

**EXPLORING THE USE OF VISUAL AIDS AS TOOL TO
UNDERSTANDING SUBJECT SPECIFIC TERMINOLOGY IN
LIFE SCIENCES**

by

CARLY KING

Thesis presented in partial fulfilment of the requirements for the
degree of Master of Education in the Faculty of Educational Support
at Stellenbosch University



UNIVERSITEIT
iYUNIVESITHI
STELLENBOSCH
UNIVERSITY

100
1918 - 2018

SUPERVISOR:

Professor D. Daniels

Department of Educational Psychology

Stellenbosch University

Stellenbosch, South Africa

DECEMBER 2018

DECLARATION

By submitting this dissertation electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part been submitted it for obtaining any qualification.

Date: December 2018.....

**Copyright © 2018 Stellenbosch University
All rights reserved**

ABSTRACT

In many South African schools the language needs of an increasingly diverse and multilingual learner population presents one of the greatest challenges to teaching and learning. This challenge stems from learners being taught in languages in which they are not necessarily conversant. In a subject such as Life Sciences, the already challenging situation of trying to master basic language skills is further complicated by specialist scientific vocabulary. The identified research problem was that Grade 10 learners who are taught in a language other than their mother tongue are disadvantaged by their inability to master the terminology and basic concepts in the Life Sciences curriculum. I argued that second language students' comprehension could be improved with the use of visual materials during lessons.

A programme was implemented for a purposively selected group of Grade 10 learners using a participatory action research design. Visual aids were utilised as a tool to facilitate students' understanding of Life Sciences. Over a period of four weeks the group of Grade 10 learners taking Life Sciences and being taught in a language other than their mother tongue, took part in the programme after school. The teaching strategy introduced a variety of visual tools to facilitate comprehension during experiments and demonstrations. The aim with the visual stimulation and activities was to encourage student-centered learning. In addition, this was done to bridge the language barrier and to enable students to access information in a practical way.

The findings show that communication among learners improved through peer mediation where students helped one another to make appropriate connections. The group work subsequently stimulated interaction and provided opportunities for conversation and mediation among peers. Students took charge of their own learning, which gave them a greater sense of independence and allowed them to construct their own knowledge based on their experiences. This in turn led to improved cognition, as learners began to develop a better understanding of the subject matter, which ultimately allowed them to build more comprehensive cognitive structures and enhanced their retention of information.

OPSOMMING

In heelwat Suid-Afrikaanse skole bied 'n toenemend diverse en veeltalige leerderbevolking se taalbehoefte een van die grootste uitdagings vir onderrig en leer. Hierdie uitdaging spruit voort uit die feit dat leerders onderrig word in tale waarmee hulle nie noodwendig vertrou is nie. In 'n vak soos Lewenswetenskappe word die reeds ingewikkelde situasie om basiese taalvaardighede te bemeester verder bemoeilik deur die spesialis- wetenskaplike terminologie. Die geïdentifiseerde navorsingsprobleem behels dat graad 10-leerders wat in 'n ander taal as hulle moedertaal onderrig word, benadeel word vanweë hul onvermoë om die terminologie en die basiese konsepte van die Lewenswetenskappe-kurrikulum te bemeester. Ek voer aan dat tweedetaalstudente se begrip deur die gebruik van visuele materiaal tydens lesse verbeter kan word.

Deur die gebruik van 'n deelnemende aksienavorsingsontwerp is 'n program vir 'n groep doelbewus-geselekteerde graad 10-leerders geïmplementeer. Visuele hulpmiddels is gebruik as 'n werktuig om studente se begrip van Lewenswetenskappe te vergemaklik. Oor 'n tydperk van vier weke het die groep graad 10-leerders wat Lewenswetenskappe neem en onderrig in 'n ander taal as hulle moedertaal ontvang, aan 'n naskoolse program deelgeneem. Aan die hand van die onderrigstrategie is 'n verskeidenheid visuele werktuie bekend gestel om begrip tydens eksperimente en demonstrasies te vergemaklik. Die doel met die visuele stimulasie en aktiwiteite was om student-gerigte leer aan te moedig. Dit is ook gedoen om die taalstruikelblok te oorbrug en studente in staat te stel om die inligting op 'n praktiese wyse te bekom.

Die bevindings dui daarop dat kommunikasie tussen leerders vanweë portuurgroepbemiddeling verbeter het waar leerders mekaar gehelp het om meer gepaste konneksies te maak. Verder het die groepwerk interaksie aangemoedig en geleenthede vir gesprek en bemiddeling tussen portuurgroeplede geskep. Leerders het beheer oor hulle eie leeraktiwiteit geneem, wat hulle 'n groter onafhanklikheidsin gegee het en hulle in staat gestel het om hulle eie kennis te konstrueer gebaseer op hul eie ervarings. Dit het tot verbeterde bewussyn gelei, aangesien die leerders 'n beter begrip

van die leerstof begin ontwikkel het, wat hulle uiteindelik in staat gestel het om meer
omvattende kognitiewe strukture te bou en hulle inligtingsretensie te verbeter.

ACKNOWLEDGMENTS

I would like to thank God for enabling me to complete this process and for all the words He has given me to make my voice heard. All honor to his glorious name.

A special thanks to my parents for their unfailing love and support, especially my mom who has always believed in me and pushed me to achieve great things – thank you for everything mom!

I would also like to thank Professor Daniels for her guidance throughout this process as my supervisor as well as the Department of Educational Psychology, at Stellenbosch University for giving me the opportunity to enrich myself.

Thanks to Sunshine High School for allowing me to complete this study in their school and to the learners who participated in this study for their eagerness to always try and improve their potential.

Table of contents

CHAPTER 1.....	3
INTRODUCING THE STUDY.....	3
1.1. INTRODUCTION	3
1.2. PROBLEM STATEMENT.....	6
1.3. RESEARCH DESIGN AND METHODOLOGY.....	9
1.4. SIGNIFICANCE OF THE STUDY	10
1.5. DEFINITION OF TERMS	11
1.6. ETHICAL CONSIDERATIONS.....	12
1.7. ORGANISATION OF THE THESIS.....	13
CHAPTER 2.....	14
REVIEW OF THE LITERATURE.....	14
2.1. INTRODUCTION	14
2.2. LANGUAGE AS A BARRIER TO LEARNING	16
2.3. ENGLISH AS THE LANGUAGE OF INSTRUCTION.....	17
2.3.1. Challenges for learners who are being taught in a language that is not their mother tongue	20
2.3.2. Challenges within Life Sciences	22
2.3.3. Strategies to overcome barriers to learning for those who are being taught in a language that is not their mother tongue	24
2.4. SCIENCE.....	26
2.4.1. Useful learning theories for teaching science.....	28

2.5. VISUAL AIDS.....	32
2.6. SUMMARY	37
CHAPTER 3.....	38
RESEARCH METHODOLOGY	38
3.1. INTRODUCTION	38
3.2. THE RESEARCH PARADIGM.....	39
3.2.1. Interpretivist paradigm	41
3.3. RESEARCH DESIGN	44
3.3.1. Participatory action research	44
3.4. SAMPLE AND POPULATION.....	49
3.5. DATA COLLECTION METHODS.....	50
3.5.1. Semi-structured personal interviews	50
3.5.2. Focus group interviews.....	53
3.5.3. Observation	54
3.6. DATA ANALYSIS.....	56
3.7. ETHICAL CONSIDERATIONS.....	58
3.8. TRUSTWORTHINESS OF THE STUDY.....	59
CHAPTER 4.....	61
PRESENTATION OF THE FINDINGS	61
4.1. INTRODUCTION	61
4.2. THE PARTICIPANTS OF THE STUDY.....	62
4.3. EXPERIENCING THE PARTICIPATORY ACTION RESEARCH PROCESS	63

4.4.	INTRODUCING A NEW PEDAGOGY.....	64
4.5.	VIEWS ON BEING TAUGHT IN ENGLISH	66
4.6.	EXPERIENCING LIFE SCIENCES AS LEARNING AREA.....	70
4.7.	PARTICIPATING IN AND EXPERIENCING THE PROGRAMME	73
4.7.1.	Communication.....	73
4.7.2.	Group work.....	74
4.7.3.	Independence.....	75
4.7.4.	Practical work.....	77
4.7.5.	Improved cognition	79
4.8.	SUMMARY	83
	CHAPTER 5.....	84
	FINDINGS AND RECOMMENDATIONS.....	84
5.1.	INTRODUCTION	84
5.2.	INTERPRETATION OF THE FINDINGS.....	84
5.2.1.	Communication.....	86
5.2.2.	Group work.....	87
5.2.3.	Independence.....	88
5.2.4.	Practical work.....	89
5.2.5.	Improved cognition	91
5.3.	PERSONAL SPACE AND RESEARCHER REFLECTIONS.....	92
5.4.	RECOMMENDATIONS.....	94
5.5.	SUGGESTIONS FOR FUTURE RESEARCH	95

5.6. CONCLUSION	96
References	98
APPENDIX A: Permission forms	105
APPENDIX B: Interview guides	106
APPENDIX C: Example of the coding process	107
APPENDIX D: Example of the assent and consent form	108
APPENDIX E: Example of a transcript	109

LIST OF TABLES

Table 4.1: Biographical data.....	63
Table 4.2: Language of instruction in primary school	67
Table 4.3: Challenges of Life Sciences	72
Table 4.4: Moving to independence	76
Table 4.5: Views on cognition	81

LIST OF FIGURES

Figure 3.1: The PAR process spiral of self-reflective cycles.....	48
Figure 4.1: Example of model building activity	65
Figure 4.2: Example of practical activity	65

CHAPTER 1

INTRODUCING THE STUDY

1.1. INTRODUCTION

Language is one of the most powerful tools that is used to convey meaning and to communicate. So too it can just as easily be one of the biggest stumbling blocks to communication. In many urban South African schools, language presents one of the greatest challenges to teaching and learning for both teachers and learners. This problem is amplified by constantly changing classroom demographics as more people migrate from rural areas, other provinces and other countries in search of better schools and opportunities for their children. Accordingly, classes are being occupied by an increasingly heterogeneous population. In addition to South Africa's 11 official languages, this increasing diversity has resulted in many more languages being spoken by the South African school learner population. Even so, the Language in Education Policy document (Department of Education, 1997) states that within the South African school environment, only English or Afrikaans is being used as the medium of instruction. In a multilingual classroom, this situation could present many challenges for teaching and learning.

The context for this study was the Life Sciences classroom where, in addition to competency in the medium of instruction, a command of scientific language is needed to engage effectively with the subject content. Learners who are being taught in a

second or third language and who lack technical scientific knowledge experience a double disadvantage. The language of science refers to the specialised language as well as the unique linguistic devices used within the scientific discipline (Seah, Clarke & Hart, 2014). Mastering the language of Science with its specialised terminology and unfamiliar words (Ferreira, 2011) through a medium of instruction that the learner has limited competencies in can be a very daunting task.

This problem of understanding Life Science is amplified for newly immigrant and migrant learners to the Western Cape whose home language is not English, the medium of instruction for the study's research population. Research by Carrier (2005) shows that because learners whose language of learning is not that of their mother tongue, but which still requires from them to attain basic literacy skills, presents an enormous challenge. Adding to this the learner then has to acquire an affinity for the language of science which makes learning the content that more difficult. At the same time as trying to acquire literacy skills, learners are also required to master the many scientific processes within the classroom, which include locating information in scientific texts and then using the information to interpret and apply it to certain scientific scenarios. Learners should be able to ask and answer questions, describe and explain phenomena, and make predictions, which is all required in a language that they are neither fluent in nor familiar with, and so causes a language barrier (Carrier, 2005). Omar (2012) states that this problem is intensified by the different connotative meanings of words for different cultures. As such, I anticipated that these learners would struggle with the renaming and recontextualising of everyday words within science contexts as

these processes involve linguistic, conceptual and cognitive shifts that are difficult for these learners to make (McCallum & Miller, 2013).

As a life Science teacher, my goal is to be an effective enabler of learner participation in scientific processes through my use of an appropriate teaching strategy. In my exploration of and search for supportive alternative methodologies, I started looking into the incorporation of visual media tools to facilitate learning. Recent research by Turkoguz (2012) shows that when learners are able to visualise abstract concepts, it allows them to adapt their existing knowledge based on the newly acquired knowledge. With regard to chemistry concepts, such as molecular structures, Turkoguz (2012) states that the use of visual imagery such as videos and animations can be very effective. His findings suggest that learners understand symbolic representations better because they can visualise them and thus can construct accurate mind models (Turkoguz, 2012). His study shows that visual aids therefore help to clarify details and concepts, which can stimulate interest in learning. It increases learners' critical thinking and problem-solving skills as well as their social skills in terms of group discussions (Turkoguz, 2012). These skills are the cornerstone of learning science as learners are required to think critically about how different processes work and to figure out what they are observing. Visual aids can thus stimulate communication and promote learner-centred learning (Turkoguz, 2012).

Israel, Maynard and Williamson (2013) state that learner-centred, collaborative learning is needed to effectively understand science. An example of this strategy in the literature includes using investigations and practical work to clarify concepts. According to this approach, learners engage with the subject material by doing experiments or looking at

demonstrations by the teacher. Israel et al.'s (2013) approach was useful in this study to improve the active participation of learners in an attempt to eliminate language barriers. It enabled learners to communicate about what they are doing and observing, which according to Ferreira (2013) improves understanding. The use of micro science kits was found to be useful when each learner was given a kit containing a variety of miniature laboratory apparatus. Her study found that the kits enabled the learners to do their own experiments, making their engagement more effective.

As such, the research that I undertook was to study how the use of visual media tools could enhance the learning process for learners of science who were taught in English, which is not their mother tongue.

1.2. PROBLEM STATEMENT

At Sunshine High School (a fictitious name for the research school) in the Western Cape, the majority of its learners have as their mother tongues isiXhosa, Afrikaans and a variety of other African languages. This former Model C, traditionally Afrikaans school became a dual-medium school when its learner population became racially, ethnically and linguistically diverse. For Grades 8 and 9, students are placed in an English or Afrikaans medium class. From Grade 10 to Grade 12, however, all content subjects are taught in dual-medium classes. This could be quite challenging for students whose home language is neither English nor Afrikaans. When teachers switch to Afrikaans, learners who have no competencies in Afrikaans are doubly disadvantaged, as they cannot follow what is being said, nor can they participate in discussions that flow from the lesson. It has been my experience as a teacher at the school, that many of these

students are not yet conversant in English, even though this is the language that they are receiving their education in. This can create barriers to their learning and their understanding and may cause them to underachieve. I found that such learners were more likely to struggle academically with a content subject such as Life Sciences, which I teach. In 2016, the average percentage in Life Sciences for Grade 10 learners whose home language is not English was 36%. I attribute this poor performance to their lack of comprehension of the written prescribed text and the difficulty of understanding abstract concepts in a second or third language for the learner.

How well learners are able to perform academically depends on their ability to understand the subject material. Their ability to understand is greatly influenced by their ability to communicate effectively. But what happens to those learners who struggle to communicate effectively because the language of instruction is not a language that they think in and communicate with? Are they given a fair opportunity to reach their true potential if they do not understand the language that is being used?

As a Life Sciences school teacher, I experience this problematic situation every day. I have to explain scientific phrases to learners, but they do not understand the words or language concepts. The learners become frustrated, and they tend to give up. The language barrier is thus not only confined to the language classrooms; it also influences their academic performance in the Life Sciences.

The context for this study was the Grade 10 Life Sciences classroom. Grade 10 is the first year of the senior phase, a year that is deemed important as all knowledge gained about Life Sciences during this year becomes the foundation on which all further

knowledge is built in the last two years of high school. A proper understanding of concepts is thus essential to achieve success in Grade 12. The study was delimited to 12 learners who seemed to be struggling with Life Sciences. All of them were included as participants as I considered it unethical to exclude some of them from the sessions.

Given the learners' struggle to master abstract terminology and concepts in Grade 10, this study sought to explore how learners' understanding of Life Sciences could be improved through the introduction of visual aids. The aim was to explore how visual aids could serve as a tool to bridge the language barriers as visual aids do not require a specific language for understanding an action or concept in Life Sciences that learners struggle with (Daniels, 2006).

Currently, there are very few studies on effective teaching strategies for Life Sciences, when teaching learners whose first language is different from the medium of instruction. The contribution that this study thus could make is to report on the experiences of participants who are taught in a language that is not their mother tongue with the use of visual teaching aids as facilitator of their understanding of Life Sciences.

The study was guided by the following research question: How can the use of visual aids in the Life Sciences class aid learners' who are non-native speakers of English?

The sub questions that the study posed were the following:

1. What are the academic challenges that learners who are taught in a language that is not their mother tongue, experience with the Life Sciences curriculum?
2. How do cognitively appropriate visual aids facilitate learners' understanding of Life Sciences?

The objectives of this research were as follows:

- To determine what learners struggled with in Life Sciences.
- To understand how the use of visual aids could enhance the learning of learners in Life Sciences.

1.3. RESEARCH DESIGN AND METHODOLOGY

I conducted a qualitative investigation because I wanted to understand the lived experiences of Grade 10 participants who were taught in a language that was not their mother tongue. Qualitative research' is the term used for a research process that describes social phenomena and interactive processes (Neuman, 2011). Though I work within an interpretivist personal paradigm, it borders on the critical because of my consideration of linguistic and ethnic backgrounds of the participants. An interpretivist approach aims to explain the personal reasons and meanings that make up social action (Terre Blanche & Durrheim, 1999). I undertook participatory action research (PAR) as it involves a process wherein action and reflection work together in an attempt to improve practice (Cohen, Manion & Morrison, 2011). As a teacher researching my own practice and seeking to make better choices about pedagogy, I found that the design was suited to what the study aimed to do, which was to address the challenges that learners face mastering abstract scientific concepts in Life Sciences in order to improve the teaching of Life Sciences (Ebersöhn, Eloff & Ferreira, 2007). Hence, this research design enabled me to confront the specific practical challenge of learners' understanding of abstract scientific concepts and created a platform where I could systematically analyse visual aids as a possible solution in a cyclical manner.

The population for the study were Grade 10 learners at Sunshine High School, of which 12 participants from an English class were purposively selected. The criteria for their selection were that their mother tongue was a language other than English or Afrikaans and that their marks were below 30%.

The data were collected by using three methods. These included semi-structured personal interviews, focus group interviews and observations. I made use of semi-structured interviews and focus group interviews as my main data collection methods. The semi-structured personal interviews were held at the beginning of the four-week programme, and a focus group interview was held at the end of each class session as well as at the end of the four-week programme to gather information on the participants' experiences of the intervention programme.

I was guided by Miles, Huberman and Saldaña's (2014) three components of data analysis, namely data condensation, data display and drawing conclusions. This study used the creation of themes and clustering as tactics to draw conclusions by grouping similar data together under correlating themes to ultimately denote meaning (Miles et al., 2014).

1.4. SIGNIFICANCE OF THE STUDY

The significance of this study lies in its potential to generate knowledge about the use of visual aids as a tool to help academically struggling learners who are taught in a language that is not their mother tongue to understand Life Sciences. The findings of the study could inform teaching practice and pedagogy that Life Sciences teachers could use to provide learning support to these learners.

1.5. DEFINITION OF TERMS

The following definitions were assigned to terms to ensure understanding and uniformity throughout the study:

English Second Language (ESL) learners:

ESL learners are learners whose home language is a language other than English (Nel, 2011).

Practical work:

In this study practical work refer to activities and experiments that use apparatus to investigate the practical components of science as described in the scientific method.

Science:

Science encompasses a systematic way of searching for answers and connecting ideas that is achieved by using specific methods that attempt to be objective and systematic in nature. It includes formulating hypotheses, designing investigations, carrying out those investigations to test the formulated hypotheses as well as careful examination of methods and analysis of results (Department of Education, 2011). This study focused on the subject Life Sciences, which is a subdiscipline under science.

Life Sciences:

Life Sciences is the scientific study of living organisms from their molecular structures up to and including their interactions with their environment and with each other (Department of Education, 2011).

Visual aids:

Visual aids are any material used to illustrate or to provide a visual representation of information such as but not limited to drawings, models, micrographs, slides and demonstrations. My use of the term throughout this study signified a more practical application and refer to various apparatus and model-building techniques used to illustrate concepts.

1.6. ETHICAL CONSIDERATIONS

All aspects of the research process were conducted in a respectful manner that carefully considered the rights and dignity of each participant. The participants were adolescents between the ages of 15 to 17 years. These participants were potentially a vulnerable group because they were learners who were taught in a language that was not their mother tongue. Ethical considerations included asking permission from the Western Cape Education Department, the principal of Sunshine High School and the Research Ethics Committee to conduct the study in the school environment (See Appendix A for these forms). Parents gave permission for their children to participate in the study and completed a consent form as the participants were under age. The adolescent participants were informed about the nature and purpose of the study, their rights as participants and that they were allowed to stop taking part in the study if they did not want to continue. They were ensured that all information would be kept confidential. All relevant documentation was kept on a password-protected computer that only I had access to.

1.7 ORGANISATION OF THE THESIS

This thesis is presented in five chapters. In Chapter 1 I introduced the study. I presented the problem statement, which includes the research question, research objectives and research design and methodology. I stated why this study was important to undertake and provided definitions for terms that are used often in the thesis. The ethical considerations that guided my decisions were explained. In Chapter 2 I report on the review of literature pertaining to the research problem, which includes second-language learning and its challenges, learning Life Sciences and its challenges and the relevance of visual aids as a tool to enhance understanding. Chapter 3 presents the methodology and procedures used to gather data. Chapter 4 presents the study results and the analyses thereof. Chapter 5 presents a summary of the study and its findings, conclusions drawn from the findings, a discussion of the findings and recommendations for further study.

CHAPTER 2

REVIEW OF THE LITERATURE

2.1. INTRODUCTION

In this chapter, I present the literature that informed the theoretical framework for the study. The role of the literature review process is to develop an understanding of research that has been done on the phenomenon and to identify gaps in the research. I engaged with the process to frame my conceptual and theoretical thinking about learners who were being taught in a language that was not their mother tongue, the role of language in effective learning and the use of educational tools that could facilitate educational outcomes. The literature also informed my decisions about the methodology for the study.

South African classroom demographics have changed in the last decade. This can be attributed to a myriad of factors including foreign families settling in South Africa due to their countries' unstable economies and families emigrating to South Africa in search of safety from war. Hiralal's (2015) research on immigration distinguishes between push and pull factors, with push factors referring to those factors that convince people to leave their country and pull factors referring to those factors that encourage people to move to another country. In many of our neighbouring countries, push factors that motivate people to leave include factors such as violence, unstable political situations, lack of economic opportunities, poverty and poor educational facilities. Pull factors that persuade people to move to South Africa include factors such as good educational

facilities, proper infrastructure and better economic opportunities (Hiralal, 2015). I argue that both factors led to an influx of immigrants into South Africa and increased the diversity and range of learners in the classroom.

The migration of South Africans from rural to urban settings has also been a contributing factor in urban school diversification. Cross, Mngadi and Mbhele (1998) explain migration from rural areas to urban areas as motivated by high expectations of better work opportunities and wages, improved infrastructure and improved service delivery. Many learners in South African schools can be classified as internal circular migrants as their parents send them to urban schools although they still reside in rural areas. The parents are in search of better opportunities for their children. These learners then travel back and forth between these two areas for school and various familial obligations.

Moreover, Nel (2011) states that parents prefer their children to attend English medium schools even when they are not English mother tongue speakers. Their reasons for doing so are grounded in a view that English is the language of the world and would offer their child more prestige and better educational opportunities. All of the aforementioned factors lead to classes that are heterogeneous in nature, consisting of learners from different cultural backgrounds speaking many different languages.

The Language in Education Policy (Department of Education, 1997a) states that schools can decide on their own language policy, leaving them free to choose their own language of learning and teaching. Although the policy encourages schools to use the learners' home language, English and Afrikaans continue to be the medium of

instruction for almost all South African schools. This can be problematic for learners who come from backgrounds where other languages are spoken in the home. The policy ultimately fails to accommodate the multitude of home languages of learners in South African classrooms. Furthermore, many learners fall behind in their schoolwork or struggle on their own to overcome this barrier to learning.

2.2 LANGUAGE AS A BARRIER TO LEARNING

South African education faces many challenges concerning effective teaching and learning. One such challenge is language. Language presents a challenge to South African public schools as there are 11 official languages that have to be considered as well as many unofficial languages that South Africa's learner populations speak.

This study embraced Whong's (2011) view of language as a function as opposed to language as a form and therefore adopted a functionalist view of language. Language in terms of function serves to facilitate interactions amongst people as opposed to only reporting on the structure of the language itself. This view engages with language as dependent on the context in which it is uttered, and this has to be taken into account when trying to make meaning and connect ideas. A functional approach to language also considers the underlying meanings of words beyond their literal meanings (Whong, 2011). Describing language in this manner supported the purpose of this study, which was trying to help learners to understand meaning.

Language is a multifaceted and complex process that according to Dednam (2011) can be described as the process of using a set of symbols in a specific manner for the purpose of making meaning and to enable a person to describe this meaning to others.

Dednam (2011) further states that the process of language consists of various dimensions, namely form, content and function.

The dimension of form refers to the system of rules that governs all languages and includes the components of phonology, morphology and syntax. The dimension of content, also known as semantics, refers to the meaning of words in a specific sentence and consists of four forms, namely lexical semantics, sentence semantics, semantic relations and interpretive semantics. Lastly, the dimension of function, also known as pragmatics, has to do with the use of language. It describes the way in which people alter the use of language to correspond to the conversational requirements of different contexts and includes the nonverbal expressions of the person in different situations (Dednam, 2011). It is this wide range of factors that are involved in having a specific language of instruction that creates barriers for second-language learners within the South African school context.

2.3. ENGLISH AS THE LANGUAGE OF INSTRUCTION

McKay and Rubdy (2009) describe South Africa as a diglossic community. This means that the country has more than one official language and that the majority of the population are bilingual. According to this description, the different languages serve different purposes with only one language, in this case English, being used in formal domains such as education and work while the other languages are used in informal domains such as the home and community. McKay and Rubdy argue that home languages end up being marginalised in the school system, creating impressions of inferiority of such languages. They also state that the lack of materials and resources in

these languages when compared to those available in English can impede the educational progress of second-language users of English in the school system (McKay & Rubdy, 2009).

Hummel (2014) states that the acquisition of a second language refers to the learning of another language after the acquisition of a first language. In the context of this study, the learners were receiving their education through the medium of English. However, English was not their first language. For some it was also not even their second language or a language that they communicated in at home. This means that their acquisition and usage of English was for the purpose of facilitating their learning in a school context only.

According to DeKeyser (2009), second-language learners have, apart from the knowledge that they transfer from their first language, a variety of different kinds of second-language knowledge. He states that they have procedural and declarative knowledge, explicit and implicit knowledge, and knowledge of rules and items.

Declarative knowledge, according to DeKeyser (2009), is factual knowledge and can be divided into semantic memory and episodic memory. Semantic memory denotes words, facts and knowledge of concepts while episodic memory refers to the knowledge associated with events that were experienced. Procedural knowledge is knowledge of how to do certain things and can include psychomotor skills or cognitive skills. With regard to the learning of a second language, DeKeyser (2009) suggests that there should be a shift from relying on declarative knowledge to relying on procedural knowledge. However, DeKeyser (2009) points out that second-language learners tend

to struggle more with grammar than with vocabulary. This would suggest that the grammatical or procedural system is less accessible to them than the lexical or declarative system. I argue that for science, a much more specialised vocabulary is required and therefore declarative knowledge is necessary for procedural knowledge to be applied in practice.

The second language-learner has both explicit and implicit knowledge. Explicit knowledge refers to knowledge that one is consciously aware of and can therefore access. This type of knowledge can be verbalised if the person has the cognitive and linguistic means to express the knowledge clearly. Implicit knowledge, however, cannot be verbalised as it is outside of awareness; it can only be inferred from behaviour. For second-language learners, the degree to which they are aware of the grammar knowledge that they possess will depend on the formalised training that they received in learning the language. According to DeKeyser (2009), second-language learners can either display implicit knowledge by knowing that a sentence is wrong although they do not know why or they can display explicit knowledge by applying certain linguistic behaviours that they were taught.

Research shows that second-language learners store chunks of high-frequency word forms as an item that can then be retrieved much faster rather than necessarily learning the rule. Thus, they have knowledge of items that are used most and they remember these forms accurately. However, when confronted with low-frequency forms, they do not always know how to apply the rule, being used to only recalling items, and fall back on the high-frequency word forms. These items may be grammatically inappropriate, leading to errors, or the learner could be expressing certain word forms that do not

convey the meaning that he/she intended to convey, ultimately leading to challenges (DeKeyser, 2009).

2.3.1. Challenges for learners who are being taught in a language that is not their mother tongue

Research shows that there are many challenges experienced by learners who are being taught in a language that is not their mother tongue. According to Hummel (2014), second-language acquisition is different from acquiring a first language. This needs to be taken into account when working with second-language learners as there are some challenges that arise from these differences.

Learners learning a second language are already equipped in some way to reflect on and use language as a tool for thought as they have already gone through the fundamental cognitive stages of language learning and development. They therefore have metalinguistic awareness and most probably prefer a certain method for learning language that needs to be taken into account (Hummel, 2014).

Learners already have a linguistic system in place that they can use to communicate effectively. However, it is not in the language that is used as the medium of instruction. Having to learn a second language can have emotional and affective challenges for learners. Using a language other than their strongly rooted native language, for example in the case of immigrant learners, can lead to feelings of exclusion as these learners' deeply embedded emotions are already linked to their first language. They might experience an increase in anxiety when having to speak in a language that they have not yet fully mastered (Hummel, 2014).

When learning a second language, the already-established first language can influence the learning process either negatively when learners have to depend on interference or positively when transference occurs. Through interference, the first language leads to errors in the second language while in the case of transference, the structures used in the second language correlate with those used in the second language and therefore support the learning process (Hummel, 2014).

Hummel (2014) further states that social expectations tend to be high when second-language learners are older and therefore expected to be able to communicate accurately. These learners are also used to being able to communicate effectively in their first language and become frustrated when they struggle to express themselves correctly in their second language.

Another difference that needs to be taken into account according to Hummel (2014) is the context in which a second language is learned. Second-language learning normally takes place in an educational setting and is facilitated by a teacher. As teachers' methods and preferences differ, the focus of different learning outcomes may also differ and this influences the content that the learner will be exposed to. Learners might therefore learn certain linguistic features rather than others, especially if also taking into account the previously mentioned preference of the learner for certain methods of instruction. Related to this aspect of context, Hummel (2014) further states that the amount of time that learners are exposed to their second language is limited and that this also influences the learning and understanding of the second language.

2.3.2. Challenges within Life Sciences

The literature on learning Life Sciences through a language that is not the learners' mother tongue identifies many challenges (Dong, 2002; Department of Education, 2011; Ferreira, 2011). Dong (2002) describes scientific concepts as complex and situated within a body of knowledge that is not known to all. Some of the science examples and texts are culture specific and might be unknown to learners from different cultural backgrounds. When second-language learners have not had much exposure to these scientific texts, it may result in misconceptions when trying to build basic knowledge. My review of the literature on how language impacts on the Life Sciences class showed that there were many challenges. In a South African context, Life Sciences is classified according to the Curriculum and Assessment Policy Statement (CAPS) (Department of Education, 2011) as the scientific study of living organisms. Ferreira's (2011) research shows that the challenges experienced by learners who are being taught in a language that is not their mother tongue are amplified in science education. This is because science education requires the use of a specialist vocabulary and linguistic devices adapted specifically for this subject, something that is referred to as 'the language of science'. To be able to achieve success in science, learners should be able to engage in the appropriate scientific discourse and extend their knowledge beyond basic vocabulary. They are thus required to be scientifically literate to be able to navigate science (Ferreira, 2011).

Seah et al. (2014) propose that learning the language of science requires learning the language at a lexicogrammatical and structural level. The lexicogrammatical level includes the grammar, semantics and lexicon that accompany the language, with

lexicon referring to the stock of words that make up a language while the structural level refers to the different structures involved in scientific texts.

Focussing on the lexicogrammatical level, Seah et al. (2014) argue that the technical specialist vocabulary of science could be experienced by learners as problematic, especially when they struggle with interlocking definitions and semantic discontinuity. 'Interlocking definitions' describes the properties of everyday words that are assigned new meanings within a science context while 'semantic discontinuity' describes the interrelationship among words that has to be internalised as well as the meaning of each word individually. The interrelationship might differ from the individual meaning, and this could complicate learning. Another concept on the lexicogrammatical level that could be difficult for learners is nominalisation. This refers to the process whereby a verb is remodelled into a noun, which leads to a whole new set of possible word meanings and descriptions. Seah et al. (2014) point out that a challenge that is unique to this subject is the higher density of words than one would use in everyday language and expressions.

On the structural level, learners are faced with various generically structured formats and frameworks used in science, for example practical reports and explanations. One could argue that learners who do not have a wide range of language skills will not be able to properly describe scientific processes due to their limited command of language (Seah et al., 2014).

My personal stance as a teacher is that it is prudent to be able to effectively support learners who are being taught in a language that is not their mother tongue through the application of appropriate strategies.

2.3.3. Strategies to overcome barriers to learning for those who are being taught in a language that is not their mother tongue

The literature presents various strategies to overcome barriers to learning for learners who are being taught in a language that is not their mother tongue. According to Berg, Petrón and Greybeck (2012), there are certain strategies that teachers can use when working with learners who are being taught in a language that is not their mother tongue, such as understanding the academic background of learners. If a teacher knows the academic background of a learner, the teacher is able to better plan teaching strategies to facilitate understanding of new content (Berg et al., 2012).

Making use of meaningful instruction is also an important strategy. This can be accomplished by connecting new information with the learners' real-life experiences and using examples and objects that they are familiar with. It also requires the teacher to constantly check whether learners understand concepts by making sure that they understand the language used to frame the concepts. This is especially important for the ESL learner as these learners are often unfamiliar with the different connotative meanings of words because they can vary in different cultures (Omar, 2012). Besides being meaningful, instruction should also embody the culture of the learners by using materials that reflect their values and beliefs. Being mindful of cultural behavioural

differences is imperative, and therefore expectations should be stated clearly to avoid cultural mismatches from occurring (Berg et al., 2012).

Another strategy is to foster peer interactions whereby learners are permitted to ask others who speak their language questions and discuss content. By pairing and grouping second-language learners with learners speaking English as home language, peer interaction can provide access to learning English and increase participation (Berg et al., 2012).

There are also certain strategies regarding teachers' language use that can reduce second-language challenges, such as speaking slower, pausing after sentences to allow learners to process the information, enunciating clearly, limiting idioms and cultural references, and supplementing spoken words with written words (Berg et al., 2012).

Other strategies proposed by Berg et al. (2012) include making written materials more comprehensible by drawing attention to headings and explaining how to analyse diagrams. For science texts, it might be beneficial to break up long texts into sections and to have groups summarise or relay the information to each other. Berg et al. (2012) argue that the focus should be on content and not on form, so teachers should mark some common grammatical errors but still give content the majority of the mark weighting. Especially in Life Sciences, the spelling of difficult words is complex and learners struggle to memorise them; they tend to rather focus on what the word means and on using it correctly in their answer than on the precise spelling.

The literature also states that different strategies are used by second-language learners in an attempt to overcome language as a barrier to learning. Ringbom and Jarvis (2009) believe that learners try to establish links between their home language or current store of language knowledge and the language that they are trying to learn and to find similarities that they can transfer from one language to another. Through this action many errors can occur, however.

According to Poole (2011), second-language learners have shown the ability to use two strategies concurrently when trying to overcome online second-language reading barriers. He proposes that they most often use paraphrasing, and if that fails, they will immediately turn to the use of a dictionary in an attempt to comprehend text and overcome reading difficulties. He further states that the ability to paraphrase depends on the learners' current vocabulary, and therefore a focus on learning how to utilise dictionaries effectively to enhance vocabulary must be emphasised (Poole, 2011). What is clear from the literature is the importance of effective educational strategies to facilitate comprehension and learning for learners who are being taught in a language that is not their mother tongue.

To develop a clear understanding of what science entails, I reviewed the relevant literature on this discipline specific to the Life Sciences classroom.

2.4. SCIENCE

Martin (2012) defines science as all the processes that produce knowledge and distinguishes two factors, namely products and processes. According to this definition, products include concepts, facts, laws, theories, attitudes and applications that occur as

a result of undergoing scientific processes. Processes include asking questions, taking measurements, making observations, collecting data, organising and interpreting data, formulating and testing hypotheses, predicting the outcome when manipulating one variable while keeping the others constant, inferring reasons for what is observed, developing experiments and communicating models to others. Martin (2012) further states that these processes can be divided into two groups: basic processes and integrated processes. Basic processes involve observing, classifying, communicating, measuring, predicting and inferring while integrated processes involve identifying and controlling variables, formulating and testing hypotheses, interpreting data, defining operationally, experimenting and constructing models.

In a South African context, science is classified according to the CAPS (Department of Education, 2011) as a systematic way of searching for answers and connecting ideas. This is achieved by using specific methods that attempt to be objective and systematic in nature and includes formulating hypotheses, designing investigations and carrying out those investigations to test the formulated hypotheses. More specifically, the major processes and design skills that learners should develop in Life Sciences and as stipulated in the CAPS document include acquiring knowledge by accessing different sources of information, selecting key ideas, recalling facts and describing various concepts and processes. Throughout this process, learners should build conceptual frameworks, develop flow charts, make use of summaries and reorganise knowledge to develop a new understanding. This will allow learners to use information in new ways and enable them to apply knowledge to unfamiliar contexts. It includes learners' having to analyse and critically evaluate information in such a way that it allows them to

recognise relationships, identify assumptions and categorise information. Following this, learners should be able to plan investigations by learning how to follow instructions, handle equipment, make observations and measure so that they can record data and interpret results (Department of Education, 2011).

According to Israel et al. (2013), a strong foundational understanding in science is necessary to enable learners to make informed decisions about the scientific factors that affect their lives on a daily basis.

2.4.1. Useful learning theories for teaching science

My review of the literature showed that the teaching and learning of science occurred most effectively when approached from a constructivist perspective. According to Donald, Lazarus and Lolwana (2010), constructivism is a theoretical perspective that aims to explain how learning and development take place. Constructivism states that knowledge is not merely passed on but needs to be actively constructed and reconstructed and happens as an individual moves to higher levels of understanding. The process is based on certain key concepts, namely active agency, social construction of knowledge, metacognition and tools of cognition (Donald et al., 2010).

Donald et al. (2010) distinguish between active agency as knowledge being constructed actively by an individual or constructed through the mediation by others and social construction of knowledge, which refers to knowledge that is constructed in social contexts. The concept of metacognition denotes thinking about thoughts and being critically aware of thoughts, which help individuals to reach higher levels of cognition because of the ability to change ineffective cognitive constructs. Tools of cognition

describe those tools through which individuals are able to actively change and reflect on experiences and include languages, forms of writing and mathematical notations, for example. These tools shape the way in which individuals think and determine the cognitive structures that are formed (Donald et al., 2010).

Constructivist teaching is informed by Piaget's (1946) and Vygotsky's (Rieber, 1998) theories. Piaget's theory advances an understanding of cognitive development as an actively ongoing process of interacting with and adapting to the world by organising and reorganising experiences and information to construct internal structures for understanding (Piaget, 1946). This process happens through the continuous interaction of three processes, namely assimilation, accommodation and equilibration. Piaget describes assimilation as the process whereby new information is interpreted and grafted into current cognitive structures. This is necessary to ensure the continuity of structures and the integration of new content into these structures. Assimilation, however, is never present without accommodation. Accommodation refers to the process of modifying any current cognitive structures based on the newly assimilated content (Piaget, 1946). As the new content is contradictory to the current cognitive structures, accommodation allows for the adjustment of these structures to accommodate the new information. Piaget (1946) further states that cognitive adaptation involves equilibrium between these two processes and refers to this as equilibration. He defines it as a process of self-regulation whereby the individual takes these altering external expansions, caused by assimilation and accommodation, and balances them with different cognitive structures.

According to Schunk (2012), equilibration is an internal process that needs to be triggered by creating a situation of disequilibrium. He defines this as any situation that does not match the individual's current internal cognitive structures, requiring the individual to assimilate and accommodate the new experience so that equilibrium can be reached. This results in the construction of new knowledge. Schunk cautions, however, that disequilibrium should never be too great, otherwise equilibration will not take place. Within the Life Sciences class, learners who are being taught in a language that is not their mother tongue might experience disequilibrium that is too great, which might cause them not to be able to assimilate and accommodate the new experience but rather to lose focus.

Vygotsky's sociocultural theory (Rieber, 1998) describes cognitive development as the process of acquiring certain behaviours as a set of assimilated actions from the people around the individual. These actions are transferred from the external environment via different role players and institutions to the individual's internal cognitive structures by voluntarily directing the individual's attention. This allows transformation to take place based on shared interactions with others who already required the necessary cognitive tools to construct knowledge. It enables individuals to change their current cognitive structures and to develop new ones in a process known as mediation.

Within this process of cognitive development, Vygotsky describes the importance of mediation taking place in the zone of proximal development. This denotes an area where an individual does not yet have the ability to construct knowledge but will be able to understand with a slight bit of interaction with and guidance from another person or mediator, normally a more developed peer or an intellectual superior (Rieber, 1998).

The mediator, be it parent, guardian, teacher or peer, therefore helps the individual to breach the gap between what he/she knows and does not know by helping him/her to make the appropriate connections. During this process of social interaction, the individual has to actively engage with the construction of meaning and adapt his/her own cognitive structures. It should be approached as a purposeful process that needs to challenge individuals' understanding and to aim to lift an individual to higher levels of understanding information more effectively. In this study I wanted to understand how the use of visual aids can mediate the effective engagement of learners in their zone of proximal development to enable the effective adaptation of their cognitive constructs.

Piaget's and Vygotsky's theories support my argument that constructivist teaching can be very useful when teaching science in multicultural learning contexts. I also support the view of Martin (2012) that learning science is a process that requires the construction and reconstruction of previous ideas and theories. Within this process, the role of the teacher is to enable learners to make their own connections and to internalise their own unique meanings by leading them through a range of activities through which they can experience the information for themselves and come to appropriate conclusions.

Some characteristics of constructivist teaching that are important when teaching science (Martin, 2012) were mirrored in my study through the use of visual aids. My paradigm was informed by constructivist teaching that encourages learners to take initiative, engage in discussions, ask and respond to questions and then allow these responses to guide the lesson. To enable these processes, teachers ask open-ended and thought-provoking questions on which learners have to elaborate, which requires

teachers to be capable of shifting instructional strategies and change content as needed. Teachers ascertain learners' understanding of concepts before they give their own and then use primary information sources with interactive and physical materials while using cognitive terminology specific to the science class such as classify, analyse and predict. They involve learners in experiences that can trigger disequilibrium of their initial hypotheses, encourage discussions and always allow some time for thought after asking a question or completing a section of work. Teachers also allow time for learners to construct relationships and metaphors and encourage the natural curiosity of learners (Martin, 2012).

The literature on learning theories that are underpinned by constructivist leanings informed my thinking and my decision to research the use of visual aids to provide support for learners who were being taught in a language that was not their mother tongue in the Life Sciences classroom. I presumed that visual aids could promote the constructivist teaching of science, which would encourage a better understanding of Life Sciences as learning area. Visual aids also do not require the decoding of difficult words and phrases that second-language learners struggle with.

2.5. VISUAL AIDS

The literature on visual aids identifies it as a bridging tool in contexts where there is no mutually spoken language to communicate with (Daniels, 2006). In educational contexts, visual aids can become a valuable educational tool to the teacher to strengthen learner comprehension of complex terminology. Daniels (2006) argues that visual aids are non-threatening tools as they do not depend on a specific language and

are thus less daunting for the learner who is being taught in a language that is not her/his mother tongue, and when exposed to unfamiliar learning concepts. The literature reflects many different interpretations and uses of the term 'visual aids'. My use of the term throughout this study signified a more practical application whereby various apparatus and model-building techniques were used to illustrate concepts.

Many recent studies, however, have focused on visual aids as they apply to e-learning and the use of various smart devices and software. Moore (2015) suggests that visual communication is used by classroom instructors in many forms, including drawing diagrams and pictures and even using their own hands as props to try and illustrate various concepts. Moore further states that all of these forms must be recreated digitally to accommodate the age of e-learning that has dawned for education and that, based on the literature, currently makes up the largest part of visual teaching methods. Within this recreation, still and moving images should be included by sourcing different images, videos and animations from different books and online sources and creating images and animations by using various graphics and software programs (Moore, 2015). Although all of this information is based on the perspective of using computer technology as visual aids, there are some applications that Moore (2015) talks about that I argue can be transferred to other forms and uses of visual aids as well. Animations and videos, for example, can be helpful to illustrate certain scientific processes and to demonstrate actions. These could be accompanied by short, concise texts to call attention to important content (Moore, 2015).

Other studies have focused on the use of visual aids in the form of computer games and virtual reality simulations such as Minecraft (Gallagher, 2015). This is a form of digital

Lego whereby players build their own world. The Minecraft computer game can be used as a visual learning tool to allow learners to create and explore concepts in a creative way. The game embodies some key characteristics such as collaboration, which is essential to teaching and learning. Teamwork has been found to develop listening and negotiating skills in learners as well as the collaborative skills of following instructions and being able to accept criticism. The use of computer games allows learners to explore and develop their creativity in an independent way while having fun and being actively engaged in an activity that is relevant to them. Another reason why Gallagher (2015) believes that Minecraft is useful as a visual learning tool is its differentiating ability for learners. This refers to the ability of the game to give learners different ways to explore and understand content, especially as learners are all different and do not learn in the same way and might be experiencing barriers to learning.

Finkelstein and Samsonov's (2008) research explored the use of PowerPoint to promote effective teaching and learning and found it to be a flexible and versatile visual aid. PowerPoint is a computer software program that incorporates various elements such as images, animations, videos, sound and text in the form of slides that can be projected. Finkelstein and Samsonov's (2008) findings include PowerPoint's promotion of constructivist teaching if it is used to engage learners through problem-based activities that necessitate active participation instead of the traditional one-way presentation that it is commonly used for. In the science classroom, PowerPoint can be used to show learners various experiments, especially when the school lacks the resources for them to experience these activities in person.

Most of the research on visual aids has been undertaken in developed nations and is Northern Hemisphere contextualised. The challenge that this posed to my study context was that it assumed a context where learners had access to technology and thus were knowledgeable about its use. My study's engagement with visual aids was in a low-technology educational environment and thus was delimited to practical experimental apparatus, model building and animated illustrations, using various physical materials. Most learners in my school come from working class backgrounds and do not have regular access to digital technologies that are assumed to be the norm in Northern Hemisphere educational contexts. I do, however, believe that making use of practical visual aids can incorporate some of the same characteristics that are promoted by technology, just in a more accessible form for all learners, no matter what their circumstances.

There is a body of literature that focuses on visual aids in a more practical capacity and that deals with the use of visual aids applicable to my study. Martin (2012) and Ferreira (2011) report on the value of visual aids during practical activities. Martin (2012) argues that the use of practical investigations promotes constructivist teaching principles. He provides various examples of practical activities that can be utilised within the science class to provide learners with the opportunity to investigate cause and effect, a principle that is very important in science. The use of visual aids during practical activities allows learners to actively take part in the scientific method and enables them to hone their investigative skills such as hypothesis and variable formulation, and observation and recording of data, which I argue are essential for science. Ferreira's (2011) practical investigations included the use of micro science kits whereby each learner was given a

kit containing different miniature laboratory apparatus. This kit enabled learners to engage with the subject material by doing experiments and communicating about what they were doing in order to improve understanding. Lee and Buxton (2013) describe these types of activities as hands-on, inquiry-based activities that can be very effective to promote understanding of scientific concepts amongst learner populations such as ESL learners. Hands-on activities are not as dependent on language and therefore lessen the linguistic burden experienced by ESL learners during class. These activities also promote the acquisition of science-specific language in the appropriate context as they are being used and stimulate communication in various formats such as graphical and pictorial.

Some research has explored the use of visual apparatus to advance comprehension of difficult scientific processes and concepts (Turkoguz, 2012; Wright, Eslami, McTigue & Reynolds, 2015). Turkoguz's (2012) study found that the use of scale models as visual aids could be effective to teach difficult and abstract chemistry concepts. Through building molecular structures or using models to explain complex and integrated processes, learning about structures that cannot be seen or are completely unknown to learners is facilitated. The process of building molecular structures and the availability of life-size models of relatively small components enable learners to visualise these abstract concepts in ways that facilitate understanding.

Wright et al. (2015) found that visual aids in the form of graphics could provide learning support in science for learners who were taught in a language that was not their mother tongue. The researchers found that graphics provided support by serving as a visual source that enabled learners to infer the meaning of words without having to disengage

from the reading activity. Purposefully selected graphics that contain clear, descriptive text in the form of captions have been found to be very effective in such contexts (McTigue & Flowers, 2011).

Ward and Wandersee (2002) researched the use of visual aids such as the Roundhouse diagram to help learners to understand concepts. In this diagram, a learner puts a concept in the centre of a circle and then divides the circle into seven segments. In each of these segments, the learner draws an icon that she/he associates with each of the underlying concepts. These icons then make up the main concept in the middle of the circle. This can be useful as a possible study method to teach learners how to use visual aids more effectively than, for example, merely summarising.

2.6. SUMMARY

In this chapter, I reviewed literature that was deemed relevant to the issue under investigation. This chapter primarily explored the literature related to ESL learners and the challenges that they experience when engaging with complex scientific terminology. I reviewed literature that informed me about the role of language, science as learning area and visual aids to develop a framework that could support my premise that visual aids in the Life Sciences class would advance learners' understanding of the subject. I examined the literature on the complexity of scientific knowledge and the challenges that it posed to learners who were studying in a language that was not their mother tongue. I explored teaching strategies that promoted effective teaching of science. Lastly, reviewed different visual aids and how these could be applied and used in various contexts.

CHAPTER 3

RESEARCH METHODOLOGY

3.1. INTRODUCTION

As a Life Sciences teacher in a dual-medium school, I am constantly faced with the challenge of language when trying to elicit understanding of terminology with second-language-educated learners. My experience with teaching science is that the use of linguistically complex concepts and phrases is problematic for learners who are being taught in English, a language that is not their mother tongue. Being taught in English seems to hinder their performance in the subject. It is for this reason that I decided to conduct research on how the use of visual aids as a tool could enhance understanding of terminology for learners who were being taught in a language that was not their mother tongue. I chose PAR as study design so that learners could participate in an intervention in which visual aids were available to them in their meaning making. Through a series of action and reflection spirals, their views of how visual aids were assisting them in making sense of Life Sciences concepts and terminology were investigated.

As a qualitative researcher, I was interested in understanding how these learners experienced visual aids to facilitate their understanding in the Life Sciences classroom and how they constructed meaning and understanding based on these experiences (Merriam, 2009). PAR as research methodology allowed for the creation of a forum for

learners who were taught in a language that was not their mother tongue to share their experiences of the Life Sciences classroom in a proactive way.

3.2. THE RESEARCH PARADIGM

The qualitative research paradigm seemed most suitable for this study as this approach attempts to understand how people make meaning of the world around them. According to Merriam (2009), there are four characteristics that describe the nature of qualitative research and these were mirrored in this study: meaning and understanding form the focal point of the study, the researcher is the primary instrument of data collection, the qualitative process is classified as inductive and the product is described as richly descriptive.

Qualitative research has at its core the goal to understand. The methodology is about understanding what people think about their experiences, how they navigate the process of understanding and what they internalise to construct and make meaning of the world around them. Silverman (2013) states that qualitative research is concerned with the study of the human experience within different realities. Consequently, it is conducted through close involvement with the participants to investigate their everyday lives (Miles et al., 2014). During this process the researcher therefore positions them from the participant's perspective as opposed to the researcher's perspective (Merriam, 2009). With my study, I sought to understand how the participants made sense and meaning when visual aids were part of their educational experiences in my Life Sciences classroom and to understand how they used these experiences to construct knowledge.

The researcher is described as the primary instrument of data collection. According to Miles et al. (2014), the role of the researcher is to obtain a holistic overview of all the different aspects within the study context. As a teacher who was also the researcher, I was a participant of the process and was able to immediately process information, respond and adapt the lesson as the situation required. I was also able to rectify any misconceptions, pick up on nonverbal cues that could be used to expand perceptions and explore alternative avenues of thought about unexpected topics (Merriam, 2009). This characteristic of qualitative research enabled me to actively engage with and participate in the data collection process, especially as the context of a classroom situation is dynamic and fluid.

The process of qualitative research is described as inductive as the data gathered are used to construct new knowledge as opposed to the deductive process of testing hypotheses. Investigations follow a specific theoretical framework that delineates the enquiry and allows for data to be gathered through interviews and observations. This data can then be interpreted from the particular and arranged into themes that are eventually used to build theories in general (Merriam, 2009; Miles et al., 2014).

The product of qualitative research is richly descriptive. This pertains to the use of words and pictures to put forth an explanation of what was discovered throughout the investigation and would include descriptions of the participants involved and the context in which the various activities took place. Interviews and field notes will usually be provided as evidence to support the findings (Merriam, 2009). This research study produced a richly descriptive end product that included quotes that represented the participants' voices and experiences.

These characteristics of qualitative research were deemed appropriate for my study.

3.2.1. Interpretivist paradigm

Denzin and Lincoln (2011) define a paradigm as the lens through which a researcher views the world and as consisting of a basic set of beliefs that guides the researcher's actions within this world. The paradigm that guides my feelings about the world and tells me how it should be understood and studied is an interpretivist paradigm. A researcher using an interpretivist paradigm attempts to gain understanding by interpreting the perceptions of people. That means that as the researcher, I aimed to understand the experience of people within their various worlds as they interpreted these worlds and made meaning of them (Cohen et al., 2011). The characteristics of an interpretivist paradigm can be discussed under three categories, namely metaphysics, position on selected practical issues and critical issues.

The metaphysics of an interpretivist paradigm denotes its basic beliefs and is rooted in three fundamental concepts of social research, namely ontology, epistemology and methodology. According to Merriam (2009), ontology refers to the views and assumptions that the researcher operates from when in search of new knowledge, in other words the nature of reality. Epistemology refers to the process of thinking about what we know and see or the nature of knowledge. Methodology refers to the process of acquiring new knowledge, what principles should be followed and how we should go about this process.

The nature of reality within an interpretivist paradigm is described as being constructed by each individual based on his/her own unique experiences and social interactions.

Since people form part of and can experience more than one reality at a time, the existence of these different realities must be considered and taken into account as this will determine and shape their experiences and mental constructs (Denzin & Lincoln, 2011). As a researcher functioning within this paradigm, I therefore had to be aware of the multiple realities that the participants existed in. I had to become actively involved with them during the research process to fully understand the extent of their interactions and to ultimately be able to correctly reflect on their experience.

Denzin and Lincoln (2011) further state that the nature of knowledge as described within an interpretivist paradigm is the result of an interaction between who we are and what we know about the world. Reality is constructed based on an individual's understanding of his/her interactions with his/her surroundings and cannot be separated from what that individual knows. That which I knew could therefore not be separated from that which I was studying; we were intricately linked. What I knew and understood about the world was central to how I understood others and would come forth in the data that I generated from my participants and in the knowledge that I created during my study.

The methodology within an interpretivist paradigm refers to the process and principles of seeking and creating new knowledge, which are facilitated through naturalistic methods such as observing and interviewing. These methods ensure an active engagement between the researcher and participants in such a way as to enable the construction of a reality or realities that reflect meaning as they emerge from the research process (Denzin & Lincoln, 2011).

Denzin and Lincoln (2011) believe that an interpretivist paradigm positioning is based on selected practical issues. With regard to the goal of research, the researcher who works within an interpretivist paradigm aims to understand by evaluating the lived experiences and multifaceted nature of what it means to be human in an attempt to reconstruct meaning. The quality of this inquiry process is judged based on an intersubjective agreement between the researcher and the participants, which is reached through shared dialogue and conversation. An interpretivist paradigm values products that are personally comparative and follows ethics that are intrinsically positioned. The interactions between the participants and me revolved around the understanding of Life Sciences concepts and thus knowledge. These interactions aimed to reveal learners' experiences with grasping the concepts to ultimately gain an understanding of the Life Sciences curriculum. By using qualitative methods and adopting a coconstructor of knowledge point of view, I endeavoured to understand the meaning of the participants' lived experiences (Denzin & Lincoln, 2011).

According to Denzin and Lincoln (2011), the critical issues confronted by an interpretivist paradigm include the axiology of intrinsically valuable knowledge that can serve a socially emancipatory function through reflection. The paradigm accommodates participatory approaches that require the engagement of participants in an attempt to understand a problem and ultimately effect change. The participants and I both had an input into the research process and how knowledge was produced, and this resulted in a voice that reflected the participants' voices mixed with my voice as the researcher. The knowledge generated by using this paradigm could enable readers of this study to

gain a better understanding of the cultural and social contexts of the research process (Denzin & Lincoln, 2011).

Within the interpretivist paradigm, the research design that denoted the methodological practice of collecting and analysing information allowed me to move from the abovementioned paradigm to the empirical world of PAR.

3.3. RESEARCH DESIGN

A study's research design symbolises the process of seeking out new knowledge and is guided by a set of principles that tells one how the inquiry process should proceed. The research strategy that anchored this study was PAR.

3.3.1. Participatory action research

Kemmis and Wilkinson (1998) describe PAR as an open and fluid process that attempts to help people to investigate their social and educational realities in an attempt to change these. It aims to do this by changing the practices that constitute these realities. In this study, PAR was used to investigate how the use of visual aids in the Life Science lesson could facilitate the learning of difficult Life Sciences concepts for Grade 10 learners who were being taught in a language that was not their mother tongue.

PAR is distinguished by a methodology that is collectively participatory, outcomes that are democratic and emancipatory in nature and focus areas that address educational inequalities (Cohen et al., 2011). According to Kemmis and Wilkinson (1998), PAR embodies six central features, namely it is a social process, it is participatory, it is

practical and collaborative, it is emancipatory, it is critical and it is recursive, features that were all mirrored in the study.

PAR is a social process as it sets out to explore the interaction between the individual and the social environment within which the individual functions. This social nature of all interactions and relationships influences and ultimately shapes the individual and therefore cannot be ignored when using PAR (Kemmis & Wilkinson, 1998). This is the case for the Life Sciences class too, as learning is not happening in isolation; it is influenced by interaction among the learners, the teacher, the resource materials and the educational development setting.

The process is participatory as it involves people reflecting on their knowledge and skills as well as the ways in which they interpret themselves and their actions within the world. It is participatory as each individual participant reflects on the ways in which her/his current knowledge influences her/his actions during the process of research (Kemmis & Wilkinson, 1998).

PAR is practical and collaborative in nature as it requires the participants to examine their interactions with others by exploring the way in which they communicate and act within social situations to ultimately improve their interactions (Kemmis & Wilkinson, 1998). In this study, the learners collaboratively and critically reflected on the usefulness of visual aids for learning about Life Sciences.

The study embodied an emancipatory nature that coalesced with that of PAR. Learners who are taught in a language that is not their mother tongue often are disempowered by their struggles to learn in a second or third language. This methodology lends itself to

helping these learners to free themselves from the constraints placed on them by social constructs that hinder their development. Through this research, these constraints were explored and exposed for how they influenced practice and were viewed within the scope of wider social structures that were economically, politically and culturally driven (Kemmis & Wilkinson, 1998). The school structure as a system that functions within the scope of social structures could be experienced by second-language learners as unjust. They could experience the Life Sciences classroom as suppressing their educational development. PAR as methodology allowed the participants with the opportunity to become emancipated through their active participation in the extra classes.

PAR can also be described as critical in nature as it aims to release people from constraints found when they use language to interact in various contexts (Kemmis & Wilkinson, 1998). Being taught in a language that is not one's mother tongue can be an exclusionary act. The study sought to determine how the use of visual aids in the teaching of Life Sciences could serve as facilitator of learning for the participants. Through this collaborative process, the research setting provided a safe space for learners who were taught in a language that was not their mother tongue to act on the constraints that language presented to their knowledge construction.

The last feature of PAR is its recursive nature (Kemmis & Wilkinson, 1998). It aims to investigate reality in a cyclical manner of action and reflection to enable people to change their practices. This is achieved by deliberately investigating the social process in which people are functioning to help them to critically reflect on and theorise about their practices, the knowledge thereof, any structures constraining these practices and the social environment in which these practices are expressed. PAR can be described

as learning through actions and with others as it changes the way that interactions take place in a social environment (Kemmis & Wilkinson, 1998). In this study, I cyclically reflected on the experiences of learners who were taught in a language that was not their mother tongue by using visual aids to help them to construct knowledge and to understand difficult Life Sciences concepts. I reflected on the knowledge gained through this study and explored possible constraints of certain practices to enhance meaning making and knowledge construction.

This recursive nature is reflected in the dominant features as described within the process of PAR. The process of PAR can be described as a sequence of steps that acts as a spiral of self-reflective cycles that includes planning a change, acting the process of and observing the consequences of the change, reflecting on both these processes and consequences, using these reflections to replan and then starting the process all over again (Kemmis & Wilkinson, 1998). The process can be illustrated by the following diagram:

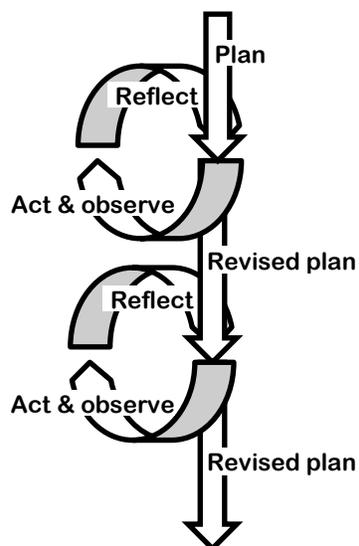


Figure 3.1: The PAR process spiral of self-reflective cycles

Adapted from Kemmis and Wilkinson (1998)

As illustrated above, in Figure 3.1., the process of PAR consists of a spiral of cycles that includes planning, implementing the plan of action, systematically observing, reflecting and replanning, followed again by implementing the plan, causing the cycle to continue (McTaggart, 1997).

The first step denotes the planning phase. McTaggart (1997) states that doing initial research and collecting data about the area of interest is a good starting point and enables effective planning of a change. The second step includes implementing the developed plan of action, which is accompanied by the third step, which entails systematically observing this action phase. During these phases, information is gathered and this is used to complete the fourth and fifth steps, which include reflecting on what was observed in order to enable changing the plan of action. This replanned action is then implemented, and the cycle is repeated to form a spiral of cycles (McTaggart, 1997).

3.4. SAMPLE AND POPULATION

According to Nieuwenhuis (2007), sampling refers to the process of selecting a representative section of the population for the research. The type of sampling that I decided on was purposive sampling. Silverman (2013) states that purposive sampling is a critical process of evaluating the characteristics of the population that one intends to study and allows the researcher to choose the sample case that contains the features that she/he is interested in. This ensures that the participants selected are a rich source of information to be utilised. The inclusion criteria for the study were as follows:

1. Participants were in Grade 10.
2. Participants took Life Sciences as a subject.
3. Participants had a mother tongue other than English or Afrikaans.
4. All who did poorly in Life Science – 30%

Qualitative research involves a small sample size that is flexible in nature to ensure rich descriptions of the participants' experiences (Nieuwenhuis, 2007). For the purpose of this study, all those participants who fitted the criteria were included as it could have been ethically challenged if some were excluded. The sample ensured a manageable teaching environment that allowed each participant to add rich descriptions of his/her experiences of using visual aids in the Life Sciences classroom to the study.

Access to the participants was gained through the school. The parents of all potential participants who met the inclusion criteria as stated above were invited to a meeting held at my school at the beginning of the second term. During this initial contact session, I explained to the parents and the Grade 10 learners the purpose of the study,

the process and what the extent of the learners' participation would entail. Thereafter, I gave parents the opportunity to ask questions and to clear up any concerns that they might have about their children's participation. We also discussed ethical issues such as the children's rights and confidentiality. Thereafter, parents who gave permission signed the consent forms and their children who agreed to participate signed the assent forms.

3.5. DATA COLLECTION METHODS

The data in this study were collected using three methods. In the first cycle of the research process, semi-structured personal interviews were conducted with all the participants to gain background information on them and to determine the challenges that they were experiencing with Life Sciences. Throughout the intervention, data were also collected through informal interviews and observation, and through focus group interviews. The semi-structured personal interviews were conducted over three days. Thereafter, the four-week intervention programme began with classes being held thrice a week. Each session ended with a focus group interview, and data collection was concluded with a final focus group interview at the end of the four weeks (See appendix B for the interview guides). All the activities took place after school in the Life Sciences classroom at Sunshine High School.

3.5.1. Semi-structured personal interviews

According to Cohen et al. (2011), an interview is a flexible tool used for data collection within qualitative studies as it is social in nature and regards the knowledge collected to be based on human interaction through the use of conversation. It is a specially constructed intersubjective event that entails a question-based approach whereby the

interviewer asks the interviewee content-specific questions that evoke detailed and explicit responses to achieve a focused and research-relevant purpose. In other words, it involves the interchanging of views between two or more people about a certain topic that is of interest to both parties involved and includes the use of multisensory pathways, namely verbal, nonverbal and hearing (Cohen et al., 2011). In addition, Nieuwenhuis (2007) states that a qualitative interview allows the interviewer access to the world of the interviewee as she/he experiences it and enables the interviewer to learn about the behaviours, views, beliefs and opinions of the participant. The collection of rich descriptive information will allow for a better understanding and a more appropriate description of the experiences of the participant when trying to understand how she/he constructs knowledge and makes sense of the world around her/him.

I concur with Nieuwenhuis (2007) that interviewing provides us with access to the lives of the participants as they experience and make sense of these. It gives us the opportunity to try and understand how participants interact with their social environment, what meanings they attach to these different experiences, how they feel about themselves and others based on these experiences and what knowledge they construct based on their interpretations of the world. This study sought to collect participants' views about how they experienced the use of visual aids in the Life Sciences class, and this method of data collection was ideally suited to that purpose.

Different types of interviews can be distinguished within qualitative research; the one most suited to this study was semistructured interviews. According to Nieuwenhuis (2007), semistructured interviews involve the use of a predetermined set of questions that guides the interview in a specifically defined line of inquiry. These interviews are not

rigidly structured as they allow for some probing and clarifying of answers if new lines of data emerge, but they are kept on track by the interviewer to avoid constant deviations from the research topic that might defeat the purpose of the study (Nieuwenhuis, 2007). As this study dealt with adolescent children who might have lacked conversational skills and might have been prone to getting side-tracked, the use of semistructured interviews was deemed appropriate.

A qualitative interview process compels the interviewer to create a comfortable atmosphere where the participants feel eager to share truthful and descriptive versions of their reality that will not be subjected to judgement and where they feel that their opinions are valued. To this end, Kvale (1996) advocates some key elements that should be present during the interview process, as I elaborate on next.

The personal semi-structured interviews were held before the start of the intervention programme in my Life Sciences classroom after school. I used basic common language to gain understanding as I was sensitive to them misunderstanding or having different interpretations of the meanings of words. I therefore had to be extra careful when asking them questions, and I had to constantly ask for clarification to ensure that I understood them correctly. I regarded the process as interpersonal and respectful of their views and emotions (Kvale, 1996).

Apart from semi-structured personal interviews, focus group interviews were also utilised during this study.

3.5.2. Focus group interviews

Kvale (2009) describes a focus group as composed of six to ten participants who are being interviewed. This interviewing process is characterised as being nondirective and aims to elicit an assortment of viewpoints on a topic. During this process, the facilitator introduces a topic for discussion and creates a permissive atmosphere that allows the free expression of different personal opinions on said topic (Kvale, 2009).

The use of a focus group interview appealed to me as the group interaction could produce a wider range of responses that was not necessarily attainable from personal interviews. The participants in this study were adolescents and were more likely to discuss issues with their peers than directly with only me, their teacher. The collective interaction provided a comfortable space for voicing their opinion as their peers who were grappling with similar learning problems could validate what they were saying. A strength of this method thus was that spontaneous and expressive opinions could be harnessed.

A personal concern, however, was the management of adolescent participant egos. My management of the process was important, and rules of engagement needed to be negotiated. I informed them about the aim of the focus group interviews, which was to hear everybody's opinion, beforehand and clearly explained to them that it was important to give everyone a fair chance to express his/her opinion and that it was not about agreeing or giving a right answer but rather about hearing how others experienced the programme. As the facilitator, I also had to ensure that each learner participated in the interview process and received a chance to voice his/her opinion and

be a part of the research conversation by skilfully engaging with quieter participants while managing the more confident members of the group. Overall, I wanted the focus group interviews to be construed as a positive and enlightening experience for the participants that brought about changes within and new insights for them.

3.5.3. Observation

Nieuwenhuis (2007) takes the view that an observation is a process whereby the use of all the senses are recruited to gather information about the behavioural patterns of participants and about occurrences, which are then recorded and used to gain a deeper understanding of the phenomenon observed. It allows the researcher to gain an insider perspective of how the setting is constructed socially and enables the investigation of the group dynamics and discursive behaviours.

During this study, the type of observation that was deemed effective was the participant as observer strategy. This type of observation strategy, according to Nieuwenhuis (2007), describes the situation where the observer becomes part of the research process. As I was the teacher implementing the intervention programme, I was fully immersed in the process and could intervene in the dynamics as I saw fit, which ultimately allowed me to develop an emic perspective. Following the observations, I made use of field notes to capture the data gathered. This method of data capturing entails a continuous and detailed account of what was observed and includes a description of the actions as well as the context in which the actions took place (Nieuwenhuis, 2007).

I recorded my observations on a voice recorder at the end of each class session and wrote them up the same day. Throughout the observation process, I had to be conscientious of not inducing behaviours for the purpose of my research. This was an area of concern for me as I was also fulfilling the role of teacher, which could potentially have led to my trying to seek specific outcomes that would benefit my study. I overcame this problem by compartmentalising the two roles. As a researcher, I remained vigilant and adopted a more passive role when observing the participants taking part in the intervention programme. I set out clear key constructs that I would look for and cues that would inform me of any noteworthy observations relevant to my study. I specifically focused on the interaction with the visual aid materials and looked for nonverbal cues of not paying attention, which could indicate a lack of understanding, such as learners fidgeting, looking around and copying what others did instead of trying to do the exercises themselves, which I then noted in my running records. Whenever I recognised any of these cues, I abandoned my researcher role and adopted my teacher role and engaged with the participant in a one-on-one manner and tried to mediate and resolve the problem by clearing up any possible language barriers. This enabled me to capture data that included rich descriptions of the actions observed as well as my reflections on what was observed (Nieuwenhuis, 2007).

In qualitative research the researcher acknowledges her subjectivity. I was always aware of the potential of my role as teacher and the power that went with it. However, PAR presented me with the opportunity to engage them in reflection on what worked for them. This they did in group context which contributed to an informal, non-threatening space.

3.6. DATA ANALYSIS

While the personal interviews and focus group interviews were conducted, recorded and transcribed and the intervention programme was conducted and observed, the analysis of the data took place. According to Miles et al. (2014), data analysis can be described as the concurrent flow of three activities, namely data condensation, data display and drawing conclusions.

Data condensation refers to the process of selecting and transforming the data found in the interview transcripts, observational running records and documents produced in order to focus and organise the data in such a way that conclusions can be drawn (Miles et al., 2014). For the data condensation process, I made use of analytical task coding. During the process of coding, codes are used to categorise data that are similar to enable the researcher to access the data quickly for further analysis and to finally draw conclusions. According to this description, codes are defined as labels used to allocate symbolic meaning to chunks of the descriptive data gathered during the study. Coding therefore enabled me to retrieve the material that was most meaningful, to group together sections of data that correlated with each other and to condense the bulk of data into more manageable and meaningful units (Miles et al., 2014).

According to Miles et al. (2014), coding can be divided into two phases, namely first-cycle coding and second-cycle coding. (See appendix C for an example of the coding process.) First-cycle coding refers to the method of initially assigning codes to chunks of data while second-cycle coding refers to the method of patterning the codes developed in the first cycle. First-cycle coding methods include many different approaches. For the

purpose of this study, I made use of evaluation coding. Miles et al. (2014) state that evaluation coding makes use of codes that assign opinions about the significance of the intervention. As this study was concerned with improving learners' understanding of Life Sciences terminology and knowledge, I deemed it an appropriate method. This method entails the use of a + or a – symbol before the code tag, depending on whether the data are evaluated as positive or negative. Following the symbol is the first-order code, denoting the area of interest, and then a second-order code, also known as the subcode, that denotes the opinion.

A second-cycle coding method is pattern coding and is used to group the summaries made during the first cycle into smaller themes or categories. According to Miles et al. (2014) and Silverman (2013), pattern codes are described as explanatory codes that identify emergent themes in such a way as to group together a vast amount of material gathered from first-cycle coding into meaningful units for analysis. These second-cycle pattern codes are then used in the next phase, namely data display.

Miles et al. (2014) state that data display denotes the organised and compressed gathering of information that will enable conclusions to be drawn. This study made use of narrative description as the data display method. It included composing a narrative that elaborated on the pattern codes and included the first-cycle codes to outline the participants' actions and how these changed throughout the study. The narrative was supported by data collected during the observations to represent how the social action was witnessed as the study progressed (Miles et al., 2014).

The third activity in the data analysis process is drawing conclusions. Miles et al. (2014) believe that there are certain tactics for generating meaning to draw conclusions. The two strategies used in this study included noting themes and clustering. Noting themes refers to identifying recurring patterns and can include involving similarities and differences as well as patterns in processes. Clustering correlates with identifying themes as it also aims to group characteristics together to conceptualise meaning (Miles et al., 2014).

3.7. ETHICAL CONSIDERATIONS

Ethical considerations guided all stages of the research process. With regard to the research question and the purpose of the study, the following ethical considerations were adhered to, based on suggestions by Creswell (2009). Before any research could commence the proposed study plans were reviewed by my supervisor and by the Department of Educational Psychology ethics review committee to advise me on possible risks that might exist and that had to be considered. I also had to ask permission from the Western Cape Education Department and the school principal to conduct research in the school.

During the research process, the rights of the participants were respected at all times. After they had been orientated to the study and agreed to participate in it, the participants were required to sign an assent form. Parents had to sign a consent form. (See Appendix D for an example of these forms.) Both the assent and consent forms adhered to the following principles, as discussed by Creswell (2009). They clearly stated the purpose of the study and contained a description of how the participants were

selected and what was expected of them throughout the study. Possible risks and benefits were described to the participants. The participants were ensured that any information gathered during the study would be kept confidential. They were also informed that they could withdraw from participating in the study at any time, should they wish to do so (Creswell, 2009).

While analysing and interpreting the data, the anonymity of the participants and the school had to be ensured. This was achieved by using pseudonyms for the participants instead of their real names and for the school. The data were kept on a secure laptop that was password protected and that only I had access to. Once the data had been analysed, it was kept till after the evaluation process and then it was permanently deleted. An accurate description of the data was provided, and no results were falsified (Creswell, 2009).

3.8. TRUSTWORTHINESS OF THE STUDY

According to Silverman (2013), a research study has to illustrate the procedures used to ensure that methods are reliable and that conclusions are valid. Reliability refers to the consistency with which the results are assigned to the same conclusions by different researchers or on different occasions. Validity refers to the credibility that can be attached to the interpretations, in other words whether the conclusions accurately describe what the study set out to describe (Silverman, 2013).

During this study, I strove to enhance reliability by making use of low-inference descriptors. Silverman (2013) states that low-inference descriptors describe the process of recording observations in as concrete a manner as possible by including verbatim

accounts of what the participants say rather than only using the researcher's perceptions of what was said. I also provided the reader with long data extracts that included the questions that I asked the interviewee as well as any continuers that she/he uttered. (See appendix E for an example of this process.)

The data were triangulated to ensure validity. According to Miles et al. (2014), triangulation is the process of supporting a finding by showing that at least three different sources yield the same result. Individual and group interviews together with observation were the data sources that were analysed and from which the findings and conclusions in this study were drawn.

CHAPTER 4

PRESENTATION OF THE FINDINGS

4.1. INTRODUCTION

In this chapter, I discuss the findings of my study. I start off by sketching the context in which the study was conducted. I also provide a description of the participants in the study. I then go on to discuss the implementation of the study and follow this with an explanation of the analysis process that I engaged in. I then present the themes emerging from the data.

The context for the study was Sunshine High School, a former Model C public school situated in a low-income community in the northern suburbs of the Western Cape. Since the transformation of the education system in 1994, the profile of the school has undergone a change in demographics, leading to an increase in the number of immigrant and black learners enrolling yearly. The school now serves 780 learners predominantly from working-class families. The learners come from a myriad of different backgrounds, cultures and locations. This change in demographics also resulted in a shift in the school's medium of instruction. In the past, the home language of the majority of learners was Afrikaans. The five Afrikaans classes and only one English class have been replaced by five English classes and only one Afrikaans class. There is a great variation in home language of the learner population although the school's medium of instruction still only provides for English and Afrikaans. Many learners are thus being taught in a medium of instruction that is not their own mother tongue.

4.2. THE PARTICIPANTS OF THE STUDY

The population for the study were Grade 10 Life Sciences learners who were being educated in English, a language that was not their mother tongue. For the study, 10 learners were purposively selected, 7 female and 3 male, with an average age of 16 years. Most of the participants were born in South Africa and had isiXhosa as home language. Only Kurt was born in Ruanda and had Kinyarwanda as home language.

The data showed that Tanya, Anele, Ursula and Olga originated from Cape Town while the remaining participants hailed from the Eastern Cape, with the exception of Charles, who came from the Free State. This speaks to parents living in the northern parts of South Africa while sending their children to schools in the southern areas of South Africa in search of better educational opportunities.

Table 4.1 below presents a summary of the participants' biographical data and background.

Table 4.1: Biographical data

Participant	Age	Home language	Place of origin
Tanya	16	isiXhosa	Kraaifontein Western Cape
Ester	16	isiXhosa	Queenstown Eastern Cape
Anele	17	isiXhosa	Belville Western Cape
Nancy	16	isiXhosa	Mtata Eastern Cape
AJ	17	isiXhosa	Idutywa Eastern Cape
Anja	16	isiXhosa	King William's Town Eastern Cape
Kurt	16	Kinyarwanda	Ruanda
Charles	16	isiXhosa	Bloemfontein Free State
Ursula	17	isiXhosa	Stellenbosch Western Cape
Olga	17	isiXhosa	Cape Town Western Cape

4.3. EXPERIENCING THE PARTICIPATORY ACTION RESEARCH PROCESS

As a Life Sciences teacher, I found that some of the learners in my class were struggling with comprehension. The majority of these learners did not have English, the medium of instruction for this subject, as their mother tongue. As their teacher, I explored ways in which I could facilitate their learning and decided on a plan of action. This plan was to engage the learners in a process that differed from the usual class teaching method in that it included visual stimulation and activities that they engaged in

to assist with their meaning making. I taught difficult science concepts using visual aids to demonstrate and support the verbal and textual lessons.

The aim was to collect information on learners' experiences of visual aids as a teaching strategy. I conducted personal interviews to gather information about the participants' backgrounds and their opinions about their experiences of Life Sciences and of being taught in English. This data were analysed and used to guide me in planning and developing the programme and to set up all the activities that were implemented.

4.4. INTRODUCING A NEW PEDAGOGY

The research was conducted after school in my Life Sciences classroom over a period of four weeks. Each session lasted an hour. I started the process by focussing on the scientific terminology and skills that formed the basis of all scientific enquiries such as hypothesis and variable formulation, and presentation and analysis of data. Secondly, I focussed on the foundational knowledge necessary for learners to understand the more difficult concepts as required in the senior phases. These included concepts of molecular structures such as atoms, elements, molecules and compounds, diffusion, osmosis and transpiration. In the traditional classroom lesson, the content is discussed from notes made from various textbooks. The process mostly involves written activities and examples of questions interspersed with pictures, a method that I found the learners struggled with. They struggled with comprehension. For the research, I changed the traditional way of presenting the lesson by introducing various visual aids and activities to scaffold the learners' meaning making of the different contents. The

scientific terminology, such as hypothesis and variable formulation, was explained through engaging the participants in practical investigations.

During the sessions, I made use of various apparatus to illustrate the different concepts. For example, to test their comprehension of molecular structures, I had the learners use materials to build models that visually represented their understanding of the concept.

The following diagrams illustrate an example of the models the learners had to build using different colours modelling clay and toothpicks:



Figure 4.1: Example of models the learners had to build (Adapted from Google Images)

Similarly, concepts such as osmosis and diffusion were explained using various practical apparatus and experiments. Again the following diagrams illustrate an example of these practical apparatus and activities used:

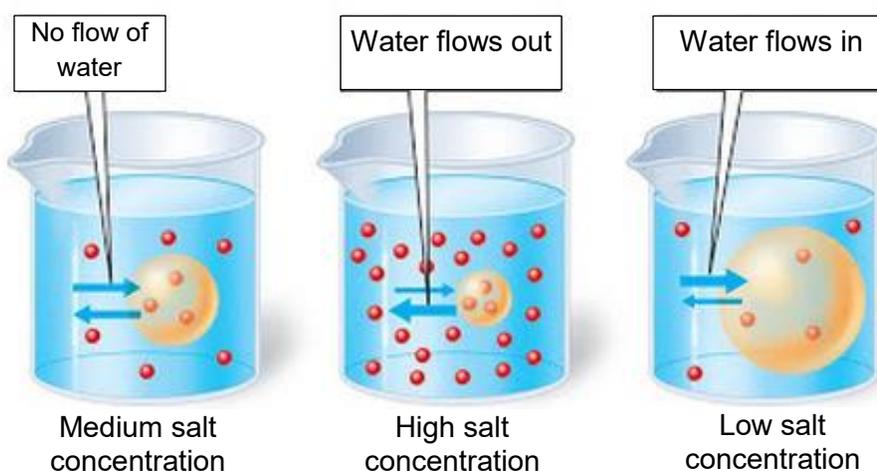


Figure 4.2: Example of a practical activity the learners had to complete (Adapted from Google Images)

Transpiration as a concept was illustrated by means of visual components similar to building models and by investigating a practical experiment. During the sessions, I tested the learners' meaning making of the subject content and would constantly ask for explanations of what was being learnt. The participants' experiences of the process and their reflections were gathered through informal questioning during the lessons and during the reflective focus group interview at the end of each session.

During the reflecting and replanning steps, I reflected on what I had observed and what the participants had shared during the focus group interviews, which helped me to revisit and adjust my own thinking and then to replan the programme strategy for the next session. During the next cycle, I then implemented the revised plan and continued to observe and reflect on how the participants responded to the improved plan. This process was followed for each of the sessions. At the end of the programme, I scheduled another focus group interview to gather the participants' reflections on the educational value that participation in the programme had for them, if any.

4.5. VIEWS ON BEING TAUGHT IN ENGLISH

Prior to their engagement in the programme, I interviewed the participants to gain insight into the academic challenges that they were experiencing with regard to being taught in English, specifically in relation to the subject Life Sciences. All the participants, with the exception of Kurt, grew up in homes where isiXhosa was their home language. As Table 4.2. below shows, some started formal schooling being taught in their home language up to Grade 3 while others were taught in a second language. According to the Language in Education Policy (Department of Education, 1997a) schools can decide

on their own language of learning and teaching. Although the policy encourages schools to use the learners' home language, which in this case should be isiXhosa, it is evident from the data collected that the medium of instruction eventually ended up being English and/or Afrikaans.

Table 4.2: Language of instruction in primary school

Participant	Home language	Former schooling experience
Tanya	isiXhosa	Grades R–3: Afrikaans, English Grades 4–7: English, Afrikaans
Ester	isiXhosa	Grades R–6: isiXhosa, English Grades 6–7: English, Afrikaans
Anele	isiXhosa	Grade R: English Grades 1–7: English, Afrikaans
Nancy	isiXhosa	Grades R–5: isiXhosa, English Grades 6–7: English, Afrikaans
AJ	isiXhosa	Grades R–4: isiXhosa, English Grades 4–7: English, Afrikaans
Anja	isiXhosa	Grades R–3: isiXhosa, English Grades 4–7: English, Afrikaans
Kurt	Kinyarwanda	Grades R–6: Kinyarwanda, English, French Grades 6–7: English, Afrikaans
Charles	isiXhosa	Grades R–3: isiXhosa, English Grades 4–7: English, Afrikaans
Ursula	isiXhosa	Grades 1–3: English Grades 4–7: English, Afrikaans
Olga	isiXhosa	Grades R–4: isiXhosa, English Grades 5–7: English, Afrikaans

From what can be seen in the table, Ester, Nancy, AJ, Anja, Charles and Olga's medium of instruction in Grade 1 till Grade 3 was isiXhosa. Anele and Ursula's medium of instruction was English while Kurt's was Kinyarwanda and Tanya's was Afrikaans.

Although the participants' medium of instruction was different, all of them had the subject, English as second language. By Grade 4, Tanya, AJ, Anja, Charles and Ursula were being taught in English and did English as first language and Afrikaans as second language subjects. Olga's medium of instruction was still isiXhosa in Grade 4, Ester and Nancy were taught in isiXhosa till Grade 6 and Kurt's medium of instruction was Kinyarwanda also till Grade 6.

While English was required to be studied as a subject and later became the medium of instruction for all these participants, Ursula, Kurt, Anja, Ester, Nancy and Anele recalled that they only had opportunity to speak English at school as the language used at home was exclusively isiXhosa. Though Charles and Olga had opportunity to communicate in English with their parents and friends, such individuals were not mother tongue speakers of English.

AJ was schooled in isiXhosa in the first five grades, and then he had to switch to English. However, despite the occasional conversation, English was not the language that his family was conversant in. The lack of opportunities to speak English at home led to limited comprehension skills in the language, as AJ reported:

So to us, where we don't use English as a common language at home, there's different ways that we talk English so it won't be the same as people that talk English at home. So there would be some words that would twist so it won't make sense like explaining stuff. Other people (teachers) will find it difficult, like you won't put it as they want you to. (AJ interview data, 2017)

For most of the participants, English was used outside of the home only and then only in contexts such as school when communicating with teachers or those learners in their classes who did not speak isiXhosa. This led to a lack of opportunities to extend their vocabulary and resulted in a continuous limited proficiency in English.

Olga, Kurt and Charles said that it was hard at first being taught in English but now that they had learnt it, it was easier; they had become more adapted to it by now. Nancy, AJ and Anele stated that they enjoyed being taught in English because they had learnt to understand English and how to speak a language that is used internationally. Nancy said the following:

For me it's good cause, like, I learn how to speak words in English or how to communicate with the different people who doesn't know my language. It's good. (Nancy interview data, 2017)

Their views were, however, not reflective of those of all the participants. Ursula and Ester held negative views about being taught in English. They found the language confusing and difficult to master, and this led to their having trouble understanding the work. When I asked Ursula how she experienced being taught in English, she responded as follows:

It's not 100% good for me because sometimes I really wish the teacher would be, I would be like, miss can you please explain it in my native language so that maybe I can understand it more ... what you're trying to say. (Ursula interview data, 2017)

Anele found it difficult to remember difficult English words, and Tanya struggled with comprehension. She often did not understand the questions that teachers posed due to her limited understanding of English. Kurt also thought that teachers did not necessarily take into account that a learner's home language might be different from that of other learners.

When asked what influence being taught in English had on their academic success in class, there were mixed responses. It was only Olga who stated that her academic achievement was hampered by being taught in English:

Since English is not my home language I think it has influenced my marks, I don't like pass with high marks, like code sevens since it's not my home language. (Olga interview data, 2017)

4.6. EXPERIENCING LIFE SCIENCES AS LEARNING AREA

Gaining information on how the study participants experienced the academic environment helped me to contextualise their experiences of Life Sciences as learning area. The interview data showed that the participants were positively inclined towards Life Sciences as subject. Their reasons differed. Despite their doing poorly in the subject, they all said that they enjoyed learning about the body, the various systems that made up the body and how it worked. Olga said the following:

I think it's great because it makes us understand more about the process of life and how things form and what process things go through. (Olga interview data, 2017)

Charles liked science itself, investigating and discovering things, while Anja responded that she liked rocks.

Although the learners had positive feelings towards the subject, they did, however, struggle with comprehension of the terminology and the content, as shown in Table 4.3. below.

Table 4.3: Challenges of Life Sciences

Participant	Comprehension of terminology	Content
Tanya	"...the questions..."	
Ester	"...the information mam, it is confusing"	
Anele	"...the words, they are very difficult..."	"...the other words, I forget them"
Nancy	"...new words...big, difficult and hard to pronounce..."	"...all the words...it's difficult to learn and to put them all together in the mind"
AJ	"...different names...we're never taught before..."	"...it has lots of things like study a lot...the work, it's a lot"
Anja	"...I struggle...with understanding" "And the words mam, those big words."	
Kurt	"...reading the work..."	
Charles	"...those big words..."	"...there's a lot of work, it takes time to put it in your mind..."
Ursula	"...the questions...don't know what they are asking..." "...the big words...is difficult"	
Olga	"...the long words, the big words"	"...hard to remember that hard word like the long words..."

The most common response to my probing about what they found difficult in Life Sciences was what Anja referred to as “the words, Ma’am, those big words being used in the subject”. What she was referring to was the scientific terminology of Life Sciences. The learners found the words long and difficult and struggled to understand them. Struggling to comprehend the terminology compounded the problem for Ursula who also struggled to understand the questions used during assessments, ultimately influencing her progress. Ester experienced the difficult terminology as confusing when trying to make sense of the content, which influenced her ability to comprehend and perform well on tests and in the examinations.

Nancy described her problem as “its new words and they are big, difficult and hard to pronounce”. Nancy went on to say that the difficult scientific terminology also hampered her ability to memorise the content, a response confirmed by Anele and Olga. Not being able to comprehend the language influences the ability to retain information. Therefore, more time is required to process the content, which leads to an increase in the time invested by the learner, as described by Charles, saying that “there’s a lot of work, it takes time to put it in your mind”, a view shared by AJ.

What stood out in the conversations that I had with the participants prior to their participation in the programme was the role that the medium of instruction played in their academic success. The population for this study was learners who were underperforming in Life Sciences. This suggested that their academic challenges in Life Sciences could be linked to being taught in English. As one of their teachers, an assumption that I held was that their marks did not accurately reflect their potential and that they would perform better if they had a better command of English.

4.7. PARTICIPATING IN AND EXPERIENCING THE PROGRAMME

The visually aided sessions differed from the usual class sessions in that they consisted of various practical activities. The participants were required to actively engage with the content by completing experiments and building various models. With practical activities learners were introduced to practical tools to support oral presentations. Furthermore it lends itself to the production of a visual artefact so for example in the lesson on molecular structures they produced a model which becomes an artefact that supports their learning. These activities were specifically chosen to give the participants the opportunity to explore and discover the content for themselves and take ownership of their learning as supported by the constructivist principles of self-discovery and mediated learning.

Throughout the sessions, the learners were asked to reflect on and record their experiences of the process. The following five themes emerged from the data:

- Communication
- Group work
- Independence
- Practical work
- Improved cognition

4.7.1. Communication

The first activity that they participated in required from the participants as a group to contemplate the correct order of a set of phrases that represented the scientific method. They had to communicate their thoughts and ideas to each other to ultimately reach a

decision about where to place each phrase to correctly illustrate the scientific method. In response to this activity, Olga and Tanya thought that the programme built communication among the group members. Tanya also referred to the promotion of communication through peer learning whereby learners explained difficulties to each other to clarify misunderstanding and stated the following:

... everyone put in their ideas and how they understand it ... and then those who didn't understand, we explained it so that everyone can be on the same page. (Tanya interview data, 2017)

For AJ and Kurt, the idea of communication, which was promoted throughout the programme, included being able to voice their opinions and to raise questions. Kurt described it as “we can ask whatever we want to ask”. This speaks to a comfortable, relaxed learning environment that promoted the asking of questions, which led to enhanced sense making. It was a safe space where everyone in the group was experiencing challenges communicating in English. They were away from the gaze of the rest of the class, so they felt more confident to ask questions.

4.7.2. Group work

Part of the programme process was to engage the participants in group work. All of the practical and visual activities were completed in groups in which the participants were continuously changed. During the interviews, Tanya, AJ and Kurt reported that this process of working in a group was enjoyable. Tanya thought that working in a group gave them a chance to participate and actively engage with each other and the content in such a way as to broaden their understanding. For AJ, who stated that he “enjoyed

this time, I loved the interact”, the interactive characteristic of group work was valuable while Kurt experienced group work as gratifying in terms of productivity.

On two occasions during the programme, very few participants were present. Anja, AJ and Charles’ opinions and feedback on the days’ experiences were that because there were so few learners present, it negatively influenced their experience. This further speaks to the enjoyment that the participants experienced with group work, showing that they appreciated the opportunity to work in a group and to learn with fellow learners.

4.7.3. Independence

The programme required the learners to participate in various activities through which they had to discover the content for themselves. One such activity included having to explore the effect of osmosis on pieces of potato. During this activity, each learner had to set up the experiment and observe the results in an attempt to visually illustrate the process of osmosis and to explain how water would move in different concentration situations. Their experience was a positive one as the comments during the reflective session afterwards showed, as captured in Table 4.4 below.

Table 4.4: Moving towards independence

Participant	Views on independence
Tanya	"...we actually did it ourselves, no one did it and then showed us...we saw the process of how it happens..."
Ester	"...I got to write what I think."
Nancy	"I actually saw everything."
AJ	"The highest to me was testing everything..."
Kurt	"...we got to play around with the stuff..." "I felt like I'm teaching this subject."
Charles	"I love the way a person has to work alone."
Ursula	"We got a chance to figure it out."

The data showed that the participants felt that they were taking control of their own learning. They mentioned that they liked the intervention programme because they were more involved in their own learning processes. For Ursula, this meant having a chance to figure out the content in a safe space, allowing her the opportunity to learn and discover without fear of being wrong. In the same way, Charles also welcomed the chance to work alone and figure things out for himself without being nervous or influenced by others. Ester appreciated being able to write what she thought as this gave her the opportunity to take ownership of her own learning processes. AJ found a strong sense of independence in testing his own experiments and measuring his results, which enabled him to construct cognitive structures based on what he experienced. Nancy concurred and found it helpful that she had a chance to see everything for herself instead of just believing what she was told or being told what she should think. Tanya shared Nancy's opinion and stated the following:

We actually did it ourselves, no one actually did it and then showed us the results, we saw the process of how it happens ... (Tanya interview data, 2017)

The use of visual aids as applied throughout my study embraced this concept and helped learners to interact with the various concepts and to draw sound conclusions based on what they had experienced. They were given the chance to experience for themselves those facts that did not coincide with their current ideas so that they could enter a state of disequilibrium. Kurt experienced the programme as empowering and even felt confident enough in his understanding that he expressed feeling like a teacher teaching the subject.

4.7.4. Practical work

The majority of activities that the learners participated in were practical in nature with the exception of some written questions to link the visual activities and aids with the current curriculum content. The practical components consisted of experiments and investigations that required the learners to engage with various apparatus to reach certain outcomes. Another form of practical work that they were exposed to during the programme was model building whereby the participants were required to use clay to illustrate different chemical components such as molecules and compounds. During the interviews, the participants reported that this aspect of the programme was fun and exciting. What they were referring to was the ability of visual aids to stimulate a more creative way of learning that involved more senses than merely acquiring information via reading notes, which could become tedious. Olga expressed this as follows:

... visual work is more exciting than normal work, because when you explaining every time by reading notes it gets boring and the mind gets tired. (Olga interview data, 2017)

Kurt concurred by mentioning that only reading notes was not sufficient class work; it should be supplemented with some form of action or practical component. AJ thought that working with his hands would help him to retain information and recall information during the examinations and that this should be incorporated into class more often. He went on to say the following:

Doing is understanding, the way we do things is the way we are going to understand them and in, like in the exams it will pop up because we are doing the things. (AJ interview data, 2017)

What he was referring to was an improved ability to apply the understanding that he had gained from this programme because he was able to visualise the work as he did it himself. Tanya commented that the practical work enhanced her visual memory and explained it as follows:

Like when you watch a movie or do something with your schoolmates, you actually have that visual memory inside you and as long as you are doing it with everyone else that visuals is going to stay there so when you are writing then it pops out and then you write it down. (Tanya interview data, 2017)

For her, the practical component and correlating visual memory enhanced her understanding, especially after building the molecules practically. Ester and AJ

nostalgically mentioned that they also enjoyed building molecules from clay. Kurt revelled in being able to play around with the various apparatus himself and taking part in independent studies by doing different experiments to reach conclusions.

Though the participants responded enthusiastically to the hands-on experiences, there was one activity that elicited discomfort and negativity and that was the one in which they had to physically perform. They were required to complete an activity that required them to investigate the effect of exercise on their heart rate. For this activity, the participants had to run on the spot for one minute. It appeared that this activity took them out of their comfort zone and exposed some of their weaknesses. For another activity, they were required to go and collect different leaves to investigate transpiration. Afterwards, Tanja responded that she did not like walking. These participants did not take part in sport and were consequently not comfortable with exercise-related activities.

4.7.5. Improved cognition

At the heart of the inquiry stood its goal to enhance the participants' understanding of the subject matter by using visual stimulation to supplement the teaching of the subject content. The interview data showed that the participants who took part in the programme reported improved cognition. The participants' responses speak to comprehension of scientific terminology and content, as Table 4.5 below shows.

Table 4.5:

Participant	Views on cognition
Tanya	<p>"I also found a perspective of how they want you to explain something..."</p> <p>"...you actually have that visual memory inside you...so when you are writing then it pops out..."</p> <p>"...I could actually understand now because...we actually saw the osmosis and transpiration in action..."</p>
Nancy	"I understood more...when I saw the results, because in class they don't show us, they just tell us"
AJ	<p>"Learning something that you know but more about."</p> <p>"...in the exam it will come because you did the stuff with your hands..."</p> <p>"...in the exam it will pop up because we are doing the things."</p> <p>"...the way to remember is by doing."</p>
Anja	"I understood the assignment much better."
Kurt	<p>"...you remember better than just sitting and writing."</p> <p>"...easier to remember..."</p>
Charles	"I think the exams will be much easier now that we know how you guys set up the paper and how you could ask questions."
Olga	"I think it is going to help us, especially in the exams."

According to Olga and Anja, the programme gave them a better understanding of osmosis and transpiration, two of Life Sciences' most difficult concepts. What they were referring to was an improved comprehension of the scientific terminology. For Anja, this improved understanding resulted from being able to observe the experimental activities illustrating the effects of both these concepts. She stated that she now understood the concepts and that her understanding had deepened. In class, she found these abstract concepts difficult to understand because, as she stated, "...they don't show us...they only tell us the results, then we don't see the results".

Tanya shared her opinion and commented that she understood osmosis and transpiration better now that she had had the opportunity to see the processes in action. For her, being able to visualise the processes increased her knowledge base, allowing her a broader perspective than merely being bound to studying the notes as given in class. She further mentioned that the programme increased her frame of reference and stated the following:

It's much better now, I can actually see and then have different perspectives because like in the book they give you one way and you might not know, if in the examination they give you something different from what they give you in class and then you would have no idea if it'll work the same way as you studied it in class and here we actually did all kinds so we not have only one way of learning that process so we'll have a vast knowledge of how the actual whole process has to work. (Tanya interview data, 2017)

AJ and Anja did not specifically refer to the improvement of their understanding of specific scientific terminology but made a generalisation about improving current knowledge stores by stating that "learning something that you know but more about". They spoke about a general increase in experience and exposure to Life Sciences that increased their knowledge base and confidence in the subject, which could have positive effects on their future encounters with the subject content in class.

Although Anja enjoyed the visual work and agreed that it enabled her to understand the content better, she thought that she might still struggle remembering the actual words.

She went on to explain that she did not think about the words when doing the visual work, which might then cause confusion when having to refer back to the words in written form.

The participants referred not only to an improved comprehension of the scientific terminology but also to an improved understanding of what was expected of them in assessments and examinations. For many learners, this is an area of great concern as they are unable to answer questions because they do not understand the question or they may understand the information but do not possess the academic language to express themselves correctly. Charles said that he now had a better understanding of the different ways in which teachers could ask questions and set papers while Tanya found being able to correctly answer questions and explain information in the correct manner helpful.

The participants held positive viewpoints about engagement with the content. For Kurt, AJ and Olga, taking part in the programme would enable them to remember the content better than, as Kurt stated, “just sitting and writing”. What he was referring to was the normal class context that requires learners to work through notes and answer exemplar questions. For AJ and Olga, the practical aspect of the programme was what would help them to recall the information when assessed during examinations. Olga explained that she had struggled to remember the difficult scientific terminology but after visually interacting with the content, she was now able to understand and therefore remember the content better. She stated the following:

I think mam, it's helpful because like, I lacked knowledge in Life Sciences cause we did more theory work, and it was hard to remember that hard words, like the long words, and I think it was nice that we did more practical work so that like we will remember it more...(Olga interview data, 2017)

Even though the participants found the programme enjoyable and helpful with regard to enhanced understanding and increased ability to recall information, Tanya still thought that the overall content of Life Sciences should be simplified. She felt that this would help them to understand the content better and make the subject material easier for them to remember.

4.8. SUMMARY

In this chapter, I presented the data that emerged through interviewing and observation. I argued that learners' comprehension of the learning materials and thus their learning were stunted when they were being taught in a language that was not the language that they used at home. Through an intervention programme, I used visual apparatus and demonstrations to supplement the teaching of terminologies that second-language learners struggled to understand. I presented the themes that the data analysis generated on how learners experienced the programme. In Chapter 5, I discuss the findings and make recommendations.

CHAPTER 5

FINDINGS AND RECOMMENDATIONS

5.1. INTRODUCTION

In this study, I explored the use of visual aids as facilitative tool in the teaching of Life Sciences to Grade 10 learners who were being taught in a language that was not their mother tongue. I focused on the role of visual aids in facilitating their understanding of the subject content. Through this study, I hoped to identify the academic challenges that these learners experienced in the Life Sciences curriculum and how cognitively appropriate visual aids could facilitate their understanding of the subject.

The research design was PAR, which allowed me to implement visual aids as a possible solution to learners' understanding of abstract concepts. Within the cyclical process that makes up the nature of PAR, the various phases enabled the gathering of information that allowed me to gain insight into the experiences of Grade 10 Life Sciences learners. The significance of this information was that it informed teaching practice and pedagogy in such a way as to enable teachers to support these learners more effectively.

5.2. INTERPRETATION OF THE FINDINGS

The data yielded are discussed in terms of what learners struggled with in Life Sciences and how the use of visual aids enhanced their learning in the Life Sciences classroom.

The data confirmed my assumptions that learners who were being taught in a language that was not their mother tongue struggled with Life Sciences because of lack of vocabulary and comprehension skills in the language. Within the scope of language difficulties, two challenges were prevalent, namely comprehension of subject terminology and comprehension of subject content.

Their limited comprehension of terminology presented challenges for learners as they were unable to understand the curriculum work. Not being able to understand the terminology that was used in the subject hampered their performance in that subject. These findings are consistent with existing research. Omar (2012) found learners from different linguistic cultures to be unfamiliar with the different connotative meanings of the words used to frame specific concepts. The learners therefore experienced the words as difficult and confusing when trying to assimilate and accommodate the new knowledge in an attempt to reach a state of equilibrium, which according to Piaget (1946) is needed for cognitive development to occur. Learners were consequently not able to understand the concepts, and this led to the second challenge, namely comprehension of subject content. If learners do not understand the concepts, they are unable to construct accurate cognitive structures, which negatively influence effective learning and retention. This disruption when trying to understand and memorise the content ultimately leads to a lack of progress in the subject. The findings of the study therefore underscore the importance of the medium of instruction in the academic success of learners who are taught in a language other than their mother tongue, especially in a difficult subject such as science.

The intervention entailed introducing visual apparatus and demonstrations to supplement the teaching of difficult terminologies and to facilitate learners' understanding of the subject content. I argued that adapting the medium of instruction to include visual aids would accommodate learners' language challenges as it did not require the use of difficult words that the learners struggled to decode. My stance was supported by Martin's (2012) and Ferreira's (2011) studies that highlighted the value of such an approach in promoting the acquisition of scientific skills and understanding. Allowing the learners to interact with the various concepts enabled them to construct cognitive structures based on their own mediated experiences instead of having to rely purely on words that they were unable to place in recognisable contexts. Using this method, underlined by constructivist principles, allowed me to support learners who were taught in a language other than their mother tongue. The data yielded in this study validated my assumptions. The discussion of the findings is presented in the five subsections that follow.

5.2.1. Communication

A benefit of the programme was that it built communication among group members as they had to express their thoughts and ideas amongst themselves to reach certain conclusions. By communicating with one another, the participants were engaged in peer learning, a process in which learners interact to clarify any misconceptions or difficulties. Engaging in peer learning is a form of peer mediation that, according to Vygotsky's social cultural theory (Rieber, 1998), can direct the individual's attention in a specific manner to allow transformation of internal cognitive structures to take place. The learners were able to explain concepts to each other by using colloquial words and

phrases that helped them to make appropriate connections and thus improved their understanding.

Another aspect of communication that was promoted by this study, as reported on by AJ and Kurt, was the relaxed atmosphere that existed, which facilitated the asking of questions and the voicing of opinions. Being comfortable enough to voice opinions and ask questions is an important cornerstone of constructivist teaching as it allows learners to take initiative and be in control of their own learning processes. As Martin (2012) states, questions provoke thought and provide the opportunity to trigger experiences of disequilibrium that are needed for the construction of cognitive structures.

5.2.2. Group work

A great deal of the activities in this programme were comprised of group work, which the participants found enjoyable. Participating in group work allowed the learners to interact with each other in an environment where they could make their own decisions and decide how they wanted to contribute. Nel's (2011) view of group work speaks to these findings when she states that group work provides more opportunities for the exchange of ideas and conversation. Learners had to listen to one another's explanations and defend their own viewpoint, which developed cooperation and negotiation among all parties involved. This instilled a sense of active participation that the learners found gratifying, hence their positive responses.

Opportunities for peer mediation were also prevalent within such an exchange of ideas and conversation from various different perspectives. Learners worked together and quickly explained the subject content if others in the group did not understand.

I constantly swapped around the learners to ensure that every learner had a chance to contribute and to prevent some learners from merely going along with what others said. This created a space that allowed the less confident learners to feel comfortable with voicing their opinions instead of being overwhelmed by the more confident learners.

5.2.3. Independence

The participants showed great appreciation for being able to take responsibility for their learning, something that Tanya described as “do it ourselves”. For each participant, this had a slightly different value depending on their personalities and learning styles. Ursula and Charles enjoyed the safe space that had been created so that they could figure things out without fear of others influencing or judging their attempts. Many learners who are taught in a language that is not their mother tongue are at risk of, as stated by Dednam (2011), interrelationship difficulties. This can lead to their becoming quiet and apathetic in class as they have to face the challenge of not understanding what is being communicated. Accompanied by not understanding is the ever-present fear of being judged or ridiculed for it, especially for teenagers undergoing many internal struggles while developing their identities. It is especially for learners with quieter dispositions that the creation of a safe, relaxed environment is key when trying to build the confidence needed to tackle challenges as required in science and increase positive expectations of the learning process.

Ester and AJ experienced the personalised nature of the programme as empowering as they could write what they thought and present the results of investigations they did themselves instead of just having to repeat or believe what other people had

discovered. Challenging what they had been told and seeing the results for themselves allowed them to develop critical thinking skills. This enabled all the learners to analyse and judge information and to construct and reconstruct ideas. I found that the potential for learners to be critical thinkers and good scientists was created. Having their opinion acknowledged and recognised, especially when they understood a difficult concept correctly, facilitated a strong sense of ownership of the learning process and caused them to take great pride in their role.

For Tanya and Nancy, independence meant being able to use and put together the various building blocks themselves in a way that enabled them to construct their own knowledge. This can be considered a form of scaffolding whereby the learners were given the opportunity to construct their own knowledge in an independent manner, with the teacher's role being that of mediator guiding them through the activities. Giving them the opportunity to see how the individual pieces made up the whole allowed for a much better understanding as it allowed the learners to put together their cognitive constructs in a step-by-step manner.

5.2.4. Practical work

The normal class routine requires learners to be able to absorb spoken words and convert these into some form of understanding. Learners who are being taught in a language that is not their mother tongue are at a disadvantage as they are at risk of not understanding the lesson or lecture because they are not able to process the information fully. It is for this reason that the study found practical work to be well received among all the participants. They experienced practical work, as stated by Olga,

as “more exciting than normal work”. This speaks to the ability of visual activities to stimulate a more creative way of engaging with the subject content that is based on a multisensory approach that the learners found more accessible. A multisensory approach refers to the utilisation of more than one sense, such as tactile and visual senses in this instance, in an attempt to access information. By using more than one sense, the learners were able to access other tools of cognition. This term is one of the key concepts of constructivism and is described by Donald et al. (2010) as any tool used by individuals to reflect on experiences in an attempt to actively change their current cognitive structures. As mentioned above, the tool normally used in class for cognition is language but since language acts as a barrier for learners who are taught in a language other than their mother tongue, visual activities offer a different way to access information.

By engaging in practical work, the learners were also able to take part actively in the process of discovering and producing knowledge. This linked up with another key concept of constructivism that Donald et al. (2010) refer to as ‘active agency’ whereby knowledge is constructed by an individual actively taking part in the learning process. AJ stated that “doing is understanding, the way we do things is the way we are going to understand them”, illustrating this concept exactly. Active agency is based on Piaget’s (1946) description of assimilation and accommodation according to which assimilation describes the process of integrating new information into current cognitive structures while accommodation refers to the adjustment of current cognitive structures based on newly assimilated information. Learners who are actively participating in practical work are given the opportunity to engage with and to interpret new information that can then

be used to alter their current cognitive structures or create more accurate cognitive structures.

5.2.5. Improved cognition

The participants all reported improved cognition in terms of comprehension of scientific terminology and content. With reference to scientific terminology, Nancy stated that “I understood more when I saw the results”, which speaks to a deeper understanding that was gained by being able to observe the experimental processes that the learners carried out themselves. This is especially important in contexts where difficult concepts are completely new and foreign to learners and when they do not have any current cognitive structures to accommodate and compare the new information with. Being able to visualise the processes allows learners to increase their knowledge base and serves as a reference point for any further usage or expansion of the concepts. As the meaning of these concepts becomes clearer, the problems with interlocking definitions and semantic discontinuity, as stated by Seah et al. (2014), become less of a challenge for learners being taught in a language other than their mother tongue. Learners are able to assign new meanings to everyday words and to analyse the concepts in different contexts, which lead to an increase in their lexicogrammatical skills. By improving their lexicogrammatical skills, they are ultimately increasing their skills in the language of science.

An increase in understanding goes hand in hand with an improved ability to remember the content. Only concepts that are understood and accommodated into current cognitive structures can be processed into long-term memory stores. Olga mentioned

that because the participants did more practical work, they were able to remember it better. She found it easier to visualise the practical work than the written words when trying to recall the information during assessments.

5.3. PERSONAL SPACE AND RESEARCHER REFLECTIONS

This study validated my views as Life Science teacher that learners who were being taught in a language that was not their mother tongue, struggled with Life Sciences because of their inability to master the technical terminology initially. The research provided me with insight into what these learners went through when trying to master the information in the various subject areas.

The individual interviews created a space for learners to open up about their feelings towards and experiences of being taught in English as well as about Life Sciences. Some learners spoke their minds and shared their feelings openly as a way of venting their frustrations about their situation. Although each participant expressed her-/himself differently, one fact remained a constant: they struggled with terminology and vocabulary. Their challenges spurred me on and led to this action research process. I felt compelled to find a solution. This led me to create the visual aids programme and to research whether its implementation could address some of their challenges in understanding the subject content.

During the implementation of the study, I had to be aware constantly of the different roles that I had to fulfil as I had to act as teacher and researcher at the same time. I managed to keep to my original plan of compartmentalising the two roles and passively observed the participants as they were interacting with the visual aids. I only intervened

when I noticed that learners were not paying attention. During the group work activities, however, there were not many instances of learners not taking part. When they did not understand, they asked each other for assistance. Only during the individual writing activities that functioned as a form of informal assessment did the learners tend to lose focus and look around for guidance with comprehension. In smaller groups of two, the learners also looked at what other learners were doing in an attempt to copy their work for fear of doing it incorrectly. In response, I adopted my teacher role and mediated the situation by explaining again, giving helpful hints to keep them on track and motivating them to give their own responses by mentioning that it was about the activity, not necessarily the answer. Overall, the majority of learners took part eagerly and wanted to be part of the fun. Unfortunately, only seven participants completed the programme due to various factors such as transport problems while others chose to withdraw from participating in the study.

An expected outcome of the PAR method was that the participants were given the opportunity to become emancipated through their participation in the extra classes. This was the case as the learners found value in the alternative teaching method that they were presented with. This method did not make use of words only; it also required them to take part in visual demonstrations and activities. The aim was to create a safe space for them to deal with the language constraints that they experienced in a normal class setup. The focus group interview at the end of the programme was confirmation of the success of this method as they reported on the enjoyment and sense of inclusion that they had experienced from being part of these fun and interactive activities. Giving them the opportunity to access the information in a different format created positive feelings

towards the content that they would normally have found challenging and exclusionary. Their willingness to take part in this study speaks to a dire need amongst the learners to help them lessen their language challenges as they found Life Sciences enjoyable and wanted to achieve.

Although they found the visual aids effective, some learners continued to struggle with the terminology when having to use it. This finding supports my recommendation that for this strategy to be optimally effective, it needs to be implemented from an early age. This will help learners to master the necessary scientific skills needed to be successful in Life Sciences in high school as stimulating curiosity and creating an interest in science add to success.

5.4. RECOMMENDATIONS

In the South African school environment, the changing demographics in the classroom require teachers to take a critical stance about their teaching methodologies. They have to be aware of the multi-linguistic challenges of their learners and problematize how all learners can be included in the learning process. This is easier said than done.

Although legislation with regard to language exists, not enough is being done to create practical guidelines and methodologies that teachers can actually use to manage these challenges. Many teachers are unable to teach the diverse learner populations effectively due to a lack of practical guidelines and effective pedagogy.

In Life Sciences, these problems are amplified as the subject contains many difficult technical terms, words and concepts that learners struggle to understand because of language barriers. In the Life Sciences classroom, an effective teaching methodology

that is able to support learners who are being taught in a language that is not their mother tongue is therefore required. The results of my study encourage me to recommend the use of visual aids as a teaching methodology to help support learners in the Life Sciences class. Visual methodology allows second- or third-language learners to be included in the learning process as visual activities serve as bridges to decoding of difficult words. Learners can take part in practical demonstrations and see the content in action rather than having to struggle through pages covered with words and concepts that are never truly understood or internalised.

I believe that for this visually supported methodology to be truly effective, the earlier it is introduced to facilitate learning in the science curriculum, for non-native speakers of English, the greater their chances for success are. When learners who experience language barriers start high school, they have already been exposed to many years of inadequate science education. Language barriers have already resulted in limited basic science skills, which impede their success with science at high school level. Introducing visual practical work as part of the science curriculum in primary school already can cultivate the scientific curiosity and skills that are needed for excellence in science and the possibility for a career in science.

5.5. SUGGESTIONS FOR FUTURE RESEARCH

This study was delimited to Grade 10 Life Sciences learners who were being taught in English, which was not their mother tongue. It would be interesting to do a comparative study that also include English mother tongue learners experience of visual tools' use in Life Science. Its unique vocabulary borrows from Latin and can be challenging for all

learners, not only learners who are being taught in a second or third language. Further research is needed with native English speakers to determine whether such learners experience similar challenges with Life Sciences.

Research into how learners at primary school level experience science and the level of competence that is created as a base for development of skills in science could also be valuable. Research could shed light on which science skills must be developed from a young age to ensure the development of the curiosity that drives all sciences. It is important that primary school teachers be supported in developing the necessary specialised skills in learners. Research in these areas can make an important contribution towards developing appropriate teaching methodologies that support learners in the Life Sciences class.

5.6. CONCLUSION

In this study I investigated the value that visual teaching aids facilitate non-native English learners' learning of difficult Life Sciences concepts and terminologies.

The study findings confirmed the general assumption that learners struggled with the vocabulary used in Life Sciences. In an effort to understand how the use of visual aids could be used as a teaching strategy to facilitate the comprehension of these abstract concepts, a visual aids programme was implemented. The experiences of the participants in response to this programme highlighted the value that visual strategies added to their understanding of this learning area and how this spoke to the challenges that language posed to achievement. I found that by using visual teaching methods, constructivist teaching was promoted, which enhanced scientific skills and

understanding. Visual strategies can serve as a tool to be utilised by Life Sciences teachers to support learners who are being taught in a language that is not their mother tongue in an effort to help such learners to reach their full potential. The insights gained during this study can thus inform teaching practice.

REFERENCES

- Berg, B.L. (2009). *Qualitative research methods for the social sciences 7th ed.* Boston: Pearson.
- Berg, H., Petrón, M., & Greybeck, B. (2012). Setting the foundation for working with English language learners in the secondary classroom. *American Secondary Education, 40*(3), 34-44.
- Carrier, K.A. (2005). Supporting science learning through science literacy objectives for English language learners. *Science Activities, 42*(2), 5-11.
- Cohen, L., Manion, L., & Morrison, K. (2011). *Research methods in education (7th ed.)*. London: Routledge.
- Creswell, J.W. (2009). *Research design: Qualitative, quantitative and mixed methods approaches. 3rd ed.* Thousand oaks: SAGE Publications.
- Cross, C., Mngadi, T., & Mbhele, T. (1998). Constructing migration: Infrastructure, poverty and development in KwaZulu-Natal. *Development Southern Africa, 15*(4), 635-659.
- Daniels, D. (2006). Using visual methods to bring marginalized people to the centre. In S.B. Merriam, B.C. Courtenay, & R.M. Cervero (Eds.). *Global issues and adult education: Perspectives from Latin America, South Africa and the United States, 129-142*. San Francisco: Jossey-Bass.

Dednam, A. (2011). First language: Difficulties in spoken language. In E. Landsberg, D. Krüger, & E. Swart (Eds.). *Addressing barriers to learning: A South African perspective* (2nd ed.), 126-142. Pretoria: Van Schaik Publishers.

DeKeyser, R.M. (2009). Cognitive-psychological processes in second language learning. In M.H. Long & C.J. Doughty (Eds.). *The handbook of language teaching* (119-138). Chichester: Wiley-Blackwell.

Denzin, N.K., & Lincoln, Y.S. (2011). *The SAGE handbook of qualitative research*. Thousand Oaks: SAGE.

Department of Education. (1997). *Language in education policy*. Pretoria, South Africa: Department of Education.

Department of Education. (2011). *Curriculum and assessment policy statement grades 10–12: Life Sciences*. Pretoria: Department of Education.

Donald, D., Lazarus, S., & Lolwana, P. (2010). *Educational psychology in social context: Ecosystemic applications in southern Africa*. Cape Town: Oxford University Press.

Dong, Y.R. (2002). Integrating language and content: How three biology teachers work with non-English-speaking students. *International Journal of Bilingual Education and Bilingualism*, 5(1), 40-57.

Ebersöhn, L., Elof, I., & Ferreira, R. (2007). First steps in action research. In K. Maree (Ed.), 123-143. *First steps in research*. Pretoria: Van Schaik Publishers.

- Ferreira, J.G. (2011). Teaching Life Sciences to English second language learners: What do teachers do? *South African Journal of Education*, 31, 102-113.
- Finkelstein, E., & Samsonov, P. (2008). PowerPoint for teachers: Dynamic presentations and interactive classroom projects. San Francisco: Jossey-Bass.
- Gallagher, C. (2015). Minecraft in the classroom: Ideas, inspiration and student projects for teachers. Berkeley: Peachpit Press.
- Hiralal, K. (2015). Migration and education narratives of student mobility in South Africa. *The Oriental Anthropologist*, 15(2), 331-344.
- Hummel, K.H. (2014). Introducing second language acquisition: Perspectives and practices. Chichester: John Wiley & Sons.
- Israel, M., Maynard, K., & Williamson, P. (2013). Promoting literacy-embedded, authentic STEM instruction for students with disabilities and other struggling learners. *Teaching Exceptional Children*, 45(4), 18-25.
- Kemmis, S., & Wilkinson, M. (1998). Participatory action research and the study of practice. In B. Atweh, S. Kemmis, & P. Weeks (Eds.). *Action research in practice: Partnerships for social justice in education*, 21-36. London and New York: Routledge.
- Kvale, S. (1996). Interviews: An introduction to qualitative research interviewing. London: SAGE Publications.

- Kvale, S. (2009). *Interviews: Learning the craft of qualitative research interviewing* (2nd ed.). Los Angeles: SAGE Publications.
- Lee, O., & Buxton, C.A. (2013). Integrating science and English proficiency for English language learners. *Theory into Practice*, 52, 36-42.
- Martin, D.J. (2012). *Elementary science methods: A constructivist approach*. Belmont: Wadsworth Cengage Learning.
- McCallum, M. & Miller, J. (2013). Supporting English as an additional language students in Science: Integrating content and language. *Teaching Science*, 59(2):37-42.
- McKay, S.L., & Rubdy, R. (2009). The social and sociolinguistic contexts of language learning and teaching. In M.H. Long & C.J. Doughty (Eds.). *The handbook of language teaching*, 9-25. West Sussex: Wiley-Blackwell.
- McTaggart, R. (1997). Guiding principles for participatory action research. In R. McTaggart (Ed.). *Participatory action research: International contexts and consequences*, 25-44. Albany: State University of New York Press.
- McTigue, E.M., & Flowers, A.C. (2011). Science visual literacy: Learners' perceptions and knowledge of diagrams. *The Reading Teacher*, 64(8), 578-589.
- Merriam, S.B. (2009). *Qualitative research: A guide to design and implementation*. United States of America: John Wiley & Sons.

- Miles, M.B., Huberman, A.M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). California: SAGE Publications.
- Moore, E.A. (2015). A practical guide for adapting face-to-face course materials for effective online delivery. In B.H. Khan & M. Ally (Eds.). *International handbook of E-learning, Volume 1: Theoretical perspectives and research*, 227-246. New York: Routledge.
- Nel, N. (2011). Second language difficulties in a South African context. In E. Landsberg, D. Krüger, & E. Swart (Eds.). *Addressing barriers to learning: A South African perspective* (2nd ed.), 167-185. Pretoria: Van Schaik Publishers.
- Neuman, W.L. (2011). *Social research methods: Qualitative and quantitative approaches* (4th ed.). New York: Pearson.
- Nieuwenhuis, J. (2007). Qualitative research designs and data gathering techniques. In K. Maree (Ed.). *First steps in research*, 69-97. Pretoria: Van Schaik Publishers.
- Omar, Y.Z. (2012). The challenges of denotative and connotative meaning for second-language learners. *ETC: A Review of General Semantics*, 69(3), 324-351.
- Piaget, J. (1946). Piaget's theory. In P.H. Mussen (Ed.). *Carmichael's manual of child psychology* (3rd ed.). New York: John-Wiley & Sons.
- Poole, A. (2011). The online reading strategies used by five successful Taiwanese ESL learners. *Asian Journal of English Language Teaching*, 21, 65-87.

- Rieber, R.W. (1998). *The collected works of L.S. Vygotsky*. New York: Plenum Press.
- Ringbom, H., & Jarvis, S. (2009). The importance of cross-linguistic similarities in foreign language learning. In M.H. Long & C.J. Doughty (Eds.). *The handbook of language teaching* (). West Sussex: Wiley-Blackwell.
- Schunk, D.H. (2012). *Learning theories: An international perspective*. Boston: Pearson.
- Seah, L.H., Clarke, D.J., & Hart, C.E. (2014). Understanding the language demands on science students from an integrated science and learning perspective. *International Journal of Science Education*, 36(6), 952-973.
- Silverman, D. (2013). *Doing qualitative research* (4th ed.) London: SAGE Publications.
- Terre Blanche, M., & Durrheim, K. (2011). *Research in practice: Applied methods for the social sciences*. Cape Town: University of Cape Town Press.
- Turkoguz, S. (2012). Learn to teach chemistry using visual media tools. *Chemistry Education Research and Practice*, 13, 401-409.
- Ward, R.E., & Wandersee, J.H. (2002). Struggling to understand abstract science topics: A Roundhouse diagram-based study. *International Journal of Science Education*, 24(6), 575-591.
- Whong, M. (2011). *Language teaching: Linguistic theory in practice*. Edinburgh: Edinburgh University Press.

Wright, K., Eslami, Z., McTigue, E., & Reynolds, D. (2015). Picture perfect: Using quality graphics to support English language learners in science classes. *The Science Teacher*, 82(4), 41-46.

APPENDIX A

THE WESTERN CAPE EDUCATION DEPARTMENT PERMISSION FORM

THE PERMISSION FORM FROM THE SCHOOL HEADMASTER

THE RESEARCH ETHICS COMMITTEE PERMISSION FORM



Directorate: Research

Audrey.wyngaard@westerncape.gov.za

tel: +27 021 467 9272

Fax: 0865902282

Private Bag x9114, Cape Town, 8000

wced.wcape.gov.za

REFERENCE: 20170209 –8146

ENQUIRIES: Dr A T Wyngaard

Ms Carly King
Brackenvilla 2
Stanley Street
Brackenfell
7560

Dear Ms Carly King

RESEARCH PROPOSAL: EXPLORING VISUAL AIDS AS A TOOL TO UNDERSTANDING LIFE SCIENCES FOR ENGLISH SECOND LANGUAGE LEARNERS

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **18 April 2017 till 30 June 2017**
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Dr A.T Wyngaard at the contact numbers above quoting the reference number?
8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:

**The Director: Research Services
Western Cape Education Department
Private Bag X9114
CAPE TOWN
8000**

We wish you success in your research.

Kind regards.

Signed: Dr Audrey T Wyngaard

Directorate: Research

DATE: 09 February 2017

EBEN DONGES

B93, Kraaifontein, 7569 VanderBijstraat,
Kraaifontein, 7570

Tel: (021)988-7439/0
Faks: (021) 988-1441
E-pos; head@edonges.org.za

HOËRSKOOL



HIGH SCHOOL

18193, Kraaifontein, 7569 Van der Bijl street,
Kraaifonteln, 7570

Tel: (021)988-7439/0
Fax: (021)988-1441
E-mail: head@edonges.org.za

2 February 2017

TO WHOM IT MAY CONCERN

PERMISSION TO DO RESEARCH IN EBEN DONGES HIGH SCHOOL

Carly King is granted permission to do research in Eben Donges High for the proposed topic and title: Exploring visual aids as tool to understand Life Sciences for English Second Language learners.

RESEARCH QUESTION

How can the use of visuals with Life Science class aid English Second Language learners' understanding of the subject content?

SAMPLEGROUP

The population for the study is 12 Grade 10 Life Sciences learners. The criteria for selection is that they are being taught in English although their mother tongue is another language.

ACTIVITY

In the second term the participants will take part in an after school's programme which will take place twice a week for an hour for the duration of 6 weeks. During these classes they will complete practical lessons that will help them understand the Life Sciences content better.



WJ TAYLOR
PRINCIPAL

Departmental Ethics Screening Committee

Report

Ethics application reference number: SU-HSD-004275

1) Please argue the ethical risks that are related to the research proposal submitted for review, together with the DESC's proposals on how to avoid or mitigate these ethical risks. *(Rows may be added if space below is limited)*

Any ethical issues that need to be highlighted?	What must/could be done to minimise the ethical risk?
<p>It could probably be argued that improved understanding of subject content is not necessarily a direct consequence because of the use of visual media tools. Media tools still would still need to be facilitated through language (verbal explanations, mediation, etc.). For instance, sometimes learners' capacity for abstract reasoning is not fully developed and therefore they need to make use of concrete and instrumental explanations and examples in order to enhance deeper meaning. Therefore your choice of visual aids becomes very important.</p>	<p>Perhaps the student want to consider including an example of the type of visual aid (linked to specific scientific content) she intends on using during her workshop. This might show that she is aware of the link between cognitive development, for instance formal operational (abstract) thinking (Piaget) and the specific accompanied visual media tool.</p> <p>She could even consider reformulating her <u>second research question</u>, for example:</p> <p>How do <u>cognitively appropriate</u> visual aids facilitate their understanding of Life Sciences?</p>
Please address the following issues:	Other considerations:
Editorial	<u>Assent form</u> : you may want to consider replacing "pull out" with withdraw
	<u>Parent consent form</u> no.3 (Risk) ... to the participant

2) Please mark with an X the applicable risk classification assessed for this project:

Minimal risk	
Low risk	x
Medium risk	
High risk	

For definitions of the above risk levels, please consult the DESC guidelines on the DRD-website: [DESC Guidelines](#)

3) If Minimal or Low risk, should this application still be referred to the Research Ethics Committee for further review? (Please mark your decision with an X)

Yes

No

3.1) If YES, please motivate why the application has been referred for REC review:

4) Please mention any additional information that should be noted by the REC:

Reviewers: *Ms K Conradie and Dr L Damons (3 March 2017)*

APPENDIX B

INTERVIEW GUIDES

Interview guides

Exploring visual aids as a tool to understanding Life Sciences for English second language learners

Personal interview (Questions before intervention)

A. Background information

First I am going to start by asking you some general background questions.

Name

Age

Place of birth

Current location

Former schooling experience

Home language

B. Experience of Life sciences

Next I want to discuss your experience of Life Sciences.

Do you like Life Sciences? (if yes)

What do you like about Life Sciences?

What do you find difficult about Life Sciences?

What methods do you use to try and understand / learn Life Sciences?

C. Experience of being taught in English

Let us also discuss your experience of being taught in English.

What has it been like being taught in English? (if the participant say it is difficult) Then:

What do you find difficult about being taught in English?

How has it influenced your academic achievement?

Focus group interview (Questions after sessions)

D. Experience of the visual aids study

Now let's reflect on your experience of the session that you completed.

Pros and cons

Share your thoughts on learning Life Sciences through visual methods like we did during the day? (will it be helpful, practical...?)

What was helpful/not?

Likes and dislikes

What did you like about being taught in this way, through visual aids?

What did you not like about being taught in this way, through visual aids?

What would you recommend we do different?

E. In conclusion

Is there anything else that you would like to say or ask?

Thank you for your time and participation.

APPENDIX C

EXAMPLE OF THE CODING PROCESS

Transcription of focus group interview held on 16 May 2017

1 End of Session 3:

2 R: Ok, any high's and low's, what did you guys like, what did you not like?

3 Ka: I liked the experiment part mam.

4 R: Ok, the experiment parts?

Why, why was it nice? s Ka:

Because we got to play around with

the stuff...

6 R: Ok, play around with the things, yes...

7 Ka: ...and that you remember better than just sitting and writing.

8 R: Ja, that's true, you remember it better. Anybody else?

9 Av: Teamwork.

10 R: Teamwork is nice.

11 Ka: Running on the spot mam, it's kind of too late in the day for that (laugh

12 R: Ok, too late for running. Anybody else? Guys really, anything that you th

13 about...

14 Av: It was exciting.

15 R: Was it exciting? Ok guys, thank you, we'll leave it at that.

+ practical
• experiment
+ independent
+ investigation
• we got to play
around with the
stuff
• remember better
+ cognition
improved
+ teamwork
group work

— physical work
• to late for
running on the
spot ✓

+ exciting

APPENDIX D

EXAMPLE OF THE ASSENT AND CONSENT FORM



STELLENBOSCH UNIVERSITY

PARTICIPANT INFORMATION LEAFLET AND ASSENT FORM



TITLE OF THE RESEARCH PROJECT:

Exploring visual aids as a tool to understanding Life Sciences for English second language learners.

RESEARCHER: Ms King

CONTACT NUMBER: 021 988 7439

What is RESEARCH?

Research is something we do to find new knowledge about the way things (and people) work. We use research projects or studies to help us find out more about problems, what causes them and how we can solve them. Research also helps us to find better ways of helping people improve their life.

What is this research project all about?

This research project is about trying to find teaching methods that can help English second language learners understand Life Sciences better.

Why have I been invited to take part in this research project?

You have been invited to take part in this research project as you are a Grade 10 English second language learner with Life Sciences as a subject.

Who is doing the research?

I, Ms King, will be doing the research. I am one of the Life Sciences teachers at Eben Dönges High School and I am doing this project to help the learners in my school understand Life Sciences better.

What will happen to me in this study?

In this study you will be expected to attend an after school programme at Eben Dönges High School. The program will be for an hour totalling 14 sessions in my Life Sciences classroom (Room 30) for the duration of 4 weeks. During this programme you will be taking part in various activities such as doing experiments and building models. You will also be asked to answer some questions about your experiences in Life Sciences and of this study during group interviews at the beginning and at the end of the program.

Can anything bad happen to me?

Nothing bad can happen to you during this study. It is like attending class.

Can anything good happen to me?

There are some good things that can happen to you during this study. It is a good opportunity to improve your understanding of Life Sciences and it might help improve your marks.

Will anyone know I am in the study?

You will participate in the study with some of your fellow learners. Information about you and what you thought of the use of visual tools to teach difficult terminology in Life Sciences will be used in my thesis (type of project report) and given to my supervisor to mark but it will be kept anonymous.



Who can I talk to about the study?

If you have any questions or problems about this study you can talk to me, Ms King or contact my supervisor Prof. D. Daniels at 021 808 2324.

What if I do not want to do this?

You can refuse to take part in the study even if your parents said that you can take part. You can also stop taking part in the study at any time without getting in to trouble.

Do you understand this research study and are you willing to take part in it?

 YES NO

Has the researcher answered all your questions?

 YES NO

Do you understand that you can withdraw from the study at any time?

 YES NO

Name and surname (print)

Signature

Date



UNIVERSITEIT • STELLENBOSCH • UNIVERSITY
jou kennisvenoot • your knowledge partner

**STELLENBOSCH UNIVERSITY
CONSENT FOR CHILD TO TAKE PART IN RESEARCH STUDY**

Title of research study:

Exploring visual aids as a tool to understanding Life Sciences for English second language learners

Your child has been asked to participate in a research study involving Grade 10 English second language Life Sciences learners. I, Ms King (Life Sciences teacher at Eben Dönges High School), will be conducting the research as part of the Masters' thesis that I am completing at the Faculty of Education at Stellenbosch University. Your child has been identified as a possible participant in the study as he/she is a Grade 10 English second language learner with Life Sciences as a subject.

1. PURPOSE OF THE STUDY

The purpose of this exploratory study is to explore how the inclusion of visual tools can facilitate English second language learners' understanding of Life Sciences terminology.

2. PROCEDURES

If you agree that your child can participate in the study, he/she will be expected to attend an after school class in my Life Sciences classroom (Room 30) for an hour totalling 14 sessions for the duration of four weeks. During this time the participants will be involved in various class activities to enhance their understanding of certain concepts. They will also be asked questions about their experience of Life Sciences and their participation in the study before and after the programme in the form of focus group interviews.

3. POSSIBLE RISKS TO THE PARTICIPANT

No possible risks to the study is anticipated as the format will be similar to attending class.

4. POSSIBLE ADVANTAGES

There are possible advantages to the study. Participation in the study could lead to the learner improving his/her understanding of Life Sciences and this might lead to an improvement in marks.

5. REMUNERATION FOR PARTICIPATION

No remuneration will be offered for participation in this study.

6. CONFIDENTIALITY

Any personal information of the learners that becomes known throughout the study and that potentially could cause harm will be kept confidential and put forth anonymously in my thesis which my supervisor will mark. Confidentiality will further be ensured by saving data in locked folders on a secured computer which only I have access to. All voice recorded interview information will be destroyed as soon as my thesis is completed and marked.

7. PARTICIPATION AND WITHDRAWAL

You have a choice to let your child take part in this study or not. If you do decide to let your child take part in the study you can withdraw him/her at any time should they feel they want to, without any adverse effects.

8. IDENTIFICATION OF INVESTIGATOR

If you have any questions or queries about the study please feel free to contact me, Ms King, at Eben Dönges High School at 021 988 7439. If you have any queries that you would like to direct to my supervisor Prof. D. Daniels she can be contacted at 021 808 2324. If you have any queries that you would like to direct to the Department of Research Development at Stellenbosch University you can contact Me Maléne Fouché at 021 808 4622.

DECLARATION OF PARENT/GUARDIAN

I [print name and surname] have read the above information and understand it.

I hereby agree that my child may participate in the study.

Name of parent/guardian

Signature of parent/guardian

Date

DECLARATION OF RESEARCHER

I, Ms King, declare that I have given the correct information and will uphold a high standard of ethical behaviour throughout the study.

Signature of researcher

Date

APPENDIX E

EXAMPLE OF A TRANSCRIPT

1 R: Ok, first I am just going to ask you some general background questions, if you
2 can please just tell me your name and surname.

3 A: Um, it's Aviwe Mkiva.

4 R: Ok, and how old are you?

5 A: I am 17 years old.

6 R: Ok, uh, where were you born?

7 A: I was born in Eastern Cape.

8 R: Ok, uh, where do you currently stay?

9 A: I currently stay here in Kraaifontein.

10 R: Ok and then what was your former schooling experience, so where did you
11 start school and how did you come to this point?

12 A: I started school in Idudedwa in a school that was called Mida.

13 R: Where, where is the area?

14 A: It is in Idudwa

15 R: Where is that?

16 A: It's in Eastern Cape mam.

17 R: O ok ok. And then? Sorry carry on.

18 A: It was a, uh, a private school which I started there Grade R, Grade 1 then
19 Grade 2 I went out of the school. I went to a school that was called Mubetwoni,
20 then I started there Grade 3, then Grade 3, uh, in the middle of the year I came
21 back here in Cape Town to stay with my parents. Then I went to a school that
22 was called Samuramichelle, then I did Grade 3 Grade 4. Then in Grade 4 I
23 came here in Simonsberg where I studied until I came out of Simonsberg.

24 R: O, ok. Um, and what is your home language?

25 A: My home language is Xhosa.

26 R: Ok. Then I also just want to discuss your experience of Life Science. Do you like Life
27 Science?

28 A: I love Life Sciences.

29 R: What do you like about Life Sciences?

30 A: Um, it teaches you, um, more about, uh, specially a person, about things happening
31 in life.

32 R: Ja, and then also the body and those things are also nice. Um, what do you find
33 difficult about Life Science?

34 A: Um, lots of things, like you, you have to...it has lots of things like study a lot, but it's
35 not difficult but just the work it's alot.

36 R: Ja, and then, uh, what else? What's all the "lots of things"?

37 A: Umm...different things like different names that, umm, we're taught before, we're
38 never taught before in like NS, we're never taught such stuff like, umm, anaphases,
39 mitosis and stuff. It was different things, different learning, different parts of plants
40 and stuff.

41 R: And then all the words? How do you find the words?

42 A: I find them very difficult, some of them, but they interesting because Life Science...

43 INTERUPTION

44 A: When we start Life Sciences, when you get in Life Science class, it's about, you want
45 to know more about Life Sciences, more things in every day.

46 R: That is true. Uh, what methods or how do you study Life Science?

47 A: Umm, I study Life Sciences by practicing, I write Life Science because if I read Life
48 Sciences it will just come from one ear to another so I write Life Sciences, different
49 things, definitions and stuff.

50 R: Oe that is a good method. Ok, I also just want to talk about your experience about
51 being taught in English. Uh, what has it been like being taught in English?

52 A: Uh, it's, it's very nice because there's like some words that we also didn't know. If it
53 was another different language it would be also interesting, but English it's our
54 international language so it's nice to learn in English some kind of things in Life
55 Sciences.

56 R: Ja, especially if you can use it again later then it's nice. Is there something you find
57 difficult, difficult about being taught in English?

58 A: No, no, but words that you don't, like you don't understand, so to us, um, where we
59 don't use English as a common language at home, there's, um, there's different ways
60 that we talk English so it won't be the same as people that talk English at home, so
61 there would be some words that would twist so it won't make sense like explaining
62 stuff, people will, other people will find it difficult, like you won't put it as they want to
63 so...

64 R: O ja, that's interesting, of course. Ah that's a good point. What do you do to try and
65 understand, uh, if you don't understand the English, what do you do? Is there a
66 method that you use for example, umm, you put it in your own language or do you go
67 look up the words or is there methods that you use to try and...

68 A: I do them both mam, um, I go research the word and try and understand the word
69 and understand what's behind the word then put it in my own language then try and
70 figure out if, um, they, it matches with what I researched.

71 R: That's a good method. Uh, do you feel that being taught in English influences your
72 marks?

73 A: It does mam, it does, because I learn, um, other things in Life Sciences maybe, then I
74 try and apply, o, I, in English, then I try to apply in Life Science the words to make,
75 um, a good sentence structure.

76 R: Oe nice, that was a good interview, thank you for your time.