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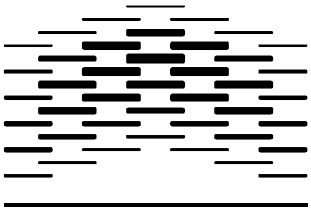
Crossing worldviews in the Life Sciences classroom:

A case of indigenous teachers and learners in South Africa



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Abstract

This thesis explores the extent to which a difference in worldviews between the Life Sciences curriculum, and indigenous Xhosa and Sotho teachers and learners, cause problems in teaching and learning. The thesis is guided by three research questions (RQ). RQ1 explores the extent to which the Life Sciences CAPS curriculum and textbook include concepts of "indigenous knowledge systems" and "worldviews". RQ2 explores the extent to which the Xhosa and Sotho teachers and learners' worldviews match the worldview in the Life Sciences CAPS curriculum and textbook. RQ3 explores the extent to which the crossing of epistemological borders causes problems in teaching and learning Life Sciences.

The theoretical framework that guides the thesis is seen from two perspectives: a) understanding the relationship between indigenous and Western knowledge systems through a historical lens of colonialism and modernization, and, b) understanding the crossing of epistemological borders through the theories of "cognitive border-crossing" and "collateral learning". A documentary analysis, two focus group interviews with Grade 10 and Grade 11 Life Sciences learners, and two individual interviews with two Life Sciences teachers generated the findings.

The findings suggest that there is an epistemological wall between the worldview of Life Sciences curriculum and textbook, and the indigenous worldviews of the teachers and learners. The epistemological wall is based on the exclusion of the spiritual and holistic worldviews of the participants through which they interpret natural phenomena, as well as the general marginalization of indigenous knowledge systems in Life Sciences. A transformation of the Life Sciences curriculum is called for where teachers and learners' holistic identities are accommodated at the same time they learn the value of indigenous and Western knowledge systems in science.

Keywords

Indigenous knowledge systems

Life Sciences

Worldviews

Epistemology

Border-crossing

Xhosa

Sotho

Abbreviations and Acronyms

AAAS:	Authors of the American Association for the Advancement of Science
CAPS:	Curriculum and Assessment Policy
CHAT:	Cultural Historical Activity Theory
DoE:	Department of Education
EMIS:	Education Management and Information System
LiEP:	Language in Education Policy
LoLT:	Language of Learning and Teaching
NCS:	National Curriculum Statement
NOS:	Nature of Science
PAC:	Practical Argumentation Course
RNCS:	Revised National Curriculum Statement
TIMSS:	Trends in Mathematics and Science Studies
WCED:	Western Cape Education Department
WEF:	World Economic Forum

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1. INTRODUCTION

This is a qualitative thesis that explores the extent to which a difference in worldviews, between the subject Life Sciences and indigenous teachers and learners, cause problems in teaching and learning.

This chapter is dedicated to an exploration of how the motivation for the thesis came about. I will discuss the background and context before describing the research problem. Thereafter, I provide insight into the relevance of this thesis and discuss the aim and objective of the research, as well as the research questions that guided the aim and objective. I will give a short description of the research design and end the chapter by describing the layout of the thesis.

1.1 Motivation for thesis

The motivation for this thesis came as result of my personal de-colonization process; a process I was exposed to during my course work for my master's thesis. After being introduced to authors such as Anders Breidlid, George J. Sefa Dei, Ngũgĩ wa Thiong'o and Catherine Odora-Hoppers, I became interested in exploring the colonizing structures inherent in science education in South Africa. These authors are of the opinion that there is a need for [1]indigenous knowledge systems to be used as a resource to uncover and eradicate the academic inequalities and loss of identity among African learners produced through Western-informed science education. Odora-Hoppers (2002), for example, states that colonialism and the science and language that accompanied it, still lingers in academic practices which leave non-Western societies with disempowering consequences. In addition, Dei (2012) discusses the importance of envisioning a "transformed African education" by giving recognition to African peoples as agents in the construction of their own knowledges. My personal reflection was probed by Ngũgĩ wa Thiong'o (1981) who discusses how, although Africans have been physically de-colonized, their minds are still colonized because of Western knowledge systems and

[1] The terms "indigenous knowledge systems" and "indigenous knowledges" will be used interchangeably throughout the thesis.

colonial languages that still dominate in African education systems. Because the ideas by these authors resonated with me, I was motivated to explore their ideas in relation to science education further.

1.2 Background

I dedicate a section to the background, in order to understand the concept and context of the problem statement which I discuss in 1.3.

The coloureds of South Africa, which have ancestry of mixed lineage because of colonization and Apartheid, were mostly associated with first nation's indigenous people called the San and the Khoekhoe. The San and the Khoekoe today make up only 1% of the population (IGIWA, 2017). The black racial groups, on the other hand, which are the focus of this thesis, make up 80% of the South African population (Statistics South Africa, 2011). The black ethnic groups in South Africa stem mainly from the Southern Bantu group which migrated to South Africa from the north. As a consequence of colonization and Apartheid, the black population was, and still is, divided into the ethnic groups of Zulu, Xhosa, Ndebele, Swati, Sotho, Tswana, Tsonga and Venda (SAHO, 2015). These black ethnic groups are also considered indigenous groups, but not the first nation's indigenous peoples like the San and the Khoekhoe.

During the early 1900's South African colonies were under British control. Missionaries came to the cape to spread the Christian gospel and to teach people their Christian ways. With the discovery of minerals, the mining industry grew and social reformers made education free and compulsory for the whites to provide skilled labour, while education for blacks was not free or compulsory (Christie, 1986, 1999). Due to the unbearable living conditions in reserves ordered by whites for blacks, the blacks started moving back into the urban areas and set up squatter camps, today also known as townships. Therefore, a township is known as an under-developed urban living area that was reserved for non-white residents. Townships came as a result of the Group Areas Act (1950) during Apartheid which assigned racial groups to different residential areas in urban areas (SAHO, 2015). Although this act was abolished in 1991 (Abolition of Racially Based Land Measures Act,

1991), the majority of blacks who stay in urban areas still live in townships. I will relate the significance of the background I provided here, to the problem statement I discuss next.

1.3 Problem Statement

South Africa has undergone three curriculum revisions since the beginning of Democracy in 1994. One of the reasons for the curriculum revisions was to rectify the unequal education between the racial groups which provided the blacks with an inferior education during Bantu Education (1953-1976) during Apartheid. The curriculum revisions are marked by three periods. After Apartheid, Outcomes Based Education was adopted in South Africa in 1997 and borrowed from countries such as New Zealand. Outcomes Based Education (OBE) was also used synonymously with Curriculum 2005 (C2005) (le Grange, 2004b; Mnguni, 2013). In 2000, OBE was revised which resulted in the production of the "Revised National Currciulum Statement (RNCS) Grades R-9" and the "National Curriculum Statement (NCS) Grades 10-12" (DoE, 2011). In 2009 the curriculum was revised again which resulted in a single document called the "National Curriculum Statement (NCS) Grades R-12", which is the current curriculum in South Africa. Included in the NCS are the curriculum and assessment policy statements (CAPS) which are individual policy statements for all approved subjects in South African schools (DoE, 2011). Each CAPS document states the following: the purpose of the subject, the teaching and learning time allocated to a subject, the organization of the subject and the concepts and content to be learned. The CAPS for each subject also includes aims and skills that learners are supposed to learn in that subject.

The general discourse in the CAPS-curriculum addresses notions of rectifying the past. It also includes ideas that are mindful of the country growing and competing on a global scale as stated in the General Aims. The General Aims are seen below:

(a) The curriculum promotes knowledge in local contexts, while being sensitive to global imperatives
(b) Equipping learners irrespective of socio-economic background, race, gender, physical or intellectual ability…

(c) Social transformation [and] redressing past educational imbalances [for] equal educational opportunities (DoE, 2011, p. 4).

One of the systems in place for reaching the aim of "redressing educational imbalances of the past" and "being sensitive to local imperatives" is the inclusion of Indigenous knowledge systems in science subjects like Natural Sciences, Social Sciences, Physical Sciences and Life Sciences (DoE, 2011). The inclusion of Indigenous knowledge systems and a new language policy were part of the aims that were set for black Africans of South Africa to return to their Indigenous African roots when it came to science and agriculture, which was the main premise of the African Renaissance movement advocated by Thabo Mbeki (Breidlid, 2013). The General Aims theoretically capture what Freire and Faundez (1989) mean when they suggest that Indigenous knowledge systems is a rich resource for any justice related attempt to bring about social change when seen in the context of South Africa's discriminatory past.

1.3.1 Border crossing: a case of science education in South Africa

With the inclusion of Indigenous knowledge systems in the science curriculum, the science curriculum acknowledges the fact that learners will have to cross between two different worldviews. In relation to Natural Science, this is what is stated:

> The existence of different worldviews is important for the Natural Science Curriculum… Several times a week learners cross from the culture of the home, over the border into the culture of science, and then back again (DoE, 2002, p. 12).

According to Onwu & Mosimege (2004, p. 1), the science curriculum "failed to consider how the recognition and valuing of indigenous knowledge systems could provide tension". In this thesis, I explore the tensions that are caused as a result of border-crossing between two worldviews.

1.4 Relevance of thesis

While the NCS, the RNCS and now the CAPS documents tried to promote equality in its policy, the reality is that, still, a majority of the learners in South Africa who are performing poorly academically, are from the black population (All Africa, 2016). According to the Stellenbosch University Socio-Economic Policy Unit, in 2014, "98.3% white pupils who wrote matric (Grade 12 examinations) in South Africa passed while only 72% of black African pupils did" (All Africa, 2016).

A press release by All Africa in January 2016 stated that in order to "transform existing patterns of inequality in South Africa a serious and comprehensive review of the education in South Africa is needed". le Grange (2004b, p. 83) also argues that if indigenous knowledge systems are to contribute to South Africa's transformation, education has a key role in the transformation of social life in South Africa.

In as much as I view the significance of this thesis as an academic contribution to research in science education, I also view it as a platform for personal reflection. I come from a South African background where I was able to receive science education in my mother tongue. With my background in science teacher training, and language-in-education studies, I am familiar with the academic difficulties faced by the majority of South African learners, who happen to be "black" and who are not taught in their mother tongues. However, through my de-colonization process which was [ironically] informed through Western education, I have begun to explore the probability of a difference in worldviews in science education, as a contributor to poor academic achievement. I found it worth looking into the worldviews of teachers and learners from the Xhosa and Sotho indigenous groups, in order to draw insight from their experiences in the Life Sciences classroom where they are exposed to two different worldviews: the Western and the Indigenous worldview. I do this in light of Dei (2012, p. 132) who states: "In claiming a voice, one needs to step outside his/ her cultural context and worldview to appreciate other people's ways of knowing or bodies of knowledge".

1.5 Aim and objective

The aim and objective of this study is twofold: a) to explore the extent to which the worldviews of the Xhosa and Sotho teachers and learners match the worldviews of the Life Sciences curriculum, and b) to what extent a difference in worldviews causes problems in teaching and learning Life Sciences. Within reaching the aim and objective of the thesis, three research questions guided the thesis.

1.5.1 Research Questions

The concepts "Indigenous knowledge systems" and "worldviews" are mentioned throughout the CAPS curriculum statement (DoE, 2011); however, I narrowed it down by focusing on the subject Life Sciences (Grades 10 to 12). The study will be informed by the following research questions (RQ):

RQ1: How does the current CAPS document of Life Sciences (Grade 10-12) and CAPS-informed Life Sciences textbooks address the concepts of "indigenous knowledge systems" and "worldviews"?

RQ2: To what extent are the Xhosa and Sotho teachers' and learners' worldviews similar or different to the worldviews in the [2]Life Sciences curriculum and textbook?

RQ3: To what extent does the crossing of epistemological boarders – in terms of two different worldviews – cause problems in the teaching and learning process of Life Sciences?

1.6 Research design

The thesis is based on a qualitative research design since it dealt with teachers and learners as subjective beings who gave insight into their individual experiences (Cohen, Manion and Morrison, 2011). The study was carried out in one high school in a township called Gugulethu which is in Cape Town, South Africa.

[2] I will use the term "Life Sciences curriculum" and "Life Sciences CAPS document" interchangeably throughout the thesis. Both terms refer to the document/ statement for the subject Life Sciences.

An analysis of the Life Sciences CAPS document and textbook was done in order to assess how the curriculum has addressed the inclusion of different worldviews and epistemologies. Semi-structured interviews with two Life Sciences teachers were conducted in order to get a better understanding of their worldviews. Two focus group interviews with Grade 10 and Grade 11 Life Sciences learners were conducted for the same reasons as the aforementioned. The data was analyzed through a coding and categorization process after the data was collected and transcribed (Cohen, Manion and Morrison, 2011). The themes that came from the data analysis are discussed in Chapter 4 of the thesis.

1.7 Layout of thesis

The first chapter provided the introduction to the thesis. Chapter Two provides the Theoretical Framework of the thesis which is divided into two sections namely, the history of marginalization of Indigenous knowledge systems, and the relevant theories related to this study such as the Third Space Theory and Cognitive Border-Crossing. I also highlight several South African studies that have been conducted and which are similar to the topic of this thesis. Chapter Three discusses the methodology on which the thesis is premised. Chapter Four is dedicated to the discussion and analysis of the findings. In Chapter Five I discuss the conclusion and the way forward.

2. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

This chapter will provide a theoretical framework and literature review for the thesis. The chapter will be divided into three sections. The first section (2.1) focuses on defining the key concepts in the thesis and a historical lens of the marginalization of Indigenous knowledge systems. The second section (2.2) provides the theoretical framework which will be understood in the framework of the Third Space Theory, Cognitive Border-Crossing and Collateral Learning. In the third section (2.3) I highlight several studies, similar to this thesis, that have been done in South Africa.

2.1 The historical lens of epistemological conflict

This chapter is limited to theories and literature of the key concepts in this thesis. These concepts are: worldviews, epistemology Indigenous, Indigenous knowledge systems and Western. For clarification purposes it is important to define these concepts at the outset after which they will be placed and understood through a historical lens of epistemological marginalization and conflict.

Worldviews

A straightforward understanding of the word "worldview" is the way in which one views the world, how assumptions influence the way one views the world and how these assumptions affect one's thinking, actions and practices. Kearney (1984, p. 1) leans towards such a definition when he states that decisions and behaviour are determined by a particular worldview held by a group of people. This worldview is based on interrelated assumptions which he defines as "a culturally-organized micro-thought". Fakudze (2004, p. 270) shares a similar view and states that a worldview is "a way of looking at reality and assumptions that provide a more or less coherent way of thinking about the world… and the epistemological structure by which reality if affirmed". Jegede (1997a, p. 5) links worldview with culture, stating that one's culture determines one's thoughts, feelings and actions. The three definitions above have influenced the way worldview will be used and understood in the thesis: a culturally-organized, subconscious interpretation of the world as influenced or held by a culture or group of people which determine thoughts and actions.

Important to note in the definitions above are the terms "culture" and "a group of people". These terms imply that a particular culture has a particular worldview, assuming that not all worldviews are necessarily based on the same set of assumptions. In this thesis, two worldviews in particular are highlighted: the Indigenous worldview and the Western worldview.

Epistemology

Epistemology deals with the theory of knowledge and what counts as knowledge. Epistemology also deals with the methods of how a certain epistemology or knowledge system is validated and legitimized (Odora-Hoppers, 2002; Visavanathan, 2002). Goduka (2012, p. 131) states that epistemology is based on "a set of assumptions about the ways in which it is possible to gain knowledge of reality, how what exists may or can be known, and what criteria must be satisfied in order to be described as knowledge". Therefore, in this thesis, epistemology will be used in reference to the methods and criteria used to legitimize a particular knowledge and reality. Epistemology and worldview are often used simultaneously. According to Goduka (2012) one's epistemological position reflects the way we can know about the world, and how we can know it. A worldview is based on a particular epistemological basis, which means that there is more than one epistemology. As with worldviews, Indigenous and the Western epistemologies are focused on in this research.

Indigenous

This thesis is primarily based on the concept of "Indigenous", its worldview and epistemological basis, especially in relation to science education. Before placing it in the context of science education, an appropriate definition is needed. Odora-Hoppers (2002, p. 8) defines Indigenous as "something natural or innate which is an integral part of culture". Her definition can be related to Hewson (2012, p. 318) who states that "different cultures develop from the particular histories, geographic movements, and psycho-social-spiritual characteristics of a group". According to these definitions Indigenous can be understood in the same way one understands "original", "aboriginal", "local", "native" or "inborn". People who are Indigenous are therefore the original people of a particular region or place

who take on a particular worldview. Examples of Indigenous peoples are the Maori of New Zealand, Inuit of Canada, Indigenous Hawaiians, Australian Aborigines and the Mapuche of Chili. Of specific interest in this thesis are the Xhosa and Sotho Indigenous groups of South Africa. The San and the Khoekhoe are the first nation's peoples of South Africa, but ethnic groups like the Xhosa and the Sotho are also associated with indigenous groups of South Africa even though they migrated from the north of Africa (IGIWA, 2017). Indigenous groups have knowledge systems that are specific to their particular group and which is, for the most part, very different from the knowledge system that dominates in the West and many African countries (Shizha, 2010).

Indigenous knowledge (epistemological) systems

When authors define Indigenous knowledge systems, many of them relate it to knowledge or "knowledges" (Breidlid, 2013) that are traditional and culture-specific, which are orally passed on from generation to generation. Indigenous knowledges are also referred to as "local" and "traditional" knowledge (Breidlid, 2013; Dei, 2002; Higgs, 2006). For Khupe (2014, p. 12), "Indigenous knowledge systems abides in the hearts and minds of Elders and specialist knowledge keepers and are regarded as a heritage for practical and survival purposes". Dei (2002, p. 4) contributes to this definition when he talks of the "epistemic saliency of cultural traditions, belief systems and worldviews that are important to the younger generation by community elders [which is based on] cognitive understandings and interpretations of the social, physical and spiritual world". According to Ntuli (2002), "African thought sees life as a cycle; the world as an interconnected whole, and that our survival depends on how these forces interact with each other" (p. 58). Dei (2002) states that these elements constitute an "Indigenous informed epistemology". Indigenous knowledge systems include values and rituals that are to be performed for certain ceremonies. Most Indigenous knowledge systems are based on respect for the relationship between man and nature, as well as the respect for a higher power such as the belief in ancestors, for which the aforementioned rituals are often performed in honour of (Breidlid, 2002; 2013; Hewson, 2012). In the African context in particular, these rituals, according to Ntuli (2002, p. 58), follow Indigenous people throughout their lives "from birth, through

initiation ceremonies, weddings and funerals". The Xhosa and Sotho Indigenous groups of South Africa also include such rituals. Their epistemology is elaborated below.

The Xhosa and Sotho worldview and epistemology

The Xhosa and Sotho Indigenous groups in South Africa are the focus of this thesis. Based on language statistics in, the Xhosa make up 28% of the black population, while the Sotho make up 9.3 % of the black population in South Africa (StatsSA, 2011). The linguistic make-up generally coincide with the ethnic make-up of South Africa. Many authors have highlighted that Indigenous groups are not homogenous and the same all-round (Green, 2012; Ogunniyi, 2007; Onwu & Mosimege; 2004; Khupe, 2014; Semali & Kincheloe, 1999). For example, the Maori of New Zealand and the Mapuche of Chile are not the same, just like the Khoekhoe and the Xhosa in South Africa are not the same. In general, much of the consulted literature on African Indigenous groups talks of the common African Indigenous knowledge system and rarely, it seems, focuses on one particular Indigenous group. It is not possible to say that the Xhosa and Sotho Indigenous groups are the same, because they have obvious differences particularly in terms of their original locality and language. However, the two groups nevertheless share similar traits when it comes to issues of ancestors, traditional healing, rituals and religious practices. The next section will be dedicated to a brief discussion into the aforementioned worldviews of the Xhosa and Sotho.

Place

The identity construction of rural and urban Xhosa and Sotho is bound to a geographical place or location where Indigenous, religious practices take place. This particular "place" referred to is also called the "homestead" and refers, in most cases, to the rural parts of the Eastern Cape of South Africa for the Xhosa and Free State in South Africa for the Sotho. Even with the growth of modernity where the move to urban locations is rapidly taking place, identity, particularly among the rural Xhosa [and Sotho], is tied to place, which is "both a physical location and a carrier of meaning" (Breidlid, 2002, p. 40).

Religious practices for ancestors

Place, for the Xhosa and Sotho, as defined above is also closely linked to the performance of religious practices and ceremonies. According to Breidlid (2002, 2013), in the Xhosa culture, there is "little separation between the present and the past, the living and the dead". Ancestors play a prominent role in the lives of both the Xhosa and Sotho, and worshipping them through rituals and ceremonies stand out as the most important element in this Indigenous systems. The rituals that are performed include the slaughtering of a cow when someone has died as a sacrifice to the ancestors, as well as the making and drinking of traditional beer called "umqombothi", which can also be symbolically received by the ancestors when thrown on the ground. Ancestors often come in dreams to send a message, and if not obeyed, a person can be punished or bewitched (informant in Breidlid, 2002, p. 41). While the belief in ancestors is held by the majority of Xhosa and Sotho, there are also those who do not believe and instead choose Christianity as the major source of higher power. Christianity was heavily influenced by "Westernization" and "modernization" when missionaries used Christianity during colonization (Khupe, 2014). However, with the rise of modern science, the spiritual aspect has been undermined in modern societies (Delanty, 2000) and have instead become "Africanized" (Ranger, 1987, p. 43 in Breidlid, 2002).

Two religions

Although there are Xhosa and Sotho who believe either in ancestors, or Christianity, there are also those who hold parallel belief systems. During his fieldwork, Breidlid (2002, 2013) found that many of the Xhosa informants also practiced the religion of Christianity simultaneously with the worshipping of ancestors (Breidlid, 2002). The ancestors are seen as the link to God. According to Breidlid (2002, 2013), the belief in God from a Christian point of view means that the indigenous belief is no tied to the sole belief in ancestors, but that

> Christianity has been incorporated in the indigenous belief system, and that the territories that these belief systems occupy are not mutually incompatible. Indigenous Xhosa [or

> Sotho], therefore, transcend what can be termed the Indigenous identity" (Breidlid, 2013, p. 90).

This belief in two "higher" masters also means going to two kinds of doctors, a traditional doctor and a medical doctor (Breidlid, 2002, p. 4). This is also emphasized by Hewson (2012, p. 318) who moves more towards a general African worldview when saying that "Traditionally, Africans believe that all spiritual powers come from the African concept of God, and exist… through ancestors, living people, animals, vegetation, rocks and soil… and earth itself". The spirituality highlighted by Breidlid's (2002, 2013) and Hewson (2012) is also in line with Dei (2012) who explains that the ""indigene" is a holistic form of knowledge where it becomes impossible to separate the mind, intellect and the spirit. We become whole persons with a connection to past, present and future" (p. 131). The last element looks at traditional healing. It is important to highlight that religion and religious practices are not all that make up the Indigenous knowledge system of the Xhosa and Sotho, but it is worth noting that it plays a prominent role in their worldviews (Dei, 2012; Hewson, 2012; Khupe, 2014).

Traditional healing

Breidlid's work (2002, 2003, 2009, 2013) on Xhosa Indigenous religious practices and his writing on the aspect of traditional healing can be supported by Hewson (2012) who has researched the role of Basotho and Xhosa traditional healers in education. According to Hewson (2012), the majority of African populations consult traditional healers for help with their problems - physical or psycho-spiritual. Traditional healers also operate through ancestors, according to the participants in Hewson's research (2012). Two types of traditional healers can be distinguished: *Sangomas*, also known as diviners, and *Nyangas*, also known as herbalists (Breidlid, 2013; Hewson, 2012). These traditional healers, according to Hewson (2012), have in-depth knowledge of herbal and animal-based medicines. They also offer therapeutic actions through rituals. Onwu and Mosimege (2004), however, caution us in equating Indigenous knowledge with traditional healing only. They state that although traditional healing and related medicines are very important

components of Indigenous knowledge in Africa, they are just one of the many elements that form part of it (p. 4).

The above section aimed to provide insight into what makes up the Xhosa and Sotho Indigenous worldview and epistemological basis, informed by research done by Breidlid (2002; 2013) and Hewson (2012). Their worldview is based on the epistemological basis of sacredness of the earth, spirituality or religion, ancestry and rituals. This epistemology extends through to the roles of traditional healers who have extensive knowledge of herbal and animal-based plants which offer healing. Traditional healing and spirituality may not necessarily be subscribed to everybody although it is a strong-held belief by many African Indigenous people (Onwu & Mosimege, 2004).

Western

The term "Western" is a key concept in this thesis and plays a big part in the later discussion of the marginalization of Indigenous knowledge systems in science education in particular. The term Western gets its origin from the scientific revolution that originated in Europe and spread to the rest of the Western world and other non-Western countries during the colonization and the scientific revolutions of the 17th century (Cronje, de Beer & Ankiewicz, 2015). Terms that are associated with West or Western in the literature are colonialism, industrialization and globalization. In its relation to non-Western countries, the discourse is dominantly premised on the power, superiority and domination of the West over these non-Western countries such as African countries. Breidlid (2013) and Taylor (2006) therefore refer to Western science and knowledge as a "hegemonic epistemology" which is how it will be understood in the context of this thesis.

The key concepts have been defined and will now be brought into the discussion of the marginalization of Indigenous knowledge systems in the subject of science in education. The section will first be dedicated to a brief discussion of the conflicts between Indigenous and Western science through a historical lens of colonialism and modernity, which will lead the way into the discussion of the epistemological conflict and the "nature of science" (NOS).

2.1.1 The marginalization of Indigenous knowledge systems

Now that the key concepts have been defined, it is useful to extend the understanding of Indigenous knowledges by placing it in the context of science. In science, Indigenous knowledges have been given an inferior status to Western knowledge systems. 'Western knowledge' is traditionally characterized as modern, scientific and rational (Gyeke, 1997; Tucker, 1992). Indigenous knowledges are traditionally characterized as primitive, traditional, aboriginal, vernacular or African (Gyeke, 1997; le Grange, 2004b; Tucker, 1992). According to Shizha (2010), indigenous knowledges are also viewed as "mythical and mystical". This has led to the marginalization of Indigenous knowledge in science education (le Grange, 2004b; Odora-Hoppers, 2002; Ogunniyi, 2007). The term "marginalization" assumes that Indigenous knowledge systems have not been entirely absent in the context of science, but that, hierarchically, Western science is dominating (Dei, 2002; 2012; Hountandhi, 2002; Shizha, 2010). The dominance of Western science can be attributed to the conflict in epistemological basis of both systems (Dei, 2002, le Grange, 2004b) which will be discussed later. The history of conflict between Western and Indigenous knowledge systems can be attributed to the strong Western forces of colonialism and modernity.

Colonialism and modernity

The reality of colonialism and modernity in non-Western countries such as South Africa resulted in deeming knowledge systems in these countries as irrelevant. The scientific inventions of the 17th century and technological revolution of the 18th century were prominent events in the history of modernity (Breidlid, 2003, p, 88). Colonization and these scientific and technological revolutions, along with the isolation of secular from the spiritual in modern worldviews, have led to the West's tendency to define reality for others (Taylor, 2006). According to Jegede (1997a, p. 5), "Modern science serves to separate the Western way of thinking from the so-called primitive thinking represented by non-western forms of thought". Le Grange (2004b, p. 87) is also right when she states "Of course, Western science's powerful position also has been abetted by the use of military power and imperialism". Colonialism and modernity have thus also led to the concept of

"Orientalism", also referred to as "Othering" (Said, 1979). The Orientalist discourse is based on an epistemological dichotomy between the Self and the Other, with the Other being subordinate to the Self, or the South, in this case, Africa, being subordinate to the West. Othering, according to Said (1979), is done in terms of race, gender, knowledges, and education systems whereas hegemonic epistemology was the only way to progress and develop. In the South African context, blacks, coloured and Indians were Othered by whites during Apartheid (Breidlid, 2013).

The discussion on the history of conflict between Indigenous and Western knowledge systems referred to the marginalization of Indigenous knowledge systems. The discussion will now turn to the epistemological conflict between Western and Indigenous science. In this discussion it is vital to focus on the nature of science (NOS) that, to a great extent, contests the West's dominating idea of science and reality. Additionally, it will also shed light on why Indigenous knowledge systems, like those of the Xhosa and Sotho in South Africa, have been challenging to include in science education.

The conflict in epistemologies and the nature of science (NOS)

In this section the discussion will be based on the nature of science (NOS). It will seek to explore the criteria or tenets (principles) used to legitimize science, and to understand why Western science has, and still is dominating in the spheres of science education. The scientific revolution or modern science discussed in the previous section, was born from a specific worldview and epistemological basis. According to Jegede (1997a, p. 5) "Modern science relies on an experimental undertaking which uses objectivity to unravel reality." In his description of scientism, Dei (2012, p. 127) also states that "It is argued that the only knowledge that has any "truth" to meaning is knowledge that can be validated through empiricism". Dei (2012) is also of the opinion that knowledge produced through scientism dichotomizes knowledge from the spiritual or metaphysical ways of understanding life (p. 127). The terms "empiricism" and "modern science" are used in the same perspective as "universalism" or "the universal construction of knowledge". According to Higgs (2006) and Jegede (1997a), Universalists are of the assumption that there is only one reality and that knowledge created through empirical science which has become academic science,

represents this single reality. Le Grange (2004a, p. 216), on the other hand, states that multiculturalists, opposed to universalists, would argue that "the criteria used by Western modern science to produce 'genuine knowledge' are not universal but a product of a particular culture and can therefore not be used to dismiss other knowledges as inferior or non-science" such as Indigenous knowledges.

I will refrain from stating the worldview and epistemological basis of Indigenous knowledge again, as an elaborate account of the African worldview, specifically the Xhosa and Sotho Indigenous groups in South Africa was given in a previous section. However, it is once more vital to acknowledge that the Indigenous worldview and epistemology is based on place or locality and a belief and value system that are unique to a specific culture and cultural and religious rituals. Additionally, natural phenomena are interpreted and understood through a particular cultural perspective and knowledge that has been transmitted in an oral fashion (Breidlid, 2002; 2003; Dei, 2002; 2012; le Grange, 2004a; Shizha, 2010). A major contributor to the marginalization of Indigenous knowledge in science is, therefore, a paucity of data on Indigenous knowledge and a lack of documentation (Onwu & Mosimege, 2004; Shizha, 2010), particularly in South Africa (Cross, 2004). It is from this point that the discussion will lead into the questions surrounding the NOS.

Although the epistemological basis and worldview of modern science or Western science has dominated also in non-Western countries, it is worth highlighting that this represents one epistemology and one worldview. According to Alters (1997) this is problematic. Alters (1997) did research with philosophers of science who shard their views on the tenets (principles) for NOS. His study revealed that these philosophers expressed major criticism of some of the basic criteria of NOS and that the different philosophers had varied views on the principles against the NOS was measured. Through Alters' (1997) research, it is assumed that there is not one agreed-upon view on the criteria used for science and he therefore questions those who decide the criteria of science education that dominates in school. Authors of the American Association for the Advancement of Science (AAAS) Project (1989) (in Alters, 1997) stated an important tenet: although "modern science is

based on traditions of thought that originated in Europe about 500 years ago, people from all cultures now contribute to science" (in Alters, 1997, p. 42). Although Alters' (1997) research dates a few years back, the current reality is that one reality of science dominates in science education. More recently Cross (2006, p. 12, 13) talks of the same reality and supports Alters' (1997) saying that

> There is no essential shared meaning for the nature of science… [and that] the nature of science and the cultural contexts such as those found in Africa, represents a further set of challenges… It is important to recognize the contested nature of science when developing a curriculum.

According to Onwu & Mosimege (2004, p. 5), "in order to accord Indigenous knowledge systems a measure of legitimacy for its integration into science curriculum, we need to address the time tested "gate-keeping" devices of science." With that said, when talking about the future of science education, Breidlid (2013), Goduka (2012), le Grange (2004b) and Ogunniyi (2007) highlight how important it is to recognize both Indigenous and Western epistemologies and worldviews to interpret natural phenomena, especially in the growth of education systems that host children from different cultures, and to refrain from imposing one reality.

Le Grange (2004b) proposes that Western epistemology and Indigenous knowledge systems should not be viewed as separate binaries, but as complementary frameworks. Le Grange (2004b) tries to demonstrate how these two epistemologies can work together and how Indigenous knowledge can influence Western science, by changing the way in which we view 'science'. She proposes that more focus needs to be on looking at alternative ways on how knowledge is produced in order for knowledges to co-exist, particularly when it comes to the knowledge of science. Botha (2012) shares her sentiment and proposes the Cultural Historical Activity Theory (CHAT) as a framework in which to practically realize the objective of a more culturally inclusive and relevant education. CHAT, according to Breidlid (2013) is used as a framework for "decolonizing knowledge-making by challenging some of the dominating knowledge traditions such as Western epistemology

which claims one universal reality. The principles of CHAT suggests innovative ways in which Indigenous learners can practically cross cultural borders in order to draw both from their traditional knowledge and the formal Western knowledge (Botha, 2009, p. 60). CHAT can also be placed within the Third Space framework where two opposing worldviews and epistemologies can negotiate through conflicts and co-exist.

2.1.2 Knowledge, power and society

At this stage it is vital to bring up the discussion of knowledge in the curriculum. Knowledge and how it is used in school is a powerful tool in producing hierarchies in society. Bernstein (1975) states this more clearly, "How a society selects, classifies and distributes knowledge it considers to be public, reflects both the distribution of power and the principles of social control". It is evident that the science curriculum in many African countries is built on notions of science accepted by the West (Odora-Hoppers, 2002; Ogunniyi, 2007). According to Ntuli (2002), because of Western indoctrination during colonization, Africans have also come to think that the Western way is the only valid way to think and act, under-valuing their own knowledge systems. This is also reflected in the current science curriculum of South Africa which, like many African countries, represents a "Euro-African" science curriculum (Botha, 2012; Breidlid, 2013; le Grange, 2004a; Odora-Hoppers, 2002; Ogunniyi, 2007; Shizha, 2010). According to Shizha (2010) "Academic Africans are assimilated into Western intellectual bondage without concern about groinw African indigenous knowledge systems." Cognitively and politically the risks associated with a science curriculum biased towards Western science is re-creating the status quo whereby a white minority and an elite black minority are the ones benefitting from such an education (Breidlid, 2009). The aforementioned sentiment is shared by Botha (2012) when he says that

> Despite many positive changes it has undergone, for most Indigenous people in South Africa, the current system in education is not based on the daily practices and cultural activity, which produce and reproduce individual and society through 'joint practical activity' (Botha, 2012, p. 59).

In light of the above sentiment shared by Botha (2012) and Breidlid (2009), and considering the unique history of discrimination and segregation of South Africa, one cannot refrain from talking about the lingering political reality of inequality in relation to education in South Africa. This is especially true in the context of knowledge and power, Indigenous knowledge and language. Though it is beyond the scope of this thesis to provide an elaborate view of this political reality, it is a view that is a necessary link in the broader discussion of science education in South Africa.

Science education and politics

To return to the issue of knowledge and power and its link with politics, it is important to consider a successful implementation for equal recognition of Indigenous knowledge systems alongside Western knowledge. For Dei (2002) and Odora-Hoppers (2002), the marginalization of Indigenous knowledges in education leaves room for further colonization of knowledges and cultures in local environments. This can lead to contexts which go unchallenged which keep up the re-production of the status quo reminiscent of South Africa's apartheid past, favouring "those who have already acquired the linguistic, social and cultural competencies" (Breidlid, 2003, p. 101).

The first section aimed to provide a historical and contextual lens through which the crossing of worldviews and epistemological borders in South Africa's science education can be seen. The next section will provide a theoretical framework which will seek to provide relevant theories concerning border-crossing between the culture of science and the culture of home, or, between Western science and Indigenous science.

2.2 Theoretical Framework

The theoretical framework will be discussed in relation to the relevant theories concerning border-crossing of learners with Indigenous backgrounds in the science classroom. A discussion of de-colonization will take place first, following a discussion on the Third Space Theory. Thereafter, practical theories relating to border-crossing in science will be understood within the Third Space framework.

2.2.1 A De-colonized science curriculum

Ngũgĩ wa Thiong'o (1981) talks about the colonization of the mind and vehemently suggests that although Africa has been decolonized physically by gaining independence from the European colonizers, the minds of Africans are still colonized in the way they consider and adopt the perceived superior epistemologies and languages of the West. Although this notion of "colonization of the mind" was suggested by Ngũgĩ wa Thiong'o (1981) many years back, the concept still applies to a great extent to the education of South Africa where, although recognition is given, Indigenous knowledge systems are still marginalized in favour of Western science. In the first section the marginalization of Ntuli (2002) and Ogunniyi (2007) also suggested that Indigenous African teachers in particular under-value their own knowledge systems as a result of the strong influences of colonization and modernization, and because science teachers are trained in the Western way they do not know how to incorporate Indigenous knowledge systems in their teaching. It is based on the notion of Western suppression of Indigenous peoples and their knowledge systems that, according to Dei (2002; 2012) and Odora-Hoppers (2002) a de-colonizing science education is necessary if the inclusion of Indigenous knowledge systems is to be taken seriously. They are of the opinion that only if Indigenous knowledge systems are started to be valued by the colonized Indigenous peoples can Indigenous knowledge systems in science come to fruition (Dei, 2002; 2012; Odora-Hoppers, 2002).

De-colonization as used by Ngũgĩ (1981), Dei (2002; 2012) and Odora-Hoppers (2002) can be linked to the African Renaissance suggested by Thabo Mbeki during his presidency, when he proposed that South Africans return to an "African identity" rooted in "Africanness". In relation to de-colonization, Freire & Faundez (1989) are right when they say that "Indigenous knowledge is a rich social resource for any justice-related attempt to bring about social change" especially considering South Africa's apartheid past. In the same breath, however,

Kulua (2009, p. 25) critiques the concept of "African Renaissance", claiming that one cannot wish away the reality of the deep-rooted effects of colonization. He says that

> It is not always practical to associate culture with place… Colonization was deep-rooted, [and] to return to pure and uncontaminated cultural origins, conceals the reality of deep-rooted and largely irrevocable cultural effects of the process of transculturation which is a result of the prolonged experience of colonization.

Kulua (2009) makes a strong statement when he suggests that Africa is a product of colonization, and therefore, the colonizer and the colonized are deeply implicated in one another. In relation to a "hybridized" identity, Skeie (1998) (in Breidlid, 2013, p. 90) speaks of a "transversal identity", which is defined as "an identity which is continually being reconstructed when confronted with the plurality of society." Kulua (2009), like Semali & Kincheloe (1999), therefore, defines the African identity as a shifting and hybridized identity rooted in modernity and "Africanness". It is from this stance that Freire & Foundez (1989) and Semali & Kincheloe (1999) warn against the romanticization of Indigenous knowledge systems and advocate for the evolution of Indigenous knowledge systems and its ever changing relationship to modern science and educational practice. A de-colonizing science curriculum should seek to uncover or resist the suppressing and alienating tendencies of Western science, but still acknowledge its merits, while maintaining and developing the merits of Indigenous knowledge systems.

An example of a decolonized curriculum can be found in research on the Maori Indigenous group in New Zealand (Bishop, 2007; Penetito, 2009; Smith, 2001). Bishop (2007) provides an example of how Western epistemology and Indigenous epistemology are given equal status in the classroom without one epistemology being viewed as more dominant or worthy than the other. Bishop (2007), discusses the use of dialogue between the teacher and learners in the classroom to develop learning-teaching relationships. The Maori Indigenous group in New Zealand is viewed as a good example of how Indigenous epistemology and language have been revitalized and used in the educational sphere in order to promote equality (Breidlid, 2013; Bishop, 2007; Penetito, 2009).

Another example of research on the Maori is by Penetito (2009) who discusses how the Maori language and culture have been revitalized in order to bring about a sense of belonging to the

people. Penetito (2009) highlights the central role that education is playing in supporting and promoting the revitalization of the Maori language and that the Indigenous epistemology is worth knowing for all students, not only the Maori.

Negotiating between the total avoidance and rejection of Western science while still revitalizing and valuing Indigenous knowledge systems, can take place within Homi Bhabha's Third Space Theory.

2.2.2 Third Space Theory

The Third Space Theory by Homi Bhabha (1994) is a space created by the collaboration and accommodation of Western and non-Western worldviews in which hybridized languages and fluid cultural identities grow. The Third Space can also be seen as the "middle state", a state of transition or a border zone (Bhabha, 1994). According to Kalua (2009, p. 25), within the theory of Third Space, "Bhabha is able to contextualize the problematic nature of the post-colonial condition and provide a counter point to identity issues". An important consideration to make when talking about the Third Space, is to move away from the idea, again, of romanticizing the co-existence of Western and Indigenous knowledge systems (Rutherford, 1990). It is worth recognizing that a hybridized or multiple African identity, where two worldviews exist simultaneously, is not some "flowering of individual talents and capacities" (Rutherford, 1990, p. 208), but that the two worldviews interact either positively or negatively, and often in conflict. Therefore, it is a space in which opposing ideas must negotiate these conflicts and accommodate alternative ways of knowing, which can then lead to a positive co-existence of knowledge systems and new knowledge (Bhabha, 1994; Kalua, 2009; Ogunniyi, 2007; Semali & Kincheloe, 199; Rutherford, 1990). What this means for science education, is to develop pedagogies within this Third Space (Taylor, 2006). The next section will focus on what can be considered as practical theories understood in a Third Space framework.

2.2.3 Border-crossing in the science classroom

Bernstein (1971) makes the case that children are exposed to two kinds of codes: restricted code and elaborated code. He states that children from working class homes do not have the same competencies – culturally and linguistically – as children who come from middle class homes. Bernstein (1971) found that learners from middle class homes in the United Kingdom were more likely to succeed academically in school where the knowledge and language was similar

to that which they are exposed to at home, therefore they had an 'elaborated' code. The learners from working class homes, on the other hand, had a 'restricted' code and they had to cross between two different cultural codes – that which they were exposed to at home and that which they were exposed to in school, which were different from each other. Bernstein's findings are applicable to this study: learners from working class which is, for the most past, Indigenous learners, have to cross epistemological and linguistic borders between home which is based on an indigenous epistemology and mother tongue, and science in school which is still largely based on a Western epistemology and Western language such as English.

In light of the discussion of Bernsten's (1971) restricted and elaborated code, I will discuss the concept of border-crossing. This section will provide insight into relevant theories concerning border-crossing in the science classroom. The term "border-crossing" in relation to learners with Indigenous backgrounds, has to do with the crossing of worldviews and epistemological borders from their home culture, to the culture of school. In terms of science, Jegede & Aikenhead (1999, p. 46) says that: "Whenever pupils enter the world of school science, it soon becomes evident that science too is another culture with which s/he has to interact, bringing with him/her the other baggage of cultures s/he carries." Fakudze (2004) makes a similar statement, saying that learners must intellectually shift from their traditional worldview to that of school science. Aikenhead (1996) calls this "cognitive border crossing". Border-crossing happens in two ways simultaneously: epistemologically and linguistically.

Epistemological border-crossing

Epistemologically, the Indigenous teachers and learners have to cross borders in terms of values and beliefs which are, for the most part, spiritual and religious, which clash with the empirically-based science they learn in school (Breidlid, 2009; 2013; Fakudze, 2003). Hewson (2012) sheds light on the outcome of such border-crossing, hinting that a conflict in paradigms in the way Africans perceive and conceptualize the world in contrast to those in the West, is the root cause of learning difficulties when African learners have to learn the Western concepts of science. When it comes to teachers, Webb (2013, p. 91) says that "Teachers may be placed in a dilemma in which science and traditional knowledge my collide … personal views about nature and naturally occurring events involving magic, mysticism, and spiritualism, may be personally valuable, but is not science." The epistemological border-crossing can cause many challenges and conflicts as can be seen from the discussion above. A double-border crossing

for Indigenous learners happen when they are taught through a language other than their mother tongue.

Linguistic border-crossing

There have been many studies that show the good correlation between mother tongue education and academic achievement (Cummins, 2000; Gibbons, 2006). However, in most cases in South Africa, at least for the learners who have an Indigenous language as a mother tongue, instruction in the mother tongue is only available up to Grade 3, after which the medium of instruction will be in English or Afrikaans (LiEP, 1997). This could be a problem not only for the learners, but for the teachers who have Indigenous languages as a mother tongue as well. Teachers and learners have to cross linguistic borders between home and school and could face challenges cognitively and in terms of identity.

Language in cognitive and identity development

According to Pell & Manganye (2007), science is one of the most linguistically demanding school subjects and a lack of scientific word structure in most of the African languages can pose academic difficulties. Brock-Utne (2001), Cummins (2000) and Gibbons (2006) talk of how important it is to acknowledge the mother tongue of learners when teaching and learning cognitively demanding subjects. In addition to cognitive development, Ngũgĩ wa Thiong'o (1981), among other scholars (Biseth, 2008; Cummins, 2000; Gibbons, 2003; 2006), agree that language is not just a carrier of words, but also a carrier of identity. Language plays an important part in a child's identity. Therefore, like the reference I made earlier about the link between science and politics, the same can be said about language. The chosen language, like the chosen knowledge in African schools, symbolises a power structure which affords academic and social power to the elite who have access to those languages and knowledge systems (Brock-Utne, 2001) When their language is denied or given little recognition in the educational sphere, a child might feel alienated from the school.

In reference to the above, border-crossing can initiate either one of two things: assimilation or enculturation (Jegede & Aikenhead, 1999; Fakudze, 2004). Border-crossing that initiates assimilation will create a situation in which a learner has to suppress his or her own worldview to the worldview of science. This can result in a learner feeling alienated within the science classroom. Epistemologically and linguistically this means that learners with Indigenous

backgrounds have to fit into a predominantly Western and modern curriculum and this creates a class environment where codes are contradictory, confusing and alien (Bernstein, 1975; Breidlid, 2009; 2013). Alternatively, border-crossing can initiate a process of enculturation. This is a process "whereby a learner accommodates school science whilst retaining his/ her identity" (Fakudze, 2004, p. 270). Returning to concept of "accommodation", one can relate it to Onwu & Mosimege's (2004) reference to prior experiences and background in building on new science learning. Ownu & Mosimege (2004) advocate for a constructivist strategy and say that "Familiarity with context is likely to elicit higher order thinking and thus make learning more meaningful and accessible" (p. 4). Jegede & Aikenhead (1999) allude to the same view and say that the Indigenous knowledge of the learner is significant in constructing knowledge in a new situation. Aikenhead (1996) and Jegede (1997b) have respectively proposed theories in which one can understand the concept of border-crossing for an Indigenous learner.

2.2.4 Cognitive Border-crossing

Aikenhead (1996, p. 2) proposes an account of students' lived experiences in a science classroom by considering those experiences in terms of students crossing cultural borders, from the subcultures of their peers and family into the subcultures of science and school science. He proposes four types of border crossing in a science classroom. These are explained below and adapted from Aikenhead (1996, pp. 17-20) and Fakudze (2004, p. 270):

- **Smooth border crossing**: when students' worldviews are similar with school science and learners have been exposed significantly to the subculture of science. Learners intrinsically resonate with the subculture of science.
- **Managed border crossing**: when the learners' worldviews are different from the science worldview, which requires the border-crossing to be managed. For such learners, crossing borders between the subculture of home and the subculture of school is not seen as an obstacle or conflict, but as a necessity in building a good career. Border-crossing is managed fairly easily, because the cultural and linguistic codes used in the classroom are familiar to them, even though the concepts learned in science might be unfamiliar.
- **Hazardous border-crossing**: when the learners' worldviews and scientific worldviews are subtle and they do not know much about the subculture of science. During such

border-crossing learners usually submit to the view of science as portrayed by the media and "experts" and assimilate into the subculture of science to pass.

- **Impossible border-crossing**: when the learners' worldview and that of science are highly inharmonious causing the learners to resist transitions from one worldview to the other. Like hazardous border-crossing, learners are assimilated into the subculture of science, but are alienated to a greater extent in which their conflicting worldviews are never resolved and could lead to failure in science for many.

The examples of border-crossing proposed by Aikenhead (1996) above are defined in the context of types of learners in a science classroom. It is suggested that Indigenous learners fall into the categories of "hazardous" and "impossible" border-crossing if they have to cross borders between a traditional Indigenous subculture at home, and a modern scientific subculture of science in school. According to Aikenhead (1996) border-crossing between sub-cultures is something that teachers and science curriculum planners need to take cognizance of to mediate instead of alienatimg Indigenous learