considered as experts, while those with a low level of knowledge are semi-experts, and those with no knowledge at all on the subject matter are considered as lay people. Users of the ISY-LSD are semi-experts in that they have some knowledge on Life Sciences but are still learning and cannot be considered as experts in the subject.

The 2020 Diagnostic Report from the Department of Basic Education on Life Sciences shows several sections of the subject that learners are battling with, which include understanding and differentiating between concepts and understanding terminology. **Figure 6.2** below shows the Grade 12 final Life Sciences results from 2016 to 2020. There is a decline in the number of learners who wrote the exam when comparing the year 2016 and the year 2020. However, there is an increase in the results of learners who achieved 30% and above, and 40% and above. The researcher observed that the great number of learners who achieved, passed at 30% and above,

and a lower number of learners who passed at 40% and above. This trend was observed in all these years. Learners are not achieving at a high level on this subject.

Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above	No. achieved at 40% and above	% achieved at 40% and above
2016	347 813	245 157	70,5	157 224	45,2
2017	318 474	236 809	74,4	166 071	52,1
2018	310 041	236 584	76,3	160 208	51,7
2019	301 037	217 729	72,3	147 436	49,0
2020	319 228	226 700	71,0	153 028	47,9

Figure 6.2: Overall achievement rates in Life Sciences (Department of Basic Education, 2020: 142)

To cite one of the findings of these results for exam Paper 1 on the subject by the Department of Basic Education (2020: 144), "Some candidates were not familiar with basic terminology in the different topics. This resulted in poor performance, even in the lower-order questions." The Department then suggested that teachers should use biological terminology to familiarise learners with concepts.

Subsequently, these learners are low experts and need supporting resources with biological concepts that should be explained in a manner that will be easier to understand. The terminology should not be substituted with common words even if they mean the same thing. For this reason, the ISY-LSD provides biological lemmata and translates them into isiZulu for clarity, while ensuring that scientific explanations are provided in English and explained in isiZulu. The dictionary serves as a linguistic resource that will enable users to reach a higher level of expertise because teachers are already code-switching in the classroom between English and an African language as a means of helping learners understand the material being taught (Gudula, 2017).

6.2.1.2. User needs

User needs are user requirements that are directly related to a defined user according to their characteristics and user situation, that must be satisfied by a lexicographic resource (Bergenholtz & Tarp, 2003). Scientific subjects employ specialised language and vocabulary, and learners on the African continent are required to learn this scientific lexicon in a language that is secondary to their own (Osborne & Collins, 2001). Therefore, the needs of users that the ISY-LSD aims at satisfying is the absence of subject-specific lemmata and their definitions in their mother tongue.

This resource provides for these needs according to the user situation of being a learner who requires terminological information to be knowledgeable enough to pass their examination and possibly arouse more interest in the field of Life Sciences. The language ability of the learner guides the format of providing for the needs of users. By providing these users, as learners who are semi-bilingual adolescents as mentioned above, with a bilingualised dictionary it can possibly bridge the gap between monolingual dictionaries and bilingual dictionaries as this type of resource provides terminology and definitions in the dominant language of the dictionary, and explains or provides examples in the language of the target user (Laufer & Melamed, 1994). The language of learning is the dominant language and provides a microstructure with isiZulu translations.

The ISY-LSD provides for the following needs:

- Spelling of lemmata;
- IsiZulu equivalents;
- English biological definition;
- IsiZulu translation of the definition;
- Additional biological information in isiZulu; and
- Searching for additional information on lemmata in the internet.

6.2.1.3. User situation

The user situation refers to a situation that may lead to the user to using a dictionary. The situation may be cognitive, meaning there is a knowledge gap in a particular topic that the user wishes to close, or it can be communicative, where the user uses the dictionary to aid communication to produce or receive information or for translation purposes (Nkomo, 2008).

The ISY-LSD is intended for cognitive purposes as the target users are learners of Life Sciences who would use the resource in order to understand and gain more knowledge on the subject. It is imperative that the user situation not be randomly presumed but there should be substantial information supporting the situations that users would require the dictionary (Nkomo, 2008). As reflected in the Department of Basic Education Diagnostic Report (2020), examination results of users reflect a lack of adequate subject-specific knowledge in Life Sciences. Therefore, the ISY-LSD can be used to acquire terminological information in the classroom, at home when doing homework, when reading additional subject-related material, or when preparing for examinations.

6.2.1.4. Lexicographic function

The lexicographic function of a dictionary determines the sincere purpose of the dictionary which helps to define users' specific needs regarding a dictionary as required in each situation. For the dictionary to fulfil its function, it has to satisfy the user needs, characteristics, and situations. Therefore, the functions can vary as required in each situation. To this end, Bergenholtz and Tarp (2003) divide the functions into communicative and cognitive functions. Since the user situation of potential users of the ISY-LSD requires a resource for cognitive purposes, the lexicographic function of the dictionary is cognitive. The function of this resource is to provide the following:

- encyclopaedic information to the users in the form of definitions;
- special subject-specific information provided to users in the form of supplementary lemmata information;
- information about the lemmata translation into isiZulu provides users with information about the language that enables them to connect the term to a native language counterpart;
- to provide a link for users to search for more resources that will assist in understanding the term, using the search feature and link to the internet.

6.2.1.5. Dictionary type

The ISY-LSD is a bilingualised dictionary as its content is not only of a bilingual nature but provides data that are commonly found in monolingual dictionaries, i.e., definitions of lemmata. The resource further provides etymological considerations and additional data to the lemmata to provide users with sufficient information to meet user needs.

Laufer (1995) proposes the development of resources that will incorporate definitions in the foreign language to relieve users of consulting other resources in foreign languages to find definitions of equivalents that they would have found in a bilingual resource, which resulted in a different type of bilingual dictionary. The ISY-LSD is the first dictionary of its kind to be produced in isiZulu targeting a scientific domain. Nkomo (2019) holds the view that domain-specific dictionaries in African languages do not completely satisfy user needs as they often comprise of lemma equivalents without definitions and suggested that lexicographers improve the situation. Subsequently, the ISY-LSD is a comprehensive domain-specific resource in an African language that has a simple and comprehensive structure.

6.2.1.6. Dictionary form

De Schryver and Wilkes (2008) posit that electronic dictionaries are advantageous in that users are at liberty of cross-referencing their search with other electronically available resources, yet despite this benefit, challenges are being experienced with the development of electronic dictionaries in languages such as isiZulu due to the agglutinative nature of the language that resulted in a lack of comprehensive dictionaries in digital form. However, the University of KwaZulu-Natal Language Planning and Development Office (hereafter referred to as the ULPDO) succeeded in creating a lexicographic resource in an electronic form despite the challenges of producing such resources in African languages.

In a discussion on Intellectualisation Through Terminology Development, Khumalo (2017) explained the strides made in the development of this digital lexicographic resource and its functions.

> ULPDO has developed two open-source platforms to cater for a broad-based end-user uptake of its authenticated terminology. ULPDO has also introduced the notion of AnyTime access so that learners and other users can access the terms anytime they need them. ULPDO has exploited technology to develop improved end-user access through the development of a mobile compatible application. The application is called the Zulu Lexicon, which is short for isiZulu Lexicon, and is a free download from iTunes and Google Play in Smartphone and Android. The Zulu Lexicon affords learners, lecturers, and other end-users anytime access at their fingertips to all the authenticated (multidisciplinary) terminology, with search functions on the APP in both English and isiZulu. (Khumalo, 2017:261)

The researcher is a user of this resource and benefits from the lexicographic functions of the resource using a mobile device. Digital tools such as mobile phones are widely available in South Africa with a penetration rate of more than 100%, according to the Telecommunications Union (2013) in North, Johnston and Ophoff (2014). Thus, the value of digital lexicographic resources is an "invaluable reference resource for many research and application projects in the linguistics and lexicography domains" (Bosch & Griesel, 2020:4). Given that there is a wide usage of mobile phones and considering the advantages of using electronic dictionaries, the ISY-LSD will be published in an electronic form as an e-book as the availability in this form caters for users who prefer both or either media platforms as the book can be downloaded and printed by the user, if they wish to do so. Further, an e-book has in-use features such as

searching and cross-references and these features are available in the ISY-LSD to help the user navigate quicker and in a more efficient manner. Providing a resource of this nature will satisfy more than the listed lexicographic functions of the dictionary.

> It is far easier to type a few characters on a keyboard − sufficient to find the headword you are interested in − than to ruffle through more than a thousand pages in order to home in on that same word. Access to an entry in an electronic dictionary is (normally) relatively instantaneous, whereas looking up in a printed dictionary is an inefficient. hit-or-miss, often frustrating process. The printed book is essentially a linear storage device, whereas conceptually, a lexical information resource is multi-dimensional. The alphabet, which has tyrannised over dictionary arrangement and access for centuries, ceases to be a tyrant when your dictionary is electronic. (Leech & Nesi, 1999: 289)

Therefore, the ISY-LSD e-book will be made available in Smashwords, which is a website (www.smashwords.com). When downloading the e-book, a user can choose a format that is convenient for them, given that e-books vary. According to the University of Johannesburg library, these are some of the most popular formats:

> **PDF (.pdf)** - A very popular eBook format from Adobe which most eReaders support.
>
> **EPUB (.epub)** - An open eBook standard created by the International Digital Publishing Forum (IDPF). It features reflowable text, inline images and the ability to use Digital Rights Management (DRM) such as Adobe Digital Editions.
>
> **Kindle (.azw)** - Native format for Amazon's Kindle products which typically comes with DRM protection to limit sharing.
>
> **MobiPocket (.mobi)** - A format primarily designed for PDAs and older mobile devices. Also used on the Kindle.
>
> **Text (.txt)** - A basic plain text format which is easy to create, but cannot contain images (https://uj.ac.za.libguides.com/UJeBooks/formats)

The researcher, as a registered user of this website, will upload the dictionary and make it available free of charge. Therefore, the user can search for it, in the search box, using its title and download it to their mobile phone. They will be able to use this dictionary without internet connection once downloaded. The user would only require internet connection should they

want to search for information on the internet. However, if browsing on the resource only, no internet connection is required, thus making the resource free to use.

The ISY-LSD will be available in PDF, EPUB, mobi (kindle), online reader, irf, pdb and text. To download the dictionary the user will have to have a reader application aligned with the choice of the e-book that they want to download. If they do not have any reader application, they can download it from the application store of their device

6.2.2. The Macrostructure

The second step in the development of the ISY-LSD was to create a macrostructure to list the harvested terminology hereinafter referred to as lemmata in plural and lemma in singular. The macrostructure of the ISY-LSD is mixed in the sense that it has lexical lemmata and multi-lexical lemmata. The theory of lexical semantics was considered during the selection of lemmata influenced by the diagnosis of the Department of Basic Education (2020) that found learners to lack in understanding and differentiating between terminology. Thus, the lemma selection and processing method was guided by resources employed in educating learners as the researcher wanted the dictionary to stay relevant to the subject content of learners at school.

6.2.2.1. Lemma selection

Geeraerts (1984) lists different influencers of lemma selection which reflect the type and function of a dictionary (Gouws & Prinsloo, 2005). Lemma selection for the ISY-LSD is aligned with pedagogy because this resource is directed at learners and contains words that they have come across in their education; and semantics because this is a domain-specific dictionary. Therefore, the researcher as a lexicographer, collected terminology that formed the lemmata for the dictionary. However, corpus has not fully been realised in African languages, subsequently, leaving lexicographers to determine their own lemma selection procedures (Nkomo, 2008). Subsequently, with an understanding of the fine line between terminology development and lexicography, the study employed terminology collection methods to harvest words making up the lemmata.

Khumalo (2017) presented a terminology development model employed by the University of KwaZulu-Natal (UKZN) that is used to harvest (collect) terms, consult and authenticate isiZulu terminology for subject-specific domains from the university.He further states that the terminology harvesting stage relies on subject field experts to source terms that they would like

to be treated through the terminology development process to enable their learners to understand terminology in English and isiZulu. These experts list terms that are central to the study module and submit them for development. In the same vein, Alberts (2014) states that terms should be extracted from educational material relevant to the subject and should be words that are considered to be critical to the subject which learners have to grasp.

Subsequently, the ISY-LSD was developed through the harvesting of critical terms from the following textbooks and educational material:

- Chetty et al., Understanding Life Sciences Grade 10 Learner's book. Pulse Education Services. 3rd. Ed. (Chetty et al.,2011)
- Understanding Life Sciences Grade 11 Learner's book. Pulse Education Services. 3rd. Ed. (Chetty et al., 2012).
- Understanding Life Sciences Grade 12 Learner's book. Pulse Education Services. 3rd. Ed. (Chetty et al., 2013).
- Curriculum and Assessment Policy Statement (CAPS) Grades 10-12 Life Sciences, 2020.

The treatment of these terms which covers the next stages of the UKZN model will be addressed in the microstructure (subsection 6.6.). Below is an explanation of the terminology harvesting method for the development of the lemmata for the dictionary:

- The researcher read the Grade 12 Diagnosis for 2020 results and found terms that the Department of Basic Education had recorded as problematic to learners. Those terms were the first to be added to the word list. For example, *Cerebellum* vs *cerebrum*.
- The researcher took prescribed Life Sciences books for Grades 10, 11 and 12 which had terminology on the last pages. All these terms were taken as they reflect the work that learners learn in class. As much as they were already explained in the textbooks, there were no isiZulu translations, therefore, there was a need to add those terms to the dictionary and the textbooks as resources of information were acknowledged in the reference section of the dictionary.
- As the researcher continued working on the terminology, she found terminological gaps in the terminology. For example, the term 'cellular respiration' could not be explained without explaining what is meant by 'cellular' therefore the study added 'cellular' as one of the terms to be added to the lemmata.

The selected terms were taken from the subject field of Life Sciences. For example, the term '*accommodation*' means the following in Life Sciences:

> The automatic reflex adjustment that allows the focal length of the lens of an eye to change to focus on an object. The lens shape, more convex for near objects and less convex for distant objects, is caused by ciliary muscles acting on the elastic property of the lens. (Rittner & McCabe, 2004:2)

The same lemma can be found in general language dictionaries to mean according to the Britannica Dictionary:

> **1**
>
> **a *accommodations*** [plural] *US***:** a place (such as a room in a hotel) where travellers can sleep and find other services.
>
> **b** [noncount] chiefly British: a place where people can live, stay, or work
>
> **2**
>
> *formal*
>
> **a:** an agreement that allows people, groups, etc., to work together
>
> **b:** something done to provide what is needed or wanted for someone or something.
>
> (https://www.britannica.com/dictionary/accommodation)

According to Pedersen (1995), lemmata contained in a subject-specific dictionary are automatically delimited from meanings of the same lemmata in other subject fields which removes the responsibility of respecifying the semantic field the lemma is defined under. Therefore, all lemmata in the ISY-LSD are systematically collected to accommodate usage in the context of Life Sciences. This scholar further recommends that lexicographers should have bibliographies that reflect resources that were used to collect and define lemmata. Therefore, as already stated in the methods employed in lemma selection above, the study added each resource used in the development of the dictionary, in the back matter of the dictionary.

6.2.2.2. Lemma arrangement

The most common form of lemma arrangement is the alphabet system, which some lexicographers believe should not be derailed from (Nielsen, 1994). The first letter of each

lemmata will take preference in lexical lemmata, sub-lexical lemmata and the multi-lexical lemmata. An example of this listing is as follows:

pupil. an aperture that permits light to enter the centre of the iris.**inhlamvu yeso.** imbobo ephakathi nendawo ngaphakathi ku-iris evumela ukukhanya kungene.

Q

quadrupedal. mv. Latin *quadrupes* okunezinyawo ezine (four-footed). an animal's capacity to move forward and backward on its hindlimbs. **okunyawozine.** ukukwazi kwesilwane ukuhamba ngemilenze yangaphambili neyangemuva.

R

rachis. the middle rib of complex leaves or fern fronds. **irekhesi**. umthambo ophakathi nendawo wamaqabunga amancane ayinhlanganisela noma iqabunga elakhiwe amaqabunga amancane esikhomakhoma.

radiant energy. energy captured by plants during photosynthesis and transformed into chemical potential energy in the food produced. **amandla emisebe yelanga.** Amandla avela elangeni agcinwa ngaphakathi yizitshalo ngesikhathi sazo sokuzakhela ukudla bese aguqulwa abe ngamandla angamakhemikhali anokusetshenziswa ekudleni okukhiqiziwe.

These entries are arranged alphabetically, and the beginning of a new alphabet is demonstrated by a big letter in capital letters as can be seen above – letters ‘Q’ and ‘R’. The letter ‘R’ which has the lemmata ‘rachis’ and ‘radiant energy’ and as they both have ‘ra’ the next letter determines which letter comes first – the ‘c’ in ‘rachis’.

The ISY-LSD is created for learners; the focus of the study was on the method that would be best for users. To this end, Nkomo (2008) asserts that learners are taught the alphabet from the early ages of their schooling. Therefore, the lemmata are arranged alphabetically in the ISY-LSD. This arrangement will not only benefit the user for easy access, but the researcher, as a lexicographer, also found the arrangement easy to perform in that with just a click on a button on the computer and all words were automatically arranged alphabetically.

The macrostructure of this resource is arranged alphabetically with the abbreviations added as lemmata at the end of the term list. The alphabetic arrangement is used in published resources, therefore, the study found them a working arrangement given that a “bilingual dictionary consists of an alphabetical list of words or expressions in one language (the ‘source language’) for which, ideally, exact equivalents are given in another language (the ‘target language’)” Klapicová (2005:57). This alphabetical arrangement can be easily followed by users of the print format of the resource, while a user of the e-book format can search for a word using the

search feature without the need to browse through pages. This search method is supported since users favour the use of electronic dictionaries in Atkins (1996:2) who states that "now at last we are liberated from the straitjacket of the printed page and alphabetical order".

6.2.3. The Microstructure

The third step was to create a microstructure for the dictionary with lemmata comprising of semantic data all entries and etymology and additional information on some entries. Decisions on data categories or microstructural elements incorporated in a dictionary are defined by lexicographic functions of a dictionary (Nkomo, 2008). Therefore, the microstructure of the ISY-LSD is simple as it only contains four data categories which are not spread throughout the dictionary. This supports the lexicographic function of the resource as it aims to assist users comprehend lemmata in their mother tongue which removes the need for linguistically related data categories, such as grammatical data.

The following examples show the entry structure of a complete entry in the ISY-LSD:

Example 1

angiosperms. *mv.* Greek angos- isiqukathi (vessel) + Greek *sperma* imbewu (seed). a blossom-producing plant**. izikhiqizimbali.** isitshalo esikhiqiza izimbali**.** *sngz.* izikhiqizimbali, zibuye zibizwe ngengezitshalo ezikhiqiza izimbali, ziyingxenye yamaqembu ezitshalo ezibalulekile ezinembewu. isibonelo. utamatisi, umoba.

The first example has the headword, etymological data, definition in English, headword in isiZulu, the definition in isiZulu and additional information.

Example 2

leukaemia. *mv.* Greek *leukos- okumhlophe/okungembala* (white/clear) + *haima* igazi (blood). a blood cancer that interferes with the body's ability to fight infections. **umdlavuza wegazi.** umdlavuza ohlasela igazi nohlelo lwelimfu.

The second example has the headword, etymological data, definition in English, headword in isiZulu, and the definition in isiZulu.

Example 3

ligament. stiff fibrous connective tissue that supports internal organs and holds bones together in joints.. **Umsipha ohlanganisa amathambo.** ibhande eliqinile eliyizintambo lethishu yokuxhumanisa esebenza ukweseka izitho zomzimba zangaphakathi noma ihlanganise amathambo.

The third example has the headword, definition in English, headword in isiZulu, and the definition in isiZulu

The signs in the entry follow the EZD arrangement as presented in the front matter (Doke et. al. 2014: xvi) where the microstructure was entered to assist the user to know what each data category represents and explanations appear in the front matter of the dictionary. The same strategy has been adapted in the ISY-LSD.

The signs should be interpreted as follows:

- > means derived from
- + means plus

Abbreviations form an important part of the dictionary as they do not bombard the resource with full repetitive words that could be shortened and still be equally understood. Simelane (2000) provides an explanation for the abbreviations employed in his dictionary template and a reason:

> *Kubalulekile ukuthi sichaze la magama azolandelwa ukuze kwazeke ukuthi umcwaningi uzowasebenzisa kanjani ocwaningweni lakhe. Onke amagama akulethemplethi afingqiwe, umcwaningi uzosebenzisa lezi zifingqo kuphela lapho ehlaziya lawo malema awakhethile*. (Simelane, 2000: 52)
>
> [Providing explanations for words to be provided are important to clarify how it will be employed in their research. All words in this template have been abbreviated, the study will use these abbreviations only when analysing the selected lemmata.]

The abbreviations that follow are taken from Simelane (2000) with an addition from the study to align them with the scope of the dictionary. The researcher used italics for abbreviations in the entries for ease of reference.

- *mv.* imvelaphi (etymology)
- *sngz*. isongezo (additional information).

6.2.3.1. Etymological data

Etymological data explain the historical roots and derivation of a word. This was included in the dictionary because it helps the user understand the origin of the word which will help them identify related words in any other resource (Hashemi & Aziznedhaz, 2011). The etymological data are provided in both languages with isiZulu as the source language explaining them with English translations in brackets and its arrangement in the resource is similar in lexical and multi-lexical lemmata.

According to Mailhammer (2014), etymology studies historical traits of a language or elements of a language. The source language of words examined in the study is English but the current study does not focus on English but on elements of the language which are specific to the Life Sciences domain. This domain has jargon of its own that is derived from other languages, as Mailhammer (2014:1) states:

> Etymology is the foundation of historical linguistics, the starting point of the historical investigation of a language and at the same time one of its subfields. In order to establish the etymology of an item one must backtrack to the chronological stage at which it was transparently formed for the first time, and account for the changes it has undergone since then. Hence, etymologies give us a view of a language's history.

An examination of historical roots of this domain of the English language is not thoroughly exhibited in the dictionary because the resource is only focused on providing the word that provided original meaning to assist the user understand the basis of the definition. The Oxford South African Pocket Dictionary edited by Waite (2015) applied a simple method of etymology by only writing the language of origin, the original form, and the meaning of the original form. For example, etymological data of the lemma apocalypse is "from Greek *apokaluptein* 'reveal'." (Waite, 2015:36). This is the same etymological structure adopted in the ISY-LSD.

Below are examples from lexical lemmata etymology (the root of a lemma that is a single word). This is a simple structure where the word of origin with its translation is provided and made available in both languages.

Example 1

kwashiorkor. *mv.* ga (a kwa language of coastal ghana) *kwàṣìɔkɔ́* isimo sokungondleki kahle kwengane ngenxa yokwelanywa (influence a child is said to be under when a second child comes). a condition caused by a protein-deficit diet. **ikhwashu.** isifo sokondleka komzimba esibangwa ukuntula amaphrotheni ekudleni okudliwayo. *sngz.* ibonakala ngesisu esivuvukele, ubuso obuvuvukele nezingalo ezizacile nemilenze ebukeka sengathi iyizinti.

Etymological data in the headword **kwashiorkor** follows the abbreviation (*mv*); the language of origin (Ga); the word of origin (*kwàṣìɔkɔ́*); the explanation in isiZulu and English.

Example 2

myopia. *mv.* late Greek *myōpia* ukubona eduze (near-sightedness). an eye problem in which a person can see clearly up close but has hazy vision when looking far away because their lens is unable to reduce its convexity. **isifo sokungasebenzi kahle kweso.** isici sehlo esibangwa ukungakwazi kwelensi ukunciphisa ukuqumbela ngaphandle okwenza umuntu abone kahle izinto eziseduze kodwa ezikude zibe lufifi.

Etymological data in the headword **myopia** follows the abbreviation (*mv*); the language of origin (late Greek); the word of origin (*myōpia*); the explanation in isiZulu and English

Multi-lexical lemmata etymology (the root of a lemma that is more than one word) is shown by showing the roots of each word and using the plus (+) sign to show that the words have been added. Both roots are provided with their meaning translated to isiZulu and English.

Example 1

osteoporosis. *mv.* Greek *osteo-* ithambo (bone) + Greek *poros* imbobo (pore) + Greek *osis* isimo/isifo (condition/disease). bones becoming more fragile as a result of calcium loss. **ubuntekenteke bamathambo.** ukuba buthakathaka kwamathambo okubangwa ukulahlekelwa ikhalsiyamu.

Etymological data in the headword **osteoporosis** which is a lemma made up of three words start with the abbreviation (*mv*); the language of origin (Greek); the word of origin *osteo-* (bone); the explanation in isiZulu and English *ithambo* (bone)) The next word of origin is added with the plus sign (+) followed by the language of origin (Greek); the second word of origin *poros* (porea) is given; followed by the explanation in both languages *imbobo* (pore); this is further followed by an addition of the origin of the suffix (Greek); the plus sign (+) follows; and then the suffix *osis*; its meaning *isimo/isifo* (condition) in both languages.

Example 2

palaeontology. *mv.* Greek *palaios* okwakudala (old, ancient) + Greek *ontologie* isayensi noma ucwaningo ngendalo nomsuka wezinto (science or study of being and the essence of things). a study where fossils are investigated. **iphalentoloji.** ukufunda ngezinsalela zezinto ezaziphila kudala esezaphenduka amatshe.

Etymological data in the headword **palaeontology** which is a lemma made up of two words starts with the abbreviation (*mv*); the language of origin (Greek); the word of origin (*palaios*); the explanation in isiZulu and English (the plus (+) points to an addition of the second word of origin *okwakudala* (old, ancient); the language of origin (Greek); the word of origin *ontologie;* and the meaning in both languages *isayensi noma ucwaningo ngendalo nomsuka wezinto* (science or study of being and the essence of things).

The dictionary developed is aimed at isiZulu mother-tongue speakers who are taught in English which is a language developed from other languages, and further, Life Sciences has its own jargon developed from various languages as required for each concept. IsiZulu learners are expected to learn and remember these concepts and their definitions which, from researching etymological aspects of lemmata in the dictionary, are developed from various languages such as Greek, Latin, Indo-European languages and even Ga, a language from Ghana.

Providing etymological data for the lemmata shows the language that words are derived from and their meaning from that language (Simelane, 2000). In instances where the lemmata is a compound word with etymological data from more than one word, all words that make up the word are provided and explained.

This data pertains to the definition of words and the amount of data to be added to the definition is guided by the lexicographic function of the resource. This is the most important element of a dictionary (Simelane, 2000) and the researcher ensured that she extracted its contents from reliable sources that are used by learners at school with an understanding of copyright issues that might arise.

Work produced by lexicographers and terminographers is not considered to be copyrightable because it contains meaning which is factual regardless of whether they are known or unknown and those who use those definitions are not committing criminal acts (Trittipo, 1996). It is in the lexicographer's and user's interest for factual definitions from reliable sources to be rendered and the information extracted from these resources should not be modified for

copyright purposes because that would be unethical and wrong in terms of terminography (Alberts & Jooste, 1998). Subsequently, resources used to collect definitions are the ones listed in 6.4.1. above.

Employed resources are in English, therefore, the ISY-LSD is a resource that render translations of semantic information to isiZulu for isiZulu mother-tongue users. The lemma is recorded in English since it is the language of teaching and testing of learner knowledge, however, the lemmata are translated into isiZulu along with definitions and additional information that has been added to clarify meaning. Translation strategies employed in the translation of the lemmata were also applied in the translation of definitions and additional information. Further, the additional information is only written in isiZulu as it does not form part of the definition that the users would have to write in their course of learning but is featured to enhance the knowledge of learners.

Words were studied in relation to how they developed over time from one word to another to convey meaning. This pertains to etymology which is considered when examining terminology being studied by learners of Life Sciences (Geeraerts, 2010).

Etymological presentations found in this terminology are depicted in examples below.

a) Related examples:

biogeography. *mv.* Greek *biotic* okuphathele nempilo (pertaining to life) + Greek *geographia* incazelo ngomumo womhlaba (description of the earth's surface). the abundance of various species and their effects around the world. **ubudlelwano bomhlaba nokuphilayo.** ukusabalala kwezinhlobo zezinto eziphilayo ezindaweni ezahlukene zomhlaba kanye nomthelela walokho.

This term has the Greek word '*biotic*' meaning 'that which has to do with life' which is broken down to a morpheme '*bio-*'and another Greek word '*geographia*' translated to English as 'geography' which is a description of the surface of earth.

biotechnology. *mv.* Greek *biotic* okuphathele nempilo (pertaining to life) + Greek *tekhnologia* ukulawulwa kobuciko noma ubuchwepheshe (the systematic treatment of an art, or technique). a field of technology that makes use of living things or biological systems to achieve a certain goal.**ubuchwepheshe bokuphilayo.** ubuchwepheshe obusebenzisa izinhlelo zemizimba yezinto eziphilayo noma izinto eziphilayo kwenzelwa inhloso ethize.

This term has the Greek word '*biotic*' meaning 'that which has to do with life' which is broken down to a morpheme '*bio-*' and another Greek word '*teknologia*' that refers to an 'art' or

‘technique’ translated to English as ‘technology which is defined as the application of scientific knowledge for practical purpose (Oxford South African Pocket Dictionary, 2015)

biotic factor. *mv*. Greek *biotic* okuphathele nempilo (pertaining to life) + French *facteur* okumele (representative). the living components or factors that affect an ecosystem or other organisms living in that ecosystem. **isakhi sokuphilayo.** okuphilayo noma izimo ezinomthelela endaweni yokuhlala nezinto zayo eziphilayo noma ezinye izinto eziphilayo ezihlala kuleyo ndawo.

This term has the Greek word ‘biotic’ meaning ‘that which has to do with life’ which is broken down to a morpheme ‘bio-’ and the French word ‘*facteur’* meaning ‘a representative’ which is translated to English as ‘factor’ is added and the word ‘biotic factor’ is formed.

These terms are related in their formation as they all have the morpheme ‘*bio*’ which is a Greek word pertaining to ‘life’ and a second morpheme which distinguishes these words from each other.

Hashemi and Aziznezhad (2011) explain etymology as follows:

> Etymology is the scientific study of the origin or history and derivation of words. When you know the meaning of a Latin or Greek root, prefix, or suffix; you can better understand, and more easily remember, all the vocabulary words built on these elements that exists in English words. Learning etymology of English words, you will feel comfortable with words—you will use new words with self-assurance, you will be able to figure out the meanings of the English vocabulary words you hear or read even if you have never heard or seen these words before. That is why the best approach to learning new vocabulary words is through their etymologies. (Hashemi & Aziznezhad, 2011:103)

The usage of the morpheme from Greek has been adapted to the English lexicon and is added to many words pertaining to ‘life’. A user who understands the meaning of the morpheme can deduce that the term has to do with life as ‘geography’, ‘technology’ and ‘factor’ are commonly used words. Adding these historical traits of terminology can help readers try to understand the next word with a similar ‘morpheme’.

b) Independent examples:

centromere. *mv*. Greek *kentron* indawo emaphakathi (centre) + Greek *soma* umzimba (body). a piece of genetic material that binds two chromosome chromatids together following DNA replication.

isibophakhromathidi. isakhiwo esihlanganisa amakhromathidi amabili esithwalafuzo angehlukani ngemuva kokuziphindaphinda kolibofuzo.

The term is taken from a Greek word '*kentron*' which refers to 'the centre' and is combined with another Greek word meaning 'body'. However, the biological term given to it refers to a central part of a chromatic that is part of the body of the cell.

cephalisation. *mv*. Greek *kephalē* ikhanda (head). Animal species often develop vital organs close to the skull as a result of evolution. **umumokusondela kwezingxenye ekhanda.** ukuvama kwezinhlobo zezilwane ukuthi zakheke ngendlela yokuthi zibe nezingxenye ezibalulekile eduze kwekhanda.

This word is taken directly from Greek and given an English suffix '-ation' which makes it a process that pertains to the head.

renal. *mv* Latin *ren* inso (kidney). that is related to the kidneys. **okwezinso.** lokho okuqondene nezinso.

The term is taken from the Latin word '*ren*' meaning 'kidney' and given an English suffix and is used for making reference to a 'kidney' rather than creating an English word with 'kidney' which is obvious for a non-English mother-tongue speaker.

The above examples are not related to each other like the previous ones which had the same introductory morpheme. These words have been formed from Indo-European languages and given suffixes that will make it fit properly in the English language. Adding these historical traits to words help readers understand and remember meanings of words which is the main reason why the study of etymology is important (Hashemi, 2004) in dictionary development. The aforementioned assisted greatly with the translation of the terminology and facilitated understanding of the word formation.

Another form of etymology is cognitive etymology where researchers focus on the etymological development where language learners learn words through association (Geeraerts, 2010). Hashemi and Aziznezhad (2011) consider three ways found in language learning – which are imitation or repetition, cognitive learning by association; and translating to a known language. When one considers the formation of most isiZulu words from examining lemmata in dictionaries under examination in the current study, a mother-tongue speaker can deduce meaning from looking at the word at face value. An example follows below:

Umyalelo meaning instruction (Oxford University Press Dictionary English-Zulu, 2015: 242)

A first language reader if given a word '*umyalo*' or '*umyalezo'* can at face value associate the meaning of the word with '*umyalelo'* which displays cognitive association.

For a second language speaker the case might not be the same, which they would be able to learn the word through their etymological knowledge. Life Sciences terminology is traced back to other languages and not from English being used as the medium of instruction at school. This makes terminology more complex for African language speakers because they are unable to associate or translate the terminology which is supposedly English because they have roots that the non-mother-tongue language speaker does not readily have. Mbatha (2006:239) states the following when discussing the interpretation of idioms in a lexicographic study:

> *Akulula ukubona isisho noma isaga solimi ongaluncelanga ebeleni bese uthi uzosiqonda kalula ngaphandle kokusondelana nabanikazi balolo limi uthole kahle yonke ingonyuluka yemvelaphi yesimo sokukhuluma.*
> [It is difficult for a non-mother-tongue speaker to identify an idiom or proverb from a language that is not their mother tongue and understanding its meaning without consulting language owners to find out the proper meaning and the historical development of that form of speech.]

The same can be said about non-mother-tongue speakers when it comes to identifying and understanding domain-specific words, especially those with roots from other languages other than English – it is not easy.

6.2.3.2. Semantic data

This data pertain to the definition of words and the amount of data to be added to the definition is guided by lexicographic function of the resource. This is the most important element of a dictionary (Simelane, 2000), and the researcher ensured that she extracted its contents from reliable sources that are used by learners at school with an understanding of copyright issues that might arise. Subsequently, resources used to collect definitions are the ones listed in 6.4.1. above.

As a scientific resource, the ISY-LSD provides additional information for some entries to enhance their semantic data for users. This is the inclusion of extra-lexicographic information

to further clarify the meaning of lemmata. This information does not describe or define the lemma but adds information about the lemma which enhances the microstructure. This information, however, should be kept minimal as the duty of the dictionary is to define and not to add extra-lexicographic information (Kiefer, 1988).

6.2.4. Translation

The fourth step was to translate data to bilingualise the dictionary. Nkomo (2008) describes translation as rendering a text from one language to a target language ensuring the meaning of the source text. Translation involves the transference of senses to another language. The ISY-LSD, as a bilingualised resource, requires the translation of lemmata from English to isiZulu. Therefore, the lemmata was duly translated from English to isiZulu by applying various translation strategies.

The researcher had to employ tailor-made translation strategies as required by each lemma, according to Rietveld and Hormelen (2019) and Dlamini (2021).

Equivalence: Lexical lemmata from the source language that have the same meaning in the target language.

Example 1

aquatic. *mv*. Latin *aqua* amanzi (water). living in or around water. **okwasemanzini.** okuphila emanzini noma eduze kwamanzi.

The headword **aquatic** was translated as ***okwasemanzini*** which is a complete equivalent in isiZulu.

Example 2

atmospheric gases. gases found in the earth's atmosphere. **amagesi asemkhathini.** amagesi ongqimba lomoya oluzungeze umhlaba amagesi atholakala ongqimbeni lomoya oluzungeze umhlaba. *sngz*. la magesi abandakanya i-oksijini nenayithrojini (okwenza ama-99% omoya); yize amagesi avimbela ukushisa komhlaba ukuthi kuphumele emkhathini (ikhabhonidayoksayidi, imetheyini, inithriyasi-oksayidi, umhwamuko nomoyamkhathi) akha u-1% womoya.

The second example provides a multilexical headword **atmospheric gases** which the researcher translated in isiZulu to ***amagesi asemkhathini***.

6.2.4.1. Semantical

Multi-lexical lemmata were translated according to semantic translation where the source text was conveyed as closely as possible to the target language ensuring that semantic and syntactic

features are captured to convey the contextual meaning as well as word meaning of the source text.

Example 1

global warming. an increase in greenhouse gas concentrations that causes the earth's average atmospheric temperature to rise. **isivuvu somhlaba.** ukwanda kwamazinga okushisa ajwayelekile ongqimba lomoya oluzungeze umhlaba ngenxa yokwanda kwamazinga amagesi agcina ukushisa okuzungeze umhlaba.

The example **global warming** is made up of two words, global + warming and the translation is made up of two words ***isivuvu somhlaba*** which are *isivuvu* meaning 'warming up' + *somhlaba* meaning 'of the world'.

Example 2

heart rate. the pattern of heartbeats, commonly measured in minutes, throughout a given time period.. **izinga lokushaya kwenhliziyo.** ubungakho bezikhathi zokushaya kwenhliziyo esikhathini esithize, ngokujwayelekile ngomzuzu.

The example **heart rate** was made up of two words heart + rate and the translation is made up of three combined words ***izinga lokushaya kwenhliziyo*** which are *izinga* 'the rate' + *lokushaya* meaning 'of the beating' + *kwenhliziyo* meaning 'of the heart'.

6.2.4.2. Transliteration

The source text was replaced by offering phonological and morphological characteristics of the source text in the target language.

Example

carbon tax. tax levied against businesses based on how much carbon dioxide each one of them emits.. **intela yekhabhoni.** intela okuphoqwa izinkampani ukuthi ziyikhokhe ehambisana nomthamo wekhabhonidayoksayidi ekhishwa yinkampani ngayinye.

The headword **carbon tax** is transliterated as ***intela yekhabhoni*** which is 'tax that is for carbon' when back translated. In this example is '***khabhoni***' from 'carbon' where the word was given isiZulu phonological spelling as well as morphological characteristics by the addition of the prefix '*ye-*' meaning 'of' but attached to the word because of the agglutinative nature of isiZulu. The '*ye-*' comes from the word '***intela***' (translation for 'tax'). The word then ends with the suffix '-i' as is the nature of isiZulu words to end with a vowel.

6.2.4.3. Borrowing

Replacing the source word in the target text because of the absence of a corresponding word in the target language with the same word from the source text is referred to as borrowing.

Example

lymph. body fluid that is primarily white blood cells and is transparent and slightly alkaline and bathes body tissues. **ilimfu.** uketshezi lomzimba olukhanyayo, olunosawoti kancane, amathishu omzimba antanta kulo oluqukethe ikakhulukazi izinhlayiya ezimhlophe egazi elitholakala emithanjeni yelimfu.

The headword **lymph** was borrowed as is and given an isiZulu prefix '*i-*' for it to fit into the grammar of isiZulu. The word remains as it is and the user will understand its meaning from the definition. The researcher was unable to offer an equivalent or related translation for this word.

6.2.4.4. Literal translation

Replacing the source text with words that convey a logical meaning in the target text so that the text sounds natural.

Example

oxygenated blood. an oxygen-rich blood cell with a low carbon dioxide content. **igazi eline-oksijini.** inhlayiya yegazi enephesenti elikhulu le-oksijini futhi ene-carbon dioxide encane.

The lemma **oxygenated blood** was translated as ***igazi eline-oksijini*** which literally means 'blood that has oxygen'. The words used convey the meaning of the source text in a manner that sounds natural and fully conveys the meaning of the source text words. The meaning of the lemma is conveyed in the definition which leaves the user at the same level of understanding as an English-speaking user.

The SZD provides two single-word translations for oxygen, namely "*umoyampilo*" and "i*oksijini*" (Dent & Nyembezi, 2009: 210) along with descriptive translations. The researcher chose *i-oksijini* (spelling it according to the latest orthography) due to consistency reasons.

> Consistency is the orderly treatment of a set of linked elements, and it is a necessary characteristic of polished, highly readable prose. Consistency is either 'uniform' or 'harmonious,' depending on whether a set of linked elements is indivisible or divisible into subsets. From the perspective of text characteristics,

> we can speak of semantic, syntactic, stylistic, spatial, and mechanical consistency. (Farkas, 1985:353)

Other elements found in the periodic table that did not have available translations, were transliterated. For the dictionary to be harmonious and consistent, the study translated **oxygen** as ***i-oksijini***, just like she did with carbon dioxide as *ikhabhonidayoksaydi*.

6.2.4.5. Descriptive translation

This is the process of describing terms that did not have equivalents. Given that the dictionary is subject specific and that the target language is still being intellectualised, most lemmata did not have equivalents and borrowing would not have assisted the user in any way. Therefore, those headwords were described in isiZulu.

Example

hypothesis. *mv.* Greek *hypothesis* isisekelo senkulumo (base of argument). a hypothesis that can be investigated and is offered as a potential explanation for an occurrence.**umbono/umcabango ongakafakazelwa.** incazelo engenasiqinisekiso yesehlakalo engahlolwa futhi engamukelwa noma ichithwe.

The headword **hypothesis** did not have an equivalent in isiZulu and the choice for translation was to describe it. Therefore, the lemma translation is ***umbono ongakafakazelwa*** which can be back translated as ‘an unproven idea’. The description tallies with the definition which explains this ‘unproven idea’ further.

Lemmata translation was necessary to help the user understand the lemma before they read the definition. Definitions attached to the lemmata assisted the study to render the correct translation as avoiding mistranslations is very important in subject fields as they can have grave consequences (Nkomo, 2008). Bearing in mind that some texts may not be translatable, various translation resources such as translation theories and dictionaries and other online resources may be employed to produce good translations. Thus, the study considered methods provided by Baker (2011) and Dlamini (2021) for dealing with hurdles in translation and these methods are explained in Chapter 5. Various dictionaries and websites were also consulted when translating the lemmata and these are listed in the bibliography section in the back matter of the ISY-LSD.

6.2.5. Dictionary development

The last step of developing the new resource comprises of dictionary structure, the outside matter, and dictionary evaluation which was a collation of steps one to four of the guidelines. In this step, the final structure is made up of the front matter, the main body and the back matter, and the evaluation of the dictionary in its form as a digital resource.

6.2.5.1. Dictionary structure

The structure of the developed resource should reflect knowledge drawn by following guidelines set for the dictionary development task. Nkomo (2008) created guidelines for a linguistic dictionary in the Ndebele language that he was developing in his study. The current study learnt from this scholar that dictionary guidelines should be drawn from a lexicographic theory in order to produce a resource that would meet lexicographic functions intended by the resource. To this end, guidelines for the development of the ISY-LSD birthed a dictionary that is analysed below in terms of the outside matter and the main body of the developed resource, which have already been explained in this chapter.

6.2.5.2. Outside matter

The outside matter of the ISY-LSD comprises of the front matter and the back matter. The front matter of the developed resource contains the table of contents, describes the users the resource is intended for, and explains how the resource is to be used generally and in the electronic form. The only information found in the dictionary not listed in the front matter is the reference section which is found in the back matter.

Gouws (1999) states that references were found in the back matter of resources, and this can be seen in the *Encyclopedia of Biology* by Rittner and McCabe (2004) in which references of resources consulted are listed in the back matter. Subsequently, the back matter provides references of resources consulted in the development of the dictionary. Below are components of the front mater and the back matter.

- **Components of the front matter**

The front matter of a dictionary explains the contents of the dictionary. The front matter of the ISY-LSD explains the user of the resource, the function of the resource and how to use the same resource. This front matter was developed in line with the theory of lexicographic

functions which helped the researcher, in her position as a lexicographer, developed the front matter of this resource.

Simelane (2000) in his Master's dissertation titled *Ukwenziwa Kwesichazamazwi Sesilengi Olimini LwesiZulu* (Creating A Slang Dictionary in IsiZulu) explained the contents of the dictionary that he developed and also created a template for the development of the resource which was part of his data analysis. The aim of the current study is to expand the scope and function of lexicographic resources through the development of a domain-specific dictionary in isiZulu by exploring lexicography and isiZulu lexicographic resources as an aid in the development of the new resource. It stands to reason that the main objective of the current study is parallel to that of the abovementioned scholar, save that the domain of the resources are completely different which resulted in the application of different research methods. Nevertheless, the study did not follow the pattern of pasting the dictionary in the report as it was too plain and would have been a tedious read. Subsequently, the study presents the dictionary structure according to its components. The ISY-LSD is, however, available online and can be downloaded to a mobile phone or any other smart device and used offline.

The front matter comprises of the table of contents which lists three main items contained in the dictionary, namely the introduction, wordlist and acronyms, and a list of online and printed resources. The front matter only discusses one of these items – the introduction – and the rest are discussed in their appropriate subsections in the main body and the back matter, respectively.

According to Hartmann and James (2002), the table of contents forms part of the front matter of dictionaries. This is evident in the OUPEZ and the EZD where table of contents are provided and indeed also lists the contents of the resources. The ISY-LSD contains only a few items as the researcher, in her position as a lexicographer, wanted to create a simple table of contents that would fit one digital page of the dictionary e-book. The introduction, as the first item in the table of contents, contains within itself various sub-items which were extracted from the dictionary in isiZulu, translated into English for record purposes and explained below. The sub-items are the Introduction to the dictionary, Introduction to a new dictionary type, Dictionary symbols, and Navigation.

a. Introduction to the dictionary

The dictionaries examined in the study were introduced and the study followed a similar pattern introducing the user to the resource. The introduction is as follows:

1. INGXENYE YOKUQALA: ISINGENISO

Lesi sichazamazwi sibhalelwe abafundi bebanga leshumi kuya kweleshumi nambili abangabafundi be-Life Sciences. Lesi sichazamazwi sibhalwe ngenxa yesidingo sokuthuthukisa izilimi zesintu. Lokhu kuzoholela ekudluliseni ulwazi nangezilimi zesintu okuzokwenza abasebenzisi bazo bakwazi ukukuqonda kangconywana okuqukethwe ngaphandle kokufunisela incazelo. Amagama aqukethwe kulesi sichazamazwi, abizwa ngamalema okuchaza igama elichazwayo esichazamazwini, achazwe ngokusebenzisa imithombo yolwazi ehlukahlukene ebhalwe engxenyeni engemuva yalesi sichazamawi. Amalema akulesi sichazamazwi esewonke anga-629 futhi wonke achazwe ngokuphelele kusetshenziswa imithombo esetshenziswa wuMnyango Wezemfundo Eyisisekelo kanye namawebhusayithi athembekile aku-inthanethi.

[**PART ONE: INTRODUCTION**

This dictionary is for Life Sciences learners who are in Grade 10 to Grade 12. This dictionary was born out of the need to develop African languages to record knowledge in African languages which contributes to language development and for language users to under scientific terminology clearly, given that it is written in their mother tongue. Words recorded in this resource, hereinafter referred to lemmata which refer to a word that is being defined in a dictionary, are explained using different resources which are acknowledged in the last part of the resource. This dictionary contains 629 lemmata and they have all been defined using resources employed by the Department of Basic Education and trusted online resources.]

The above introduction states the target users who are Grade 10 to 12 learners as explained in the user profile in the first step of the guidelines, which is an important part of any piece of writing. Profiling the target reader is of primary importance. The introduction further provides the motivation for developing this resource, which is for scientific language development and

clarifying information in the mother tongue of users. This feature states the number of lemmata which are all defined in accordance to what learners are learning in public schools. The researcher selected to use definitions from the prescribed material to prevent the resource being foreign to what learners are being taught in the classroom and what is expected from them during their testing of knowledge processes.

b. Introduction to a new dictionary type

The second part of the introduction introduces a new type of dictionary and explains how it will be arranged. The OUPEZ employed in its unique dictionary arrangement an explanation of the structure for users. The new type of dictionary that was developed in the study was explained to the user so that they can be clear about the type of resource they will be using. Subsequently, the following information is recorded in the front matter.

> ***Uhlobo olusha lwesichazamazwi***
>
> *Lesi sichazamazwi, esinamalema alandelana ngokohlobo lwezinhlamvu zamagama, siwuhlobo olwakhiwe ngezilimi ezimbili kube kugxilwe olimini okuphokophelwe kulo kunalolo okuthekelwe ulwazi kulo. Ulimi lwesiNgisi yilo oluphaka amagama nezincazelo bese lokhu kuchazwa ngesiZulu. Ukuhleleka kwaso kumi kanje:*
>
> *Ilema lesiNgisi + umsuka welema + incazelo yesiNgisi + ilema lesiZulu + incazelo yesiZulu + isithasiselo*
>
> [**New dictionary type**
>
> This dictionary containing alphabetically arranged lemmata is a bilingual dictionary which focuses mostly on the target language instead of the language that serves as a foundation. Words are extracted from English and provided with isiZulu translation of lemmata, definitions and additional information. It is arranged in this format:
>
> English lemma + Etymology + English Definition + IsiZulu lemma + IsiZulu definition + Additional information]

This arrangement briefly explained in the front matter is as follows:

- The English lemma: This type of dictionary arrangement is a first in isiZulu. Its purpose was to help the user find the lemmata easily by following the alphabetical arrangement

and if one prefers, they can search using the navigation feature which is deliberated upon below. Another advantage is that users can search for the term in English on Google search from the e-book directly.

- Etymology: Not all entries have etymological insertions as some etymological roots are not readily available. The entries with these insertions were easier to unpack which assisted with translation of the term to isiZulu. These entries are easier to understand as they can be associated with words who have similar roots.
- English definition: The English definition is provided to explain the term according to prescribed literature for learners.
- IsiZulu lemma: The lemma is translated into isiZulu using relevant translation strategies for each lemma.
- IsiZulu definition: The definition is translated according to translation strategies to convey meaning to users in their mother tongue.
- Additional information: This data is provided in isiZulu only in order to extend the meaning for the user.

This manner of dictionary arrangement is different from that of bilingual dictionaries which only provide a lemma and its English translation as it contains data that is commonly found in monolingual dictionaries. This dictionary is thus a combination of strategies employed in the development of monolingual and bilingual dictionaries, which makes it a new type of resource in an African language.

c. Dictionary symbols

The front matter lists symbols that are used in dictionary entries. The symbols are as follows:

> *Kunezimpawu ezisetshenziswe kulesi sichazamazwi ukucacisa okuqukethwe kwingqikithi yelema ngayinye. Lezi zimpawu zichaza okulandelayo:*
> •> *kususelwe*
> •= *kuchaza*
> •+ *kuhlanganiswa*
>
> [There are symbols used in this dictionary to clarify the contents in the of each lemma. These symbols are as follows:

•> deduced from

•= means

•+ added

d. Dictionary Abbreviations

Symbols used in dictionary entries are listed with their complete form recorded in isiZulu.

Incazelo yezinqamulelo imi kanje:

- *mv.> imvelaphi*
- *sngz.> isongezo*

[The translation of the abbreviations are as follows

- *et*.> etymology
- *add*.> Additional information]

e. Navigation

Ukuthola ilema olifunayo, thepha/chofoza kuphawu lokusesha oluphezulu kwesokudla eduze kohlamvu lwamagama akulelo khasi bese ubhala lelo gama ofuna ukulisesha/ukulibheka. Kuzobe sekuvela umphumela wokuthi libhalwe kangaki kule nsiza. Njengoba amanye amalema kanye namagama akhiwa ngamagama angaphezu kwelilodwa, kungenzeka libe nemiphumela eminingana. Imiphumela yonke izovela kanye nekhasi elitholakala kulo.

[To find a lemma, tap on the search icon on the top right next to the alphabet for words listed on that page and type the lemma you are searching for. Results will show the frequency of the word in this resource. Other results will be the option to 'search web' which means you can also search for the word on the internet directly from the dictionary.]

The navigation process for this digital resource is simple, especially for users who are already listed as people who are users of digital devices. The results with words appearing in different parts of the resource can be easily accessed by tapping on the word or the lemma. The use of the word 'word' here is based on that the results will not only be for lemmata but will show the lexical item even if it is part of a word. Further, the

link to the internet for results from Google works conveniently for the user if they want to find more information such as images or any other referential data.

- **Components of the back matter**

The back matter of the dictionary comes after the last entry of the main body of the dictionary. It provides extra information that the lexicographer deems as useful to the user. The ISY-LSD contains information about sources of information consulted during the dictionary development stage of this lexicography project.

The reference section is found in the back matter as it provides secondary but important information about the resource (Gouws, 1999). The EZD and the SZD acknowledged sources of information in the front matter but did not provide complete bibliographical details of the resources. The current study provides these details in the back matter where the full details are added thus enabling users to find these resources easily should they be interested in them. This strategy was employed by Rittner and McCabe (2004) in the *Encyclopedia of Biology* who listed printed resources as well as websites they had consulted. The ISY-LSD, as a resource of a similar nature, lists all the resources beginning with printed resources and followed by online resources.

- **Main body**

The main part of the dictionary contains the dictionary entries as stipulated in the front matter. The dictionary was developed with the user in mind, therefore, the contents of the resource was taken from user textbooks and ensured that terminology, that has been listed as problematic by the DBE, is listed in the dictionary. The ISY-LSD then added these terms as part of the lemma list and arranged them alphabetically. For recording purposes, these entries are listed below. The study found that the DBE does not focus on linguistic issues of learners but instead focuses on their general incompetence in their subjects. Even though South Africa has not intellectualised educational resources for target dictionary users in African languages, the lemmata found in the main body of the ISY-LSD serve as a bridge between the learner as a user and Life Sciences as a scientific subject being taught in an additional language.

The researcher did not select Life Sciences as a subject during high school because of the challenges with subject terminology. This is one of the reasons for selecting this subject to help current and future learners learning in a second language. The motivation to develop this

resource came with the challenge of lacking background knowledge on the subject. The challenge of not having background knowledge of a subject was also stated by Aryani, Sudipa, Yadnya and Dhanawaty (2019:12) as follows:

> Translating terms especially in a specific field of study tends to be challenging for a translator to discover their application from SL into TL. This is due to terms specificity and differences of SL and TL so a translator needs to know the background knowledge of study.

Subsequently, the researcher immersed herself in the terminology to understand what was meant in each of the topics covered in the subject. Although the researcher is by no means an expert in the subject of Life Sciences, as an experienced translator, she applied various translation strategies to translate the lemmata. Concepts incorporated in the dictionary are Reproduction in vertebrates, Disease related, Biodiversity of plants and reproduction, the human anatomy, Terrestrial components, Aquatic components, Genetics, Human reproduction, Meiosis, Human evolution, Impact of human on the environment, and Human endocrine. The researcher further added miscellaneous lemmata and abbreviations which are part of the education curriculum. Three samples from lemmata from each of these concepts were randomly selected from the ISY-LSD and explained according to Chetty et al. (2013) as that is the prescribed resource for potential users. A total of 42 lemmata samples are recorded below.

a. Reproduction in vertebrates

According to Chetty et al. (2013), reproduction in vertebrates takes place in different forms determined by the nature of each species. This reproduction can be internal or external fertilisation and below are lemmata related to these reproduction strategies.

amnion. a bird, a mammal, or a reptile's embryo's inner membrane. **ulwebusembatho lombungu**. ulwebu olungaphakathi lwemibungu yezinyoni, izilwane ezincelisayo nezilwane ezihuquzelayo.

chorion. the placenta's outermost membrane, which is found surrounding the embryo.. **ulwelwesi lomzanyana.** ulwelwesi olungaphandle olutholakala luzungeze umbungu olwakha i-placenta.

ovipary. a reproductive strategy where eggs are placed and grow outside of the mother's body. **ukuchamusela kwamaqanda ngaphandle.** indlela yokuzala lapho amaqanda ezalelwa bese ekhula ngaphandle komzimba kamama.

b. Disease related

The Paperback Oxford English Dictionary (2012) defines the word disease as a disorder in living things such as animals, plants and people that are resultant from an infection or diet among other causes. Lemmata from this category include healing remedies as well.

arthritis. *mv*. Greek *nosos* isifo (disease) + *arthritis* amalunga omzimba (joints) a joint-related inflammatory disease. **isifo samathambo.** isifo esibanga ukuvuvukala nobuhlungu esiba semalungwini omzimba.

chemotherapy. the employment of several chemicals together to directly kill cancer cells or to kill their DNA and stop them from replicating.. **ukwelapha ngamakhemikhali.** ukusetshenziswa kwamakhemikhali ahlukahlukene ahlanganisiwe ukuze ashabalalise izinhlayiya zomdlavuza ngokuqondile noma ngokushabalalisa ulibofuzo lwazo nokuvimba izinhlayiya ekukhiqizeni amanye afana nawo.

dialysis. a way to artificially remove waste from the bloodstream if the kidneys cannot do it on their own. **ucwengogazi ngemishini.** indlela yokususa ngokuzenzela imikhiqizo ewudoti egazini uma izinso zingakwazi ukukwenza ngokwazo lokho.

c. Biodiversity of plants and reproduction

Chetty et al. (2013) posit that biodiversity of plants includes plants that grow on land as well as those that grow in water. Lemmata under this topic include flowers from both territories.

anther. a bilobed pollen filled structure at the tip of the filament. **isikhiqizimpova**./i-antari isakhiwo esinamakhanda amabili esigcwele impova esicongweni sothi lwembali lwengxenye yesilisa.

bryophytes. a category of plant species that produce spores instead of flowers or seeds for reproduction. **amabhayrofaythi.** iqembu lezinhlobo zezitshalo ezizala ngokusebenzisa izinhlayiya ezikwazi ukukhiqiza izinto eziphilayo ezintsha kunokusebenzisa izimbali noma imbewu.

dicotyledonous. a class of blooming plants in the angiosperm family called the magnoliopsid. **ungcezumbili.** iqembu lezitshalo ezikhiqiza izimbali eziqhumayo ezikhiqiza izimbali.

d. The human anatomy

The Paperback Oxford English Dictionary (2012) defines the word ‘anatomy’ as a study of the body of a species. This category of the ISY-LSD is concerned with the study of the human body.

diaphragm. the main breathing muscle, which has a dome shape and works continuously and rhythmically. **untu.** isicubu okuyisona esibaluleke kakhulu sokuphefumula esinyakaza ngesigqi esilinganayo nangokuqhubekayo.

cerumen. wax that lines the auditory canal to prevent desiccation. **isigonogono**. amafutha endlalela umgudu wendlebe ukuze kuvinjelwe ukoma.

false ribs. the last five pairs of ribs, two of which are not linked to the sternum at all and three of which are fused together before being attached to it. **izimbambo ezingezansi.** izimbambo ezihamba ngambili eziphindwe kahlanu zokugcina lapho ezintathu zihlangene ngaphambi kokuthi zinamathele ethanjeni lesifuba bese lezi ezimbili ezihamba ngambili azinamathele ethanjeni lesifuba nhlobo.

e. Terrestrial components

Components included in this category comprise of things involving the earth and dry land (Chetty et al., 2013).

erosion. topsoil loss as a result of wind, flooding, or overgrazing. **ukuguguleka komhlabathi.** ukuguguleka kwenhlabathi engaphezulu emhlabeni okubangwa ukudliwa kakhulu kotshani, umoya nezikhukhula

terrestrial biomes. an area of land with a comparable climate, which includes a comparable plant and animal community**. izindawo zokuphilayo ezweni.** indawo yezwe enesimo sezulu esifanayo efaka imiphakathi efanayo yezitshalo nezilwane**.**

grasslands. biome that contains tall and short grasses. **imfunda/isifunda esinotshani**. indawo enkulu ehlala izilwane nezitshalo ezithize enesimo sezulu esithize esijwayelekile enotshani obude nobufishane.

f. Aquatic components

Components included in this category comprise of things involving water from the ocean to water in other parts of the world (Chetty et al., 2013).

aquifer. moist subsurface layer of water-containing minerals that, when removed with a drill, may release groundwater. **umkhumengo.** ungqimba olumanzi olungaphansi komhlaba lwezinto ezithwala amanzi ezingakhipha amanzi angaphansi komhlaba uma ekhishwa kusetshenziswa umgodi ombiwe.

bivalvia. molluscs that live in water and have bodies that are contained in two-part shells (valves) that may be opened at one end. **izilwane ezinegobolondo elingxenyembili**. izilwane zasolwandle ezinemizimba ethambile ezingenawo umgogodla ezivaleleke (ngokwemvelo) egobolondweni elinezingxenye ezimbili (izivalwana) ezingavulwa ohlangothini olulodwa

wetland. a region of moist soil that has been saturated enough to let water to replace the oxygen-rich air that typically exists between the soil's solid particles.. **ixhaphozi.** indawo enomhlaba omanzi, isikhathi eside ngokwanele ukuthi umoya one-oksijini eningi ngokujwayelekile otholakala phakathi kwezinhlayiya zenhlabathi eziqinile indawo yawo ithathwe amanzi. *sngz*. inhlabathi igcwala amanzi futhi amanzi angaqoqana phezu kwayo inhlabathi.

g. Genetics

This is a study of characteristics inherited from parents to their offspring and variations that occur in the line of heredity (Chetty et al., 2013). A sample of lemmata from this category is presented below.

alleles. *mv*. german *allel*, isifinyezo segama elithi allerlomorph elichaza olunye uhlobo lwesakhi sofuzo (abbreviation of *allelomorph* "alternative form of a gene"). two distinct gene types that influence the same trait in various ways. **ama-eliyezi.** izimo ezimbili ezingafani zesakhi sofuzo ezilawula uphawu olufanayo ngezindlela ezingafani.

dihybrid. a genetic cross comprising two distinct traits, e.g., shape and colour of seeds. **okuxube okubili.** ukuxutshwa kwezakhi zofuzo okubandakanya izimpawu ezimbili ezahlukene, isb. umumo nombala wembewu.

chromatin network. a tangled mess of filaments that give chromosomes their form and are located in the nucleus of cells. **isixhobo somsukasithwalafuzo**. inqwaba yezintambo ezithandelene etholakala kumongo yezinhlayiya eyakha izithwalafuzo.

h. Human reproduction

This topic covers body parts responsible for the production of human offspring from the male reproductive system to the female reproductive system. It explains how the fusing of male parts and female parts results in the formation of a child (Chetty et al., 2013). Below are lemmata samples from this topic.

allantois. *mv.* Greek *allantoeidēs* okumiswe okwesoseji (sausage-shaped). a structure in a growing embryo that is often employed for gaseous exchange but is inactive in human foetuses.. **ulwelwesi oluphefumulisa umbungwana.** umumo embungwaneni osakhula ngokujwayelekile osetshenziselwa ukushintshana kwamagesi ongasebenzi embungwini wabantu.

chorion. the thinnest membrane around the embryo that serves as the placenta. **ulwelwesi lomzanyana.** ulwelwesi olungaphandle olutholakala luzungeze umbungu olwakha i-placenta.

endometrium. *mv*. Greek *endo*, ngaphakathi (within or inside) + Greek mētra isibeletho (uterus). the uterine cavity's mucous membrane, which is where the embryo is implanted. **ulwelwesi-sibeletho lwangaphakathi.** ulwelwesi olungaphakathi olunamafinyila olwendlalela isibeletho lapho ukushunyekwa kombungu kwenzeka khona.

i. Meiosis

Meiosis can be defined as the division of a cell where two complete sets of chromosomes from different parent cells go through two cell division and further divide to four sex cells (Chetty et al., 2013). Terms relevant to this topic are covered below:

endoplasm. *mv*. Greek *endo* ngaphakathi (within or inside) + Greek plasm okudaliwe noma okubunjiwe (created or moulded). this is the inner cytoplasmic layer that surrounds the nucleus deeper into the cell. **i-endoplazimu.** lolu ungqimba olungaphakathi lwe-cytoplasm olutholakala ekujuleni ngaphakathi kunhlayiya lapho izungeze imongo. *sngz***.** iqukethe izinhlayiyana eziningi (izikhwama ezikhipha uketshezi) futhi, ngalokho, iminyene kakhulu uma iqhathaniswa ne-ectoplasm.

karyotype. a diagram illustrating the number, shape, and organisation of each chromosome in the somatic cell nucleus. **ikhariyothayphu.** ukukhonjiswa kwenani, umumo nokuhlelwa kwamakhromozomu wonke kumongo yenhlayiya yomzimba

nuclear membrane. eukaryotic cell's double-layered membrane enclosing the nucleus and dividing the cytoplasm from the nucleoplasm. **ulwelwesi lomongo.** ulwelwesi oluyizingqimba ezimbili oluzungeze imongo yenhlayiya enomongo ecace kahle, lwehlukanisa i-nucleoplasm ku-cytoplasm.

j. Human evolution

This is the study of how human beings originated according to scientists who explained that human beings shared a common ancestry with apes and originated from Africa (Chetty et al., 2013).

cladogram. a diagram illustrating potential evolutionary links between various species. **umdwebokuhlobana.** umfanekiso owumdwebo okhombisa ubudlelwane okungenzeka ukuthi bukhona ekwakhekeni kwezinto eziphilayo phakathi kwezinhlobo zezinto eziphilayo ezahlukene.

hominin. any individual who belongs to the only extant species of the zoological "tribe" hominin, sometimes known as humans or Homo sapiens. **ihominini.** noma yiliphi ilungu “lesizwe” sezilwane i-hominini kulona osekukhona uhlobo olulodwa namhlanje—i-homo sapiens, noma abantu. *sngz* igama lisetshenziswa ngokuvamile ukukhuluma ngamalungu asashabalala emhlabeni ozalo lwabantu, amanye awo manje aziwa kahle ngenxa yezinsalela zawo esezaphenduka amatshe.

out of Africa hypothesis. the theory that claims modern people, or Homo sapiens, were born in Africa and moved to other part of the world. **umqondo wokuqala kokuphila kwabantu e-Afrika.** ukucabangela okubeka ngokuthi abantu besimanje/i-homo sapiens yadabuka e-Afrika bese yathuthela kwezinye izindawo zasemhlabeni.

k. Impact of human on the environment

Chetty et al. (2013) discuss the atmosphere and climate change, availability of water and its quality, food security, loss of biodiversity and solid waste disposal under this topic. Lemmata from this category are sampled below:

atmospheric gases. gases found in the earth's atmosphere. **amagesi asemkhathini.** amagesi ongqimba lomoya oluzungeze umhlaba amagesi atholakala ongqimbeni lomoya oluzungeze umhlaba. *sngz*. la magesi abandakanya i-oksijini nenayithrojini (okwenza ama-99% omoya); yize amagesi avimbela ukushisa komhlaba ukuthi kuphumele emkhathini (ikhabhonidayoksayidi, imetheyini, inithriyasi-oksayidi, umhwamuko nomoyamkhathi) akha u-1% womoya.

biotechnology. *mv.* Greek *biotic* okuphathele nempilo (pertaining to life) + Greek *tekhnologia* ukulawulwa kobuciko noma ubuchwepheshe (the systematic treatment of an art, or technique). a field of technology that makes use of living things or biological systems to achieve a certain goal. **ubuchwepheshe bokuphilayo.** ubuchwepheshe obusebenzisa izinhlelo zemizimba yezinto eziphilayo noma izinto eziphilayo kwenzelwa inhloso ethize.

carbon footprint. each person's emissions of carbon dioxide into the environment through a variety of energy sources. **ukusabalala kwekhabhoni.** isikhutha esikhishwa ngumuntu ngamunye iye ongqimbeni lomoya oluzungeze umhlaba kusetshenziswa imithombo yamandla ehlukahlukene.

l. Human endocrine system

This system is responsible for co-ordination and homeostasis where the body communicates through a messenger system found in all mammals and other types of living organism (Chetty et al, 2013). Lemmata from this category are sampled below.

adrenal glands. the kidney-based glands that produce the hormones aldosterone and adrenalin. **indlala esensweni.** izindlala ezitholakala ensweni ezikhiqiza i-adrenalini ne-aldosterone kwamahomoni.

hormone. mv. Greek *hormon* okuqalisayo (that which sets in motion). chemical messengers that are protein-based in nature and are released by endocrine glands. **ihomoni.** izithunywa ezingamakhemikhali ezingamaphrotheni ngokwakhiwa kwazo ezikhishwa izindlala zohlelo lwamahomoni.

hypophysis. a hormone-secreting gland that is located near the base of the brain. **indlala esebuchosheni ekhiqiza izigqa.** indlala etholakala ngaphansi kobuchopho ekhipha amahomoni.

m. Miscellaneous

Lemmata from various themes covered in the field of Life Sciences are found below.

asexual production. *mv*. Greek *a-* okuphikisayo (not) + Latin *sexus* okuqondene nocansi noma ukukhiqiza (pertaining to copulation or generation) + Latin *producere* ukukhiqiza (bring forth). a method of reproduction that does not involve the joining of gametes or sex cells. **ukukhiqiza kungahlanganwanga.** indlela yokuzala engaphathelene nokuhlangana kwezinhlayiya ezimbili noma ama-gamete. *sngz*.into ephilayo ingazala ngokuhlukana komzimba wayo ukuze kwakheke izinto eziphilayo ezintsha, ukumila kwezinto ezintsha eziphilayo emizimbeni yazo noma ukuzala ngokukhula kwezinto eziphilayo ezintsha zisuka engxenyeni yento ephilayo endala. lokhu kwenzeka ngaphandle kokuba khona komlingani lapho, kulokhu, into ephilayo ikhiqiza abantwana abafana nse nomzali.

cell. 1. the smallest structural and functional unit of living things that is capable of independent existence and makes up all living things as well as physical tissues. 2. any little space or hollow, like the pollen-containing cavity in an anther. 3. a region on an insect wing that is bordered by veins. **inhlayiya.** 1. iyunithi encane kunazo zonke yesakhiwo sezinto eziphilayo esebenzayo engaziphilela yodwa futhi eyakha zonke izinto eziphilayo kanye namathishu omzimba. 2. noma iyiphi imbobo noma indawo encane, efana nembobo equkethe impova ngaphakathi kwenhloko yezingxenye zesilisa ezimbalini. 3. enye yezindawo ephikweni lesinambuzane ezungezwe imithambo.

detrivore. a creature that consumes substantial amounts of decomposing and dead organic stuff. **idlambola. i**nto ephilayo edla izingxenye ezinkulu zezinsalela zemizimba yezinto ebeziphila esezifile kanye nezingxenye zezinsalela zemizimba yezinto ebeziphila esezibola.

n. Abbreviations

The above listed lemmata in all topics are defined according to the prescribed material for learners and translation strategies make them easier to understand in isiZulu. A similar strategy was applied when defining and translating abbreviations. The abbreviations are, however, listed alphabetically but at the end of the wordlist to make them prominent, as the last part of the main body because of their common usage in daily lives and domains of study.

The development, emergence, and disappearance of abbreviations frequently occur without warning and are complex and troublesome (e.g., COVID-19). Some words are permanently or very long-lasting in a language (such as FBI), whereas others vanish after a specific period of time (e.g., LDS). Lexicographers debate whether to include them in dictionaries because of their unpredictable nature. They concur that dictionaries of abbreviations must be up to date when published because new abbreviations emerge frequently in every language, making it difficult to discern who actually needs them. (Lukančič, 2020).

The researcher found it important to add them as scientific subjects often have abbreviations for long terms which is common in the domain. Examining of millions of scholarly articles has revealed that abbreviation in biomedical research papers has increased steadily over the past 70 years.

> The analysis, which included more than 24 million titles and 18 million abstracts of papers published between 1950 and 2019, identified 1.1 million unique acronyms that have been used in biomedical research1. Unsurprisingly, DNA was found to be the most widely used acronym, appearing in titles and abstracts more than 2.4 million times. (https://www.nature.com/articles/d41586-020-02466-3)

Subsequently, abbreviations were added to the back matter with their complete form of the term and defined in isiZulu. As the data in the abbreviation was to made available in isiZulu, the study considered the translation of the same. Kuzmina, Fominykh, and Abrosimova (2015) studied the translation of abbreviations in the medical field and found that some abbreviations were used to refer to different items as determined by the anatomy, procedure or disease discussed. Examples of this is ADA which depending on where it is used can mean 1) American Dental Association; 2) American Diabetic Association; or 3) American Dietetic Association. For this reason, translation of abbreviations is necessary by the employing appropriate translation strategies to ensure that target audience receive the intended meaning. These scholars propose that when translating abbreviations, the translator should have various dictionaries and study the abbreviations in question thoroughly.

Given that the current study, aims at assisting learners in the academia, the study did not focus on translating the abbreviations but ensured that the complete terms provided in their English form with definitions are translated into isiZulu. The complete form of the abbreviations was not translated as their translation would not enhance the function of the dictionary in any way since the user is being directed to an explanation of the abbreviation, and its definition is provided for the user to understand the meaning of the abbreviation. A sample of these abbreviations are as follows:

BCG (bacille calmette-guerin). a TB vaccination typically administered to young children. umgomo ovikela i-tb ojwayele ukunikwa abantwana abancane.

DNA (deoxyribonucleic acid). portion of a chromosome that carries genetic information from parents to their children, influencing the appearance and functionality of thousands of sections.. ingxenye yekhromozomu equkethe ulwazi olunamakhodi lokulawula ukubukeka nokusebenza kwezinkulungwane zezitho zomzimba nokuthwala ulwazi lofuzo olusuka kubazali luya kubantwana babo.

MRNA (messenger rna). it takes information for protein synthesis from the nucleus to the ribosome. ithatha ulwazi lokwakha amaphrotheni lusuka kumongo luya kuma-ribosome.

6.2.5.3. Dictionary evaluation

The application of theories in dictionary development are invaluable as they contribute to the credibility of dictionaries and guide lexicographers in creating resources that satisfy lexicographic functions. Nkomo (2019) examined domain-specific resources produced in African languages in terms of lemma selection and the structure of these resources to determine

whether these resources contributed to language intellectualisation and the expansion of functional usage. To this end, he distinguished between dictionary entries that contained data that could be considered as insufficient and irrelevant, and states the following:

> While a well-conceived and diligently constructed lemma list will provide a solid foundation for a specialized dictionary, it will not automatically translate into an effective and user-friendly product. After locating the lexical item that prompts dictionary consultation, the user must find the relevant data type(s) from which the needed information may be retrieved. Thus, the lexicographical treatment of included lemmata is another equally important theoretical decision with practical import. The retrievable information must be relevant, sufficient and accurate in order to address the question(s) that prompted the dictionary consultation procedure. Questions of relevance, adequacy and accuracy are therefore crucial in the analysis of the surveyed dictionaries. (Nkomo, 2019:107-108)

The developed resource contributed to domain-specific lexicography by providing a necessary new resource which is structured as closely as possible to published resources in an African language. The resource was also evaluated according to guidelines set by Ball and Bothma (2018) for evaluating electronic lexicographic resources. The evaluation included a consideration of the content, information architecture, editing, navigation and access, help and customisation of the resource. An evaluation of ISY-LSD according to these features that are part of the structure of the resource showed that the developed lexicographic resource satisfied lexicographic functions which were "to provide assistance to a user group with specific characteristics in order to cover the complex needs that arise in a specific type of user situation" (Bergenholtz and Tarp, 2003:176) which would assist these users meet their pedagogical lexicographic requirements which were the genuine purpose of developing the ISY-LSD.

The ISY-LSD is developed as a first of its kind and not in a group setting of trained lexicographers and terminologist, like in the case of the UKZN which relies on lecturers to provide them with harvested term lists to be developed in organised workshops with discipline experts, lexicographers, linguists, terminologists and students; this project requires an estimation of R65 000 to R95 000 per 3–5-day workshop depending on the content being developed (Khumalo, 2017).

The ISY-LSD is developed as part of research into the viability of the development of pedagogical dictionaries as a resource to elevate the language barrier learners experience in their course of learning as demonstrated by the Grade 12 examination results from the Department of Basic Education. With an understanding of the difference between terminology development and lexicography, the study did not follow the UKZN model because lemmata were not being developed in isiZulu. The resource is bilingualised and focuses on providing the user with an isiZulu microstructure and an English macrostructure as the language of learning is English.

Subsequently, the reliability of the resource developed is dependent on the lexicographic process and not terminology development procedures. To this end, the following evaluation criteria adapted from Ball and Bothma (2018) are presented in this chapter.

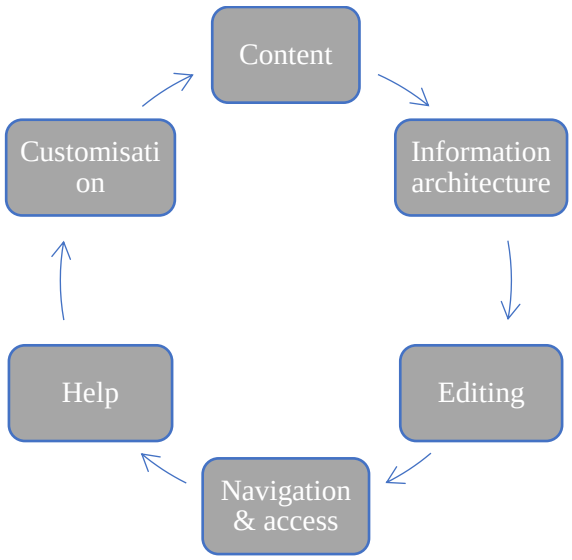


Figure 6.3: Dictionary evaluation criteria

- **Content**

Collection of dictionary content is motivated by the information needed by users (Gouws, 2004). Thus, a dictionary should have the relevant information; be at the required level of complexity; provide the required level of detail; currency; credibility; writing style; and provide for multimedia usage, as required by its users in line with the lexicographic functions of the resource. Thus, the research extracted content from prescribed books by the DBE as that content is relevant to the users.

- **Relevance**

This means that a dictionary should be able to provide the information being sought by the user which could be meaning or any other information available in dictionaries. As stated by Alberts (2014), textbooks are a reliable source of information for developing lexicographic resources for learners. Thus, the study extracted information from textbooks prescribed by the DBE and created the dictionary according to terminology and concepts found in that resource because that is the material needed by the users.

- **Complexity**

Dictionaries provide for different users and should be tailored to meet the needs of specific users. In meeting these needs, the content of the resource should be written in a manner befitting the target users. As the ISY-LSD is directed at users who are low experts in the field as learners of Life Sciences, the level of language used in isiZulu and English is medium and not complicated. The researcher understands that although users may be mother-tongue speakers of the language, they are only taught their mother tongue in the language class and do not have the privilege of learning scientific language in their mother tongue. Thus, the subject-specific information in isiZulu is provided in simple language.

- **Detail**

The resource should have enough content to meet the lexicographic needs of users, and this may include links to other resources that could enhance the knowledge of users. As there are many available resources that can be consulted, it is important for lexicographers to select the reliable resources that will sustain the authenticity of dictionaries as reliable sources of information (Tarp, 2012). The ISY-LSD provides a list of textbooks, dictionaries and websites consulted during the treatment of its content. This information can be found in the bibliography section of the resource and can be used by users should they seek more information.

- **Currency**

Content is updated from time to time; therefore, it is important for lexicographers to provide the latest content in their resources. As noted in Chapter 5, the EZD is a resource that has been updated more than once to ensure that its content was time relevant to users. The researcher extracted data from textbooks that are updated as all books are third editions with relevant information updated to be aligned with the National Curriculum and Policy Statement for the

subject of Life Sciences, which was introduced in 2012 for Grade 10, 2013 for Grade 11, and 2014 for Grade 12 (Chetty et al., 2013).

- **Credibility**

Credibility refers to the trustworthiness of the resource based on information about the publishers of the same. Details about the publishers and editors of dictionaries should be recorded in the resource for users to be able to reach them should a need arise. The ISY-LSD as an unpublished resource does not have publication information.

- **Writing style**

A dictionary should be written in a manner that will be clear to the user for them to navigate smoothly. The lemma should be written in a manner different from the microstructure to assist users to read each lemma without confusing it with irrelevant content. Electronic resources come with the advantage of space thus enabling the lexicographer to add as much content as they wish, which makes the resource simpler to comprehend.

Below is the writing style of the ISY-LSD:

> **animalia**. *mv.* > Latin *animale* = **okunomphefumulo.** *hms.* isilwane. nczln. the arrangement of the kingdom of all animals. nczlz. uhlelo lombuso wezilwane. sngz. izilwane zalolu hlobo zivame ukuhlukaniswa ngokuba nemizwa engenalo uhlaka lwamanhlayiya, futhi zidabuka kumbewu esesizalweni

The above entry is written by providing a bolded macrostructure and a normal font for the microstructure. Microstructural elements are abbreviated, and their full wording is written in the front matter of the resource. These elements are presented in a different colour to make them prominent. The etymological root of the lemma is in italics as the languages of the resource are English and isiZulu.

- **Multimedia usage**

Multimedia enhances dictionaries by providing visual or audio files of the content, however, it can also be sometimes regarded as information overload. Gouws (1994) posits that illustrations in dictionaries enhance the microstructure of the dictionary. This explains the use of illustrations by Rittner and McCabe (2004) in their *Encyclopedia of Biology* where they added

illustrations to explain some of the lemmata to further clarify them for the user. The ISY-LSD did not use multimedia as a source for the content since the prescribed textbooks for learners already provide illustrations. Hence, the study did not want to overload users with information.

- **Information architecture**

This refers to the structuring and organising of information in a resource for the user to find and use. This evaluation criteria are guided by the lexicographic functions of the resource which place the user as the paramount influencer in dictionary development. Information architecture considers the structure and the content available in pages of the resource.

- **Structure:**

As the ISY-LSD is specifically designed for learners of Life Sciences, the structure of the dictionary is different from that of language dictionaries studied in Chapter 5. The structure of the research dictionary is provided in Chapter 6 where the front matter, macrostructure, microstructure, and the back matter were explained. The structure of the ISY-LSD is depicted in **Figure 6.4** below:

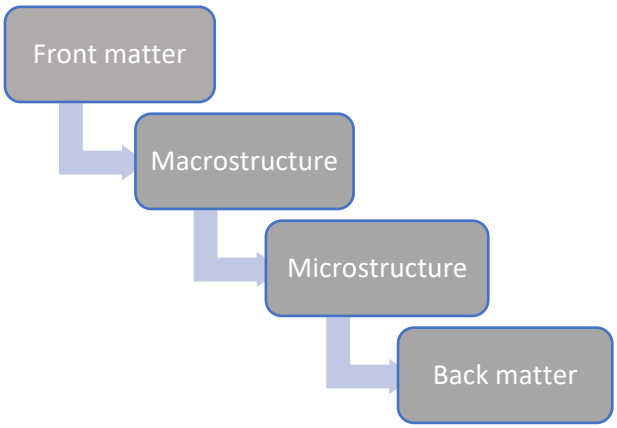


Figure 6.4: The structure of the ISY-LSD

As much as the front matter and back matter, as the outside matter, are often studied together (Busane, 1990; Assam, 2006; Gouws, 2007; Nielsen, 2009), the current study scrutinised them separately to examine each matter according to the structure of the dictionary.

- **Page content**

The organisation of information in the resource was thoroughly explained in the front matter of the dictionary in Chapter 6, to be an alphabetically arranged macrostructure with a microstructure relevant to the lexicographic functions of the resource. Nielsen (2009) emphasises the importance of creating pages that can easily be scanned through as users may not always be interested in reading the entire entry. The ISY-LSD has one sentence definitions and quick to read, thus enabling users to scan through. Further, the microstructure should be arranged in a logical manner that is easy to understand. Thus, the arrangement of the ISY-LSD starts with the lemma, followed by its etymology, lemma translation, English definition, definition translation, and finally additional information where necessary. This arrangement is adapted from the OUPEZ which provided a consistent structural arrangement of entries that enables users to find information easily (De Schryver, 2015: 496).

- **Editing**

Lexicography is the process of writing or editing dictionaries (Bergenholtz & Gouws, 2012). Thus, after the lexicographer can work as the writer or editor of the resource. The researcher as the compiler of the ISY-LSD was not in a position to edit her own work because she wanted to ensure the quality control of the resource. According to Chong (1998: 377), "The peer review process is the basis of evaluation or "quality control" in modern science. Peer review ensures publication of valid scientific results that are appropriately presented and interpreted."

Mistakes are bound to happen when writing (Harper, 1992), therefore, the researcher requested the help of a language practitioner to proofread the final material to check for linguistic errors in both isiZulu and English. As the resource is bilingualised, the language practitioner had to be a person with expert knowledge of both languages who has more than 15 years of experience. This decision was based on the fact that "Good peer reviews do make a difference in assisting the authors and the journals to publish valid scientific results that are appropriately presented." (Chong, 2012: 378).

- **Navigation**

Navigation and accessibility refer to the user-friendliness of the dictionary with the assistance of a tool that refers the user to various elements in the dictionary. Users should never feel lost when consulting a dictionary, especially electronic dictionaries where clicking on the wrong link can land the user on the wrong page. Another important aspect of navigation is the time it

takes for a user to find an entry in a resource. This is calculated by the number of steps or clicks that the user should perform in an electronic resource. The ISY-LSD navigation process is explained in the front matter, where the search feature is explained. A user can page through the resource or use the search button on the top right-hand of the screen by typing the word they are searching for. Entries with that word will pop up and the user can make their selection. **Figure 6.5** provides images of the navigation process in the electronic dictionary.

Search feature **Results**

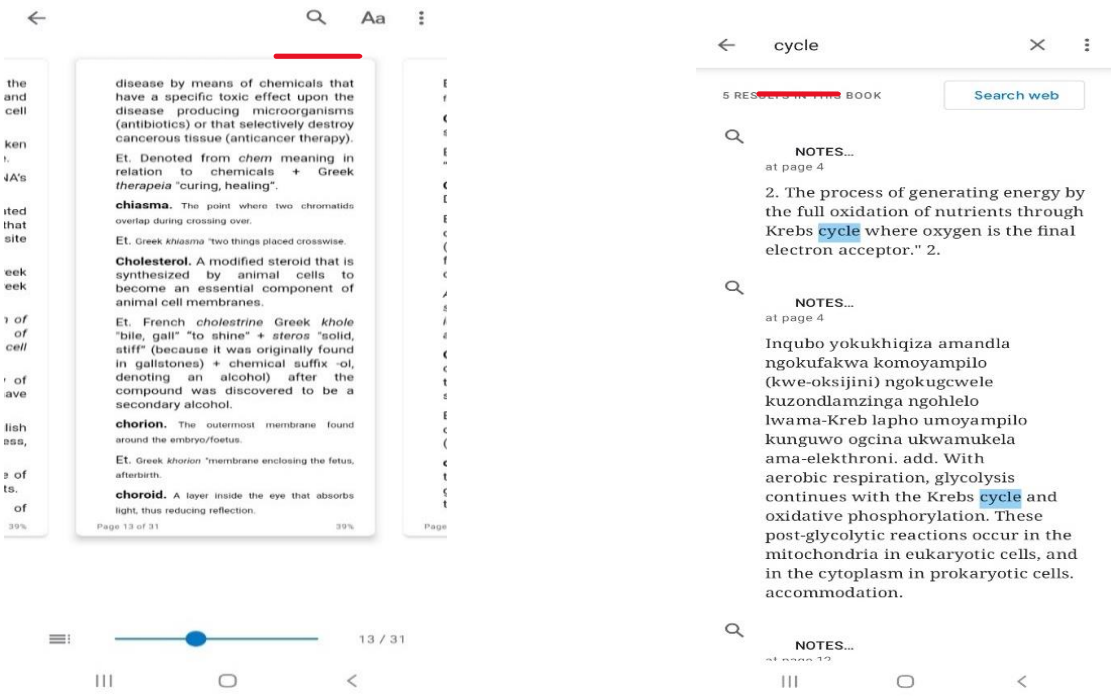


Figure 6.5: Search feature of the ISY-LSD and the results

The results of the search show the frequency of the entry in the resource, and the pages that it can be located in. The results further provide a 'search web' feature. This can be used by the user to search for the word on the world wide web, and upon clicking there, the page is directly linked to a web search for the word. This is important in a resource as links contribute to services offered by electronic dictionaries as "External links (links to pages on a different site) can be used to lead to more information outside the dictionary" (Prinsloo, Heid & Bothma, 2012: 275).

- **Help**

The help feature is a tool to assist users should they get stuck while using the resource. This feature explains how to navigate the resource. This can be in the form of an icon on a screen or any other means. The ISY-LSD explains the navigation and accessibility of the resource in the front matter and users can always page to the front matter manually or by typing the word '*isingeniso*' which will take them back to the introductory pages of the dictionary where its usage is explained.

- **Customisation**

The theory of lexicographic functions requires that dictionaries be designed to meet specific needs of users. This can also be explained as the customisation of dictionaries to meet user needs. Nkomo (2019) argues that dictionaries should meet both cognitive and communication needs of users as determined by the lexicographic functions of each resource. To this end, he delved on the importance of catering for language needs of users in specialised domains given that the language of education in South African is English.

The employment of specialised English words in a variety of academic and professional professions makes it difficult to understand texts in both written and spoken form. For the most part, information relating to meaning is given in the mother tongue either in the form of translation equivalents or explanations of meaning in the form of terminological definitions in order to solve the issue of text comprehension that is hampered by English. Once English terms have been simplified through the mother tongue, they can subsequently be employed more effectively for text production in English, the main official language (Nkomo, 2019).

The researcher examined the user according to their profile, situation and needs and designed a resource that will cater for these needs. As the dictionary is directed at adolescent users, it is designed to be in line with their age, language proficiency, and expertise as learners. With regard to their situation, the resource satisfies cognitive functions by providing information that will be useful to them in their course of learning. The need for a resource that will provide scientific information in their mother tongue was also considered.

Earlier in this chapter, the evaluation of currency in dictionary development focused on creating a resource that is relevant in the present day. In this criterion, the study considered the relevance of the dictionary form in printed and electronic form. Paper dictionaries can take up time and are considered as inefficient, while electronic dictionaries are easier to use (Leech & Nesi, 1999). Further, South Africans have access to mobile phones (North et al., 2014). Joseph Johnson (2021) states that there were 60.73% internet users in South Africa, according to statistics of usage between 2017 to 2026. This share is projected to grow to 66.06 percent in 2026. Subsequently, electronic dictionaries can be made available as their accessibility will be feasible.

6.3. Conclusion

This chapter explained how the ISY-LSD was developed by providing guidelines for its development. These guidelines stipulate the need for a planning process, an examination of the macrostructure and the microstructure of the dictionary being developed, and the translation and development of the resource. Each of these steps in practical lexicography are explained beginning with the planning step which is when the lexicographer considers the users of the resource to be developed. The user is profiled in terms of age group, their needs, their situation, lexicographic function of the resource being developed, the type of dictionary being developed and the form that the resource will be published in.

Consideration of each of these features helps the lexicographer create a resource that will resonate directly with the user because it will be tailor-made for them. An example of a resource created for a target user is the OUPEZ which has been developed for school learners who are learning to read, write and hear the language. This study receives the latter resource as being unsuitable for FET mother-tongue speakers of isiZulu as they often would already have this information. The generalisation of resources can result in a resource being less friendly than intended whereas if a specific group is the target market, the content will be at the level of that age group, catering for their needs in their situation of requiring the resource.

When considering the needs of users, this study suggests that FET learners who speak African languages as their mother tongue should be considered when planning for their education and means for them to attain educational information in their mother tongue. This will cater for their comprehension needs in their education because they do not only need quality education but quality education that they can understand, interpret and be able to implement during their time of learning and beyond. Speakers of African languages are deprived of these resources which is detrimental to their learner outcomes, therefore, the ISY-LSD is created to cater for their linguistic needs and assist them to understand, interpret and implement what they are being taught by engaging with resource explaining concepts in their mother tongue.

Users find themselves in a situation where they are forced to rely on resources written in an acquired language and try to unpack information for understanding. Knowledge is best acquired when delivered in the mother tongue and the DBE does acknowledge this. The situation learners find themselves in, is the lack of resources to cater for the dissemination of knowledge in their mother tongue. A resource such as the ISY-LSD will not only help learners

understand the material but will also help teachers who code-switch in class by providing them with isiZulu words that they can employ as the resource contains microstructural features that are subject specific that will be helpful to the user.

The function of this pedagogical practical lexicographic exercise is to create a resource that will satisfy the lexicographic functions of a dictionary with the creation of a resource that will help FET learners understand Life Sciences content in their mother tongue. Therefore, this resource provides lemmata translations, etymological data, definitions, and additional information for the lemmata as determined by content available for each lemma. This function is crucial in the planning stage of dictionary development because it informs decisions on the microstructural feature of the resources. The lexicographer ensures that this resource has microstructural features that will not be difficult for users to understand.

A lexicographer should be clear about the type of dictionary they are creating as the type of dictionary should be aligned with the type of users the resource is created for. Most English-isiZulu dictionaries are bilingual, providing users with lemmata equivalents. This is helpful but can be enhanced through the addition of definitions to the lemmata. Thus, this study developed the first bilingualised English-isiZulu dictionary. This dictionary contains English lemmata with definitions provided in both languages. The researcher found this type of dictionary as most relevant in domain-specific lexicographic resources because of the scientific nature of the resource. These resources are filled with jargon specific to the scientific field which may be difficult for the user to interpret, especially when learning in a second language. Therefore, definitions are provided for each lemma and this makes this dictionary different from published dictionaries in the language.

Most English-isiZulu dictionaries are printed on paper and with technological developments this is expected to shift to or feature technological forms as well. The MNST-NGUNI is available as a downloadable and printable online PDF form which makes this resource easy to access if one has the internet for downloading the document. The dictionary developed in this study will also be in a digital form and will be available on the Smashwords website for free download. This e-book will have search features that will make finding words easier for the user. It will also have an internet link enabling the user to conduct a further search online should they seek for information or even pictures of the lemmata. This is a first in isiZulu language

and the study envisages to demonstrate that African languages are ready for development in the digital space; all that is needed are people who will feature these languages in the space.

Lemmata for domain-specific dictionaries should be carefully selected from informative and relevant resources to meet the lexicographic functions of resources. Thus, the macrostructure of the ISY-LSD was developed from studying prescribed material from the DBE and carefully selecting terms that needed to be defined in isiZulu. These lemmata are arranged alphabetically according to the English lemmata and each lemma is treated as necessary for the needs of the user in their situation. In the same vein, the microstructure of the developed dictionary was created to contain features necessary for a domain-specific dictionary, where etymological and semantic information were provided. This information enables the resource to provide users with information necessary for them to understand Life Sciences as a subject that is not taught in their mother tongue.

The provision of this information in isiZulu required translation skills and the use of other dictionaries (listed as part of references in the back matter) for clarity of meaning. Different translation methods were employed as required by each term. Some terms such as 'kidney (*inso*)'already had equivalents in other dictionaries, which the research employed and transferred to the new resource, but all definitions were translated from scratch with dictionaries being consulted during their translation. Other terms such as 'lamina' were transliterated to '*ilamina*' because of the absence of an equivalent in the language. Descriptive translation was also employed where an equivalent was not available and transliteration or borrowing was not going to be sufficient, such as in the term 'meninges' which was described as '*untwentwesi lobuchopho'*. The incorporation of translation skills in lexicography demonstrates the need for lexicographers to work with translators to create a resource that will be translated correctly through the application of translation skills. Other experts needed in the planning stage of lexicography are terminographers who coin words that do not exist in the language and once these words are created and approved, they can form part of the lemmata lists of dictionaries.

In developing the structure of the new dictionary, the study respected the position of English as the language of education in South Africa, and created a dictionary with a structure that has English as the source language for the ISY-LSD. It is not intended for this resource to be foreign to users, therefore, it provides terminology in English and translates it into isiZulu. This

application of translation of content was done through the application of translation methods appropriate for each term.

Creating guidelines for to develop a dictionary are important because it serves as a blueprint for the dictionary to be developed and the lexicographer can study the blueprint to identify gaps that could exist in the development of a new resource. Once the planning phase is completed, the lexicographer compiles the dictionary content by collecting the data and translating or writing it as required for the dictionary. After completing this stage, a user-friendly dictionary explains the content of the dictionary in the front matter. Thus, the ISY-LSD has a front matter that explains how it is arranged and how it can be used. All features are stated clearly to ensure that the user understands. The front matter of English-isiZulu dictionaries has always been informative as explained in Chapter 5. The developed dictionary also has an informative front matter relevant for a digitally produced resource. It is concise but explains each feature of the resource in isiZulu. The use of isiZulu in explaining the front matter is because the target market is isiZulu speakers. Explaining the front matter in English, as is the case with the EZD and the SZD, did not make much sense in this study because the resource is only for isiZulu mother-tongue speakers and not English speakers. African lexicographers should consider the target market when creating dictionaries and not only follow the norm. This will show pride and promote the use of African languages as languages of subject content.

The main body of the dictionary provides the contents of the dictionary where concepts are listed and defined as planned. Adhering to the plan is key in developing a functional main body of a dictionary because this will help the lexicographer create a resource that is relevant to the target user who represents the starting point of dictionary development.

Lexicographic resources in African languages have been criticised for not following lexicographic information in their development and have been treated as translation exercises (Nkomo, 2019). This can be changed by ensuring that guidelines are set according to lexicographic theories selected for the task. The ISY-LSD was developed according to the theory of lexicographic functions because its emphasis falls mostly on creating a resource that will function as an aid to linguistically and jargon challenged learners of Life Sciences. Selecting a theory will not only be a guide but it will also help the lexicographer in creating a sketch for dictionary development through planning. This would entail consulting other linguistic and subject-specific resources to help create a functional resource. Resources

consulted should be referenced as an acknowledgement of those resources. This feature of the dictionary is listed in the back matter of the ISY-LSD.

Once a dictionary has been completed, it should be evaluated to determine whether the lexicographer managed to create a resource that meets the needs and functions listed in the guidelines. The current study followed evaluation guidelines developed by Ball and Bothma (2018) as they were relevant to a digital dictionary. The content, relevance, information architecture, editing, navigation and access, help, and customisation of the resource should be evaluated. This helps lexicographers to assess whether the resource they created is aligned with the plan and lexicographic functions of the resource. This further ensures that lexicographers are not randomly adding content but that they are following a plan that will work for the type of dictionary that was developed.

The absence of domain-specific dictionaries in previously marginalised languages is unfortunate as these languages can be developed and are still being developed to cater for such needs. The ISY-LSD was carefully created through the formation of a theoretically underpinned plan ensuring that the resource meets the lexicographic functions of the target users. The translation of terms to African languages may not be enough as lexicographers can work with terminographers to create new terms, but at this stage of the development of the ISY-LSD, terminography is not necessary as learners are to be examined in English. These users need to understand the meaning of the English terms, which is why they are explained in both languages. The provision of term equivalents and descriptions (in some cases) in isiZulu is simply because the resource would have appeared clumsy without them. It would not make sense to have an isiZulu dictionary without isiZulu terms. The use of English as a language of learning greatly influenced the source language selection and proportion of using languages in the resource.

African languages can create resources that can stand independently of English but the language of learning creates a need to align themselves with the colonial language. It will take time before monolingual domain-specific dictionaries are developed because pedagogical resources should cater for educational needs which place English as a pedagogical language in the FET phase of learning. Once African languages are employed as a language of learning, monolingual dictionaries in field-specific domains will be easier to create. At this moment, these languages do not even have bilingual dictionaries with domain-specific definitions which

makes the development of the ISY-LSD a necessity. As already explained, a bilingualised dictionary is a much-needed dictionary type in African languages. In this way, these resources can provide content that will equip speakers of previously marginalised languages with information in their home languages that the DBE is not able to provide. Dictionaries are useful resources in learning and the bilingualised form will boost the knowledge of learners more than a bilingual dictionary, which only focuses on the lemma and not the definition. Dictionaries developed for learners of previously marginalised languages should also cater for contextual needs of users where they will be placed in a position to understand the content in a similar manner as their peers who have access to multiple domain-specific resources in their languages.

This was the inspiration behind the development of a domain-specific lexicographic resource for FET phase learners which resulted in creating the ISY-LSD − a bilingualised digitally available resource. This resource, as evaluated, according to Ball and Bothma (2018), is relevant for the target users as it will cater for their needs. This chapter presented various stages of dictionary development that the study employed in the development of the isiZulu Life Sciences dictionary. Structures of the dictionary were explained and how the strategies were employed in development of the dictionary. The dictionary type and how it is to be used plus the arrangement and meaning of its content were explained. Finally, the chapter examined the criteria used to evaluate the developed dictionary as a means of assessing its feasibility as a domain-specific pedagogical lexicographic resource.

The next chapter (Chapter 7) presents the research findings, conclusion and recommendations.

CHAPTER SEVEN

FINDINGS, CONCLUSION AND RECOMMENDATIONS

7.1 Introduction

This chapter provides a summary of the study process, research findings, the conclusion of the study, contribution of the study, and finally, the recommendations. These subtopics follow each other respectively.

7.2 Summary of the study process

The study sought to analyse domain-specific terminology in the field of Life Sciences with the intention of developing a dictionary that would assist Grade 10 to 12 isiZulu mother-tongue speakers being taught a scientific subject, among others, in English. The intention of creating this resource was to assist learners currently deprived of mother-tongue education by providing them with access to scientific concepts in their mother tongue. Situated under the pragmatic paradigm, this study employed the qualitative method and data were collected by means of document analysis where dictionaries and textbooks were purposively selected for analysis as part of the dictionary development process. The Marshall and Rossman (1999) data analysis procedure was adapted to create order, structure and understanding in this research. This led to the analysis of terminology through lexical semantics and the theory of lexicographic functions as a theoretical framework for this study, and an analysis of data, which was divided into three chapters (Chapters 4, 5 and 6).

This analysis comprised of an examination of terminology in the Life Sciences domain investigating lexical semantics of the terminology and its availability in isiZulu lexicographic resources with the intention of understanding their treatment in these resources. IsiZulu lexicographic resources were examined to learn dictionary structures as a foundation for creating guidelines for the development of a new dictionary. A new dictionary was developed with the ISY-LSD which was evaluated to determine whether the resource managed to meet lexicographic needs of users and fulfilled the function it was developed for.

7.3 Findings

An examination of learner terminology from the field of Life Sciences through the study of lexical semantics depicts that isiZulu mother-tongue learners need lexicographic resources that will explain the terminology in a language they understand best, which will contribute to better

learner outcomes. The study revealed that current isiZulu lexicographic resources do not enhance knowledge of learners in scientific domains as the few terms listed as lemmata in isiZulu dictionaries are only given equivalents in general language rather than the scientific domain. This is a reasonable position because the available resources for learners are created for general language use and not domain-specific usage. Subsequently, the study developed a resource for isiZulu learners that provides them with translations of the terms as well as definitions in their home language. Findings from this study are explained in terms of terminology analysis and isiZulu dictionaries. Based on the need for a new resource the study developed a dictionary and guidelines for the development of this dictionary which was systematically explained in Chapter 6.

7.3.1 Terminology analysis

Terminology from the Life Sciences glossary was analysed in relation to its availability in isiZulu lexicographic resources. The researcher learnt that recorded terms have equivalents and no definitions because the dictionaries examined were not domain-specific resources. The available domain-specific resource in the lexical field of science is for younger learners of Grade 4 to 6, therefore, the few terms (from the high school list) with equivalents provided are not applicable for high school learners.

The study of terminology that has general and domain-specific meaning was explored. As an example, the term ‘accommodation’ has a domain specific meaning and a general meaning. IsiZulu dictionaries do not have the domain-specific meaning from prescribed textbooks for learners which is the ‘ability of the lens in the eye to change shape to clarify the view in relation to the distance of an object from the eye’. Equivalents found in the explored isiZulu resource explains the term by providing an equivalent ‘*Indawo yokuhlala; indawo yokungenela’* which is a place to stay or a place where one can visit. The needs of users in their situation as learners of Life Sciences are thus not met in this resource. Lexical semantics is about the conceptualisation of word meaning by the person encountering the word in any form. Learners encountering domain-specific resources in English are in a position to gain a better understanding of terminology as compared to users who only have general language resources as lexicographic resources in their mother tongue.

The analysis of Life Sciences terminology presented different types of lexical relations such as antonyms that have affixes as items that change meaning to an opposite meaning of another word. For example, ‘vertebrate’ and ‘invertebrates’ are related in their complete form save for the prefix in invertebrates that changes the meaning. Learners who understand English prefixes

can easily deduce that ‘vertebrate’ is the opposite of ‘invertebrate’ if they understand how the prefix ‘in-’ is used. Further, this analysis of terminology demonstrated the need to study lexical relations when developing dictionaries because they can help in preliminary deduction of meaning and also help lexicographers bridge terminological gaps. Thus, lexicographers can structure lemmata to show lexical relations because this can help users deduce meaning. The cognitive data of people who have good knowledge of English place them in a better position to assume the meaning of terms at a glance rather than non-mother-tongue speakers of English who need advance knowledge of the language first in order to decode texts in domain-specific fields.

Lexical relations further reveal the importance of understanding the hierarchy of lexical items from the superordinate term (which is a high level) to meronyms (which are types) of that superordinate. A superordinate has been used in isiZulu dictionaries to close lexical gaps in terms such as ‘uterus’ and ‘ovary’. These terms are distinct but they share a superordinate term which is ‘a reproductive organ’. Therefore, dictionaries have ‘*isizalo*’ meaning ‘reproductive organ’ as an equivalent for both entries despite their different meanings. An understanding of relations that exist between lexical items can play an important role in dictionary development, especially in a language that is developing in scientific domains such as isiZulu.

An examination of the terminology and terminological practices were necessary in this study to prepare for the development of the dictionary. This demonstrated terminological gaps in isiZulu dictionaries and the need to develop a dictionary that will cater for the needs of learners as stated in the theory of lexicographic functions. The incorporation of lexical semantics was important in helping the study understand the words and different meanings that can be inferred. The researcher found terminography and lexicography as different but related fields of study which lexicographers should have knowledge of both fields for them to meet lexicographic functions of their resources. The terminographer considers definitions and develops a term then the lexicographer applies lexicographic theories to add the new term to the lemmata. This makes the relationship between these fields important in practical lexicography and the development of an isiZulu dictionary in the domain of Life Sciences.

7.3.2 IsiZulu dictionaries

The study explored three (3) bilingual dictionaries (English-isiZulu) and a multilingual resource comprising of twelve (12) official languages of South Africa. The researcher examined the dictionaries to study the structure of the resources. Atkins (1996) states that bilingual dictionaries should consider the function of the dictionary information, mode of

expression, source and target language speakers, and the purpose that the dictionary is used. This coincides with Tarp (2003) who in the theory of lexicographic functions posits that lexicographers should study the user, their needs and their situation. The absence of domain-specific data in isiZulu dictionaries does not mean lexicographers failed to study the user but reflects rather a standard consideration of terminology in their general usage according to general needs. This situation is influenced by the fact that isiZulu is one of the South African languages that were previously marginalised, and education in the country was only offered in English and Afrikaans, which is a position still being held by those in authority (Molepo, 2008).

Further, these resources do not provide definitions as bilingual dictionaries, because of their nature as most bilingual dictionaries, only provide equivalents (Nkomo, 2019). This study demonstrated the need for definitions to be provided in bilingual resources (general language dictionaries and domain-specific dictionaries) in order to supply users with extensive information about the lexical items listed. Thus, the typology and the megastructure of the *Scholar's Zulu Dictionary* (Dent & Nyembezi, 2009) abbreviated as the SZD; *Oxford Bilingual School Dictionary: IsiZulu & English* (De Schryver, 2015) abbreviated as the OUPEZ; *English-Zulu / Zulu-English dictionary* (Doke et al., 2014) abbreviated as the EZD; and the *Multilingual Natural Sciences & Technology Term List* for English, Afrikaans, IsiZulu, IsiXhosa, Siswati and IsiNdebele (Department of Arts, Culture Science and Technology, 2013*)* abbreviated as the MNST-NGUNI, were examined.

The typology of these dictionaries demonstrated an understanding of lexicographic functions of dictionaries in all four (4) resources. Bilingual dictionaries were explained as dictionaries targeting general learners of isiZulu in different age groups and the contents of these resources were aligned to this description. The target users were identified as English and isiZulu language learners and users thus leading to bilingual dictionaries. The researcher, after having examined the typology of these resources, created a typology for the dictionary developed in this study. The typology for the new resource is different in that the end product is not a bilingual dictionary but a bilingualised dictionary. The difference between bilingual and bilingualised dictionaries lies in that bilingual dictionaries provide equivalents for lemmata instead of definitions (Hartmann, 1994). Bilingualised dictionaries brings the function of dictionaries found in monolingual dictionaries to bilingual dictionaries. The researcher created a dictionary that provides users with an all-encompassing dictionary with English lemmata and isiZulu equivalents plus definitions and explanatory data for some terms. Laufer (1995) posits that bilingualised dictionaries relieve users from the need to consult multiple resources in order

to understand a term and calls for the development of dictionaries of this nature. Consequently, the provision of a new typology in isiZulu resources will provide users with a comprehensive resource that will not only assist in getting an isiZulu word for the English term but will provide the definition of the terms from prescribed resources translated into isiZulu.

The megastructure of a dictionary comprises of the outside matter and the main body. The outside matter consists of the front matter, middle matter and the back matter, while the main body comprises of the macrostructure and microstructure of a dictionary. The front matter of explored dictionaries explained the content to be expected in the dictionary and how to use the resource. Only one resource (OUPEZ) has middle matter which provides extra information about the isiZulu language. The back matter was also only found in some of the resources. An analysis of the outside matter of dictionaries provides an overview of expectations from a resource, as well as reference material consulted in the development of the resource. The structure of isiZulu dictionaries provides information about the user needs which makes isiZulu dictionaries resources that satisfy lexicographic functions in their position as general language dictionaries.

In the same vein, the megastructure of these dictionaries shows a macrostructure with a list of lemmata in the first half of the resource in one language and the second half in another language. The MST-NGUNI provided a different structure in that it listed terms in all languages under one entry instead of grouping them according to languages. The terms in the latter resource have English only, as the source language while the bilingual dictionaries have an English and isiZulu macrostructure. The OUPEZ began with isiZulu in the first half and entered the lexical items as full words, which is not a common practice in isiZulu dictionaries that begin with an English macrostructure and in the second half of the resource provide an isiZulu lemmata with entries added according to isiZulu grammatical practices where words are entered from the stem. Below is a sample from the SZD and the OUPEZ where different approaches to the macrostructure are demonstrated.

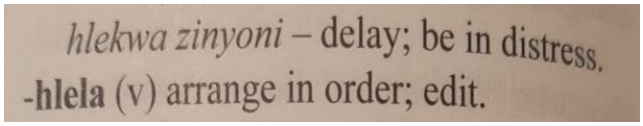

hlekwa zinyoni – delay; be in distress.
-hlela (v) arrange in order; edit.

Figure 7.1: Dent and Nyembezi (2009:426)

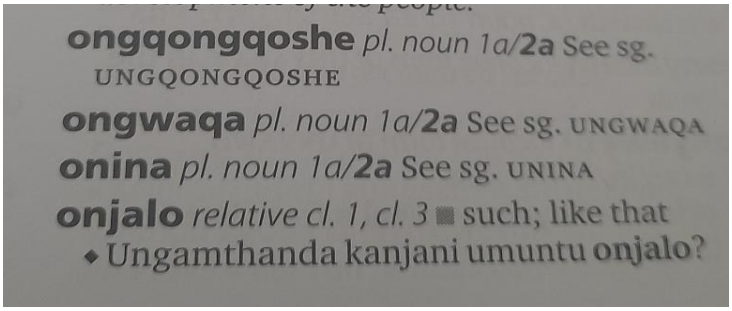


Figure 7.2: De Schryver (2015:187)

Figure 7.1 displays the microstructure of the SZD showing a macrostructure with lemmata that begins with a hyphen to show that the word is incomplete as it may take different prefixes when used, and Figure 7.2 displays a complete word from the OUPEZ. The macrostructure of isiZulu dictionaries adapted in the Life Sciences dictionary comprises of English lemmata entered in their complete form, as is the case with English words, and with its uniquely designed microstructural elements. The microstructure of isiZulu dictionaries comprises of parts of speech and equivalents with usage examples also provided. This microstructure is not imported to the Life Sciences dictionary as this resource is a bilingualised resource. The microstructure of isiZulu dictionaries does not benefit users in lexical fields specific to their studies as it only provides equivalents without explanations. Subsequently, the structure of the developed dictionary is the lemmata in English with etymological information (for some lemmata), the definition and additional information (for some lemmata). This typology will provide the user with sufficient data to explain each term according to information provided in the prescribed material. The provision of a bilingualised microstructure does not only provide the language with a new resource but it provides a remedy to terminology comprehension challenges faced by high school learners of Life Sciences.

7.3.3 Dictionary development

The last part of data analysis was a practical contribution to isiZulu lexicography by developing a new dictionary. The researcher created guidelines to serve as a framework for dictionary development (Nkomo, 2018). These guidelines were structured on the theory of lexicographic functions (Tarp, 2003) and elements featured in these guidelines include planning, the macrostructure, microstructure, translation, and development.

Target users for the new resource are Grade 10 to 12 learners of Life Sciences whose mother tongue is isiZulu. These learners have been found by the DBE and scholarly research to be faced with terminology comprehension challenges which contribute to their learning outcomes.

Therefore, the user situation and user needs were established which contributed to the lexicographic function of the new dictionary with the function to help isiZulu learners understand subject-specific terminology in their language. The profile of learners placed them as people who have knowledge and interest in the use of the internet; therefore, it was decided to produce the dictionary in the form of an e-book. The e-book can be used online and offline which is beneficial to users as they can use it at any location. This was part of the planning process of the guidelines which included a choice on the typology of the resource. Given that learners are being taught in English, and their prescribed textbooks are written in English, a bilingualised typology was decided upon as already mentioned that bilingualised dictionaries add more value to a bilingual dictionary through the addition of definitions and other semantic data relevant to each entry.

It was decided to have an English only macrostructure which lists lemmata alphabetically. This lemmata was translated into isiZulu and their definitions were also provided in both languages for learners to receive data in the language of schooling and a language they understand better to help users in their knowledge acquisition (Diko, 2018). Therefore, the microstructure of this resource comprises of two languages and in its development, if required, an intensive translation of scientific terminology that at times was not available in isiZulu. The researcher, as an experienced translator, applied translation strategies to produce a resource that will convey the text on a level that is understood and contributory to target users.

Ball and Bothma (2018) applied the theory of lexicographic functions to establish a criterion for evaluating electronic dictionaries. The current study employed this criterion and evaluated the resource to ensure that it was a valuable resource in terms of its content, relevance, complexity, detail, currency, credibility, writing style, multimedia usage, information architecture, structure, page content, editing, navigation, help and customisation. These criteria showed the resource contributes to the structure of isiZulu dictionaries by providing a comprehensive bilingual dictionary with a difference.

English into isiZulu bilingual dictionaries provide users with the lemmata equivalents rather than defining them which is common in bilingual dictionaries in many languages. The introduction of bilingualised resources by Laufer (1995) brought a new type of bilingual dictionary that envisages placing the user at a closer position of knowledge acquisition than a user of a monolingual resource. Subsequently, the developed dictionary offers the following:

- A bilingualised dictionary structure

- Translated equivalents
- Definitions for lemmata
- Etymological data
- Electronical dictionary format
- Printed dictionary format

The development of a bilingualised domain-specific dictionary is a contribution to a new type of resource that can place isiZulu mother-tongue speakers who are learners of Life Sciences at a position, of not only acquiring equivalents, but also receiving comprehensive semantic data.

The developed resource is accessible in an electronic form as it was developed to enable easy access as preferred by the users which led to the adaptation of the paper form dictionary in a freely available online resource. The study further contributes to metalexicography by the consideration of lexical semantics in dictionary development. Identifying lexical relations in dictionary development can assist lexicographers employ superordinates where there are lexical gaps provided that the resource will offer a definition and avoid using the superordinate as an equivalent for more than one entry. Consequently, the study developed a resource that will contribute to the study of lexicography and the changing language spectrum of South Africa.

7.4 Conclusion

There were five questions asked in the study with the aim of expanding the scope and function of lexicographic resources through the development of a domain-specific dictionary in isiZulu. The dictionary developed in this study is the English IsiZulu Life Sciences Dictionary. This resource was developed by exploring lexicography and isiZulu lexicographic resources to aid in the development of a new lexicographic resource.

This study analysed domain-specific terminology for pedagogical lexicographic resources with the intention of developing. *Isichazamazwi Sesayensi Yezokuphila - Life Sciences Dictionary* (ISY-LSD). Domain-specific dictionaries for learners developed for previously marginalised South African languages have been created by means of terminology exercises rather than practical lexicography, which resulted in the end products being glossaries instead of dictionaries (Nkomo, 2010). In the same vein, limited research focuses on pedagogical lexicography in South African languages (Taljard & Prinsloo, 2019). The current study sought to contribute to pedagogical lexicography through metalexicography where a theory of lexicography was explored as a guide to practical lexicography. This led to the development of

a novel lexicographic resource – a bilingualised dictionary in Life Sciences for Grade 10, 11 and 12 learners who are isiZulu mother-tongue speakers who obtain their education in English – a secondary language.

Since English is their language of knowledge acquisition at school, literature studied placed the hegemony of English over African languages as the main contributor to the language situation of South African schools. This hegemony, born from historical events that took place on the African continent and South Africa, on its own accord, contributed to Afrikaans and English being languages of trade before 1994 and currently, English being the favoured language of education and trade in South Africa. The Department of Basic Education provides mother-tongue education from early childhood until Grade 3 and has policies that allow parents to select a language that they would prefer their children to continue their learning. However, because of the unavailability of learning material in previously marginalised languages, the mentioned choice becomes impracticable since it automatically promotes learning in English or Afrikaans from Grade 4 (Mohohlwane, 2020). This places learners who are English and Afrikaans mother-tongue speakers in a better position of comprehending what they are being taught compared to their peers who are learning in a secondary language.

The study sought to contribute to the alleviation of learners' linguistic challenges by providing a dictionary that would assist learners understand scientific material in their mother tongue. As an isiZulu mother-tongue speaker, the researcher selected isiZulu as a language of focus and Life Sciences as a subject for the intervention. Naidoo (2017) states that Life Sciences is one of the subjects that isiZulu learners struggle with because of linguistic challenges, and the most common method employed for teachers in assisting their learners is code-switching between English and isiZulu when explaining scientific concepts. Another intervention in learner difficulties that can be employed is the development of dictionaries as Tarp (2008), Gouws and Prinsloo (2012), Gudula (2017), Diko (2018), Charamba (2017) and Mohohlwane (2020) pose that pedagogical lexicography and the development of pedagogical resources can elevate language problems faced by learners in their course of education.

Over the years, studies were conducted in lexicography which focused on African languages (Simelane, 2000; Nkomo, 2008; Dladla, 2021; Tshikota, 2021) by focusing on different aspects of lexicography. The objectives of the study were to investigate pedagogical lexicography in

African languages; to explore the development of a domain-specific dictionary in English-isiZulu; to examine lexical semantics in domain-specific terminology for the enhancement of lexical resources; to demonstrate the impact of digital lexicographic resources in the digital age; and to establish the expansion of the development of African languages through the development of new types of lexicographic resources. These objectives were met by responding to questions posed in the study as part of an analysis of domain-specific terminology for pedagogical lexicographic resources. Raising these questions assisted in developing a comprehensive English-IsiZulu Life Sciences dictionary, which is a novel resource in isiZulu.

Subsequently, this study focused on analysing terminology from the domain of Life Sciences. This was done under the theoretical framework of lexical semantics (Purdy, 1987; Geertaerts, 2010; Kroeger, 2018) where etymological developments of terminology and lexical relations that exist within the terms were investigated. This was necessary for the treatment of scientific terms in a manner that would lead to a translation as close as possible to the terms through an understanding of how the terms were created and which words were related to them. The development of the bilingualised Life Sciences dictionary in isiZulu for FET learners was founded on the theory in lexicography, and to this end, the theory of lexicographic functions by Bergenholtz and Tarp (2003) was selected. This theory focuses on profiling users according to their needs and situation plus the lexicographic function of the dictionary being developed. The researcher also considered translation strategies by Baker (2011) and Dlamini (2021) given that education is provided in English and the study was developing a dictionary in isiZulu.

This was a qualitative study in which primary sources were investigated in the form of document analysis for data collections. These resources were textbooks studied by learners in the subject as well as published English-isiZulu dictionaries. Textbooks were examined to extract terminology that would make up the lexical units of the developed dictionary while dictionaries were examined in order to understand the megastructure of dictionaries already developed in languages of focus. Data were analysed using the Marshall and Rossman (1999) order to create order, structure and to organise the data.

Findings of the study revealed that the structure of published dictionaries in isiZulu makes them easy to use. The major challenge with South African dictionaries is that they exclude

specialised terminology such as subject-specific terms that could benefit learners (Gouws & Prinsloo, 2012), and current dictionaries lack sufficient information because the lexicographic process has at times been mistaken for a mere translation exercise, excluding domain-specific issues of terminography and lexicography (Nkomo, 2019). Therefore, more lexicographic resources should be created on the foundation of metalexicography which would help lexicographers and terminologists develop functional dictionaries that will consider the user situation, their needs and function that they need the dictionary for. Thus, the development of pedagogical dictionaries should be guided by the genuine purpose of developing a dictionary – satisfying lexicographic needs of users.

Dictionary users range from those who use print and those who use electronic dictionaries; therefore, all users should be considered. African lexicography has tapped into the digital space with technological advances leading to the development of digital lexicographic resources such as the Zulu Lexicon and the Yoruba language dictionary, among others. South Africa has a high rate of mobile phone use which opens the door for developing digital lexicographic resources. Digital lexicographic resources are valuable tools required by users and the same can be said about printed dictionaries (Fuertes-Olivera, 2009). Printed dictionaries were the first dictionaries developed and with technological inventions digital resources have developed, however, they have not replaced the need for printed dictionaries. However, the developed resource is made available as an e-book because it will grant users free access to the resource.

This research resulted in a new resource – the English-IsiZulu Life Sciences Dictionary which is a bilingualised lexicographic resource for mother-tongue FET learners. This resource is not only a bilingual dictionary, but it includes comprehensive information. Dictionaries of this type are called bilingualised dictionaries as they go beyond the traditional provision of equivalents but also provide translated definitions for the terms (Humblé, 2001). The researcher translated the terminology and their definitions, and further added etymological data as well as additional data randomly, to the lemmata. The structure of the developed resource is similar to that of bilingual dictionaries save that the functions of the resources are different. Published dictionaries are linguistic dictionaries and have linguistic information while the developed dictionary is domain specific intended to elevate subject-specific challenges for the users. Since the dictionary was developed based on user needs and situation, the main purpose of the study

was to develop a resource that would cater for conceptual comprehension needs in learners' mother tongue.

Samples from the dictionary template form part of the study, and it is found in Chapter 6 of this research report. The dictionary will be available as a free electronic dictionary once published and will be downloadable as a free resource. The resource, once downloaded, can be used by learners and teachers from any mobile device without paying for data or connecting to the Wi-Fi. This resource is intended to assist learners find the meaning of concepts which will help them understand learning material better and be in a position to produce better results (Mji & Makgato, 2006). The burden of elevating linguistic issues of learners lies with the Department of Basic Education (Beacco et al., 2016); however, pedagogical lexicography can also play an assistive role by providing domain-specific resources for learners.

The current study demonstrated that developing new types of dictionaries necessitated by needs of users such as bilingualised domain-specific dictionaries can expand the function of lexicographic resources in African languages. These new resources will contribute to language development while helping users find the information they need. In addition, the study revealed the need for further studies to be conducted in pedagogical lexicography focusing on African languages. This would not only bring the parity of esteem afforded by the South African Languages Act (Act 108 of 1996), and language policies from the Department of Basic Education to life, but will also provide learners with an opportunity to be on an equal footing with their peers who are learning in their mother tongue.

7.5 Recommendations

In light of the findings and conclusion above, the study recommends the following:

- The DBE is currently in the process of passing the Basic Education Laws Amendment Bill (B2 – 2022) which envisages changing the language position learners are faced with, such as the addition of more than one language of instruction at public schools. The Head of Department of public schools is required to consider language requirements of societies in which schools are situated. This means learners who are in an area that speak isiZulu should be in a position to learn in isiZulu as a language of instruction should they prefer to do so. The number of people who speak a language at the school should also be considered. The Bill also states that resources, as enablers of

learning in the preferred language of instruction, should be made available by the DBE. Subsequently, the study recommends that the DBE involves lexicographers and language specialists in the production of these resources as part of solution finding measures to resolve linguistic challenges faced by learners in their education. These professionals can assist the DBE by creating lexicographic resources to be part of educational material.

- The researcher has not come across a published domain-specific dictionary in African languages for learners in the senior phase of school. This study recommends that these resources be developed in previously marginalised languages for every subject at school.
- Bilingualised dictionaries are recommended for bilingual dictionary development as this would improve the microstructure of dictionaries providing definitions and other semantic data that express the full meaning of a lemma.
- The researcher is unaware of studies conducted on definition treatment procedures in African languages. These procedures could serve as guidelines for lexicographers in developing future dictionaries.
- Digital dictionaries should be considered as important and contemporary resources that are aligned with choices of users. A study pertaining to dictionary typologies favourable to users is recommended so that developed dictionaries can lead to more dictionary use.
- Finally, the study recommends that the guidelines established in this study be considered in dictionary development by the lexicographic unit of DSAC in the development of future lexicographic resources for learners.

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Appendix

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Research Office

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)
R14/49 Dladla

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: H22/01/04**
PROJECT TITLE	An analysis of domain-specific terminology for pedagogical lexicographic resources: Towards a comprehensive English-IsiZulu life sciences bilingualised dictionary
INVESTIGATOR(S)	Mrs C Dladla
SCHOOL/DEPARTMENT	SLLM/
DATE CONSIDERED	28 January 2022
DECISION OF THE COMMITTEE	Approved Risk Level: Minimal
EXPIRY DATE	17 March 2025
DATE 18 March 2022	**CHAIRPERSON** _____ (Professor J Watermeyer)

cc: Supervisor : Dr B Zungu

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University. Unreported changes to the application may invalidate the clearance given by the HREC (Non-Medical)

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to submit an amendment of the protocol to the Committee. **I agree to completion of a regular progress report. For Minimal and Low studies, this is due annually on 31 December. For Medium and High Risk studies, this is due twice annually on 30 June and 31 December.**

_____ _____/_____/_____
Signature **Date**

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

Appendix 8-1: Ethical clearance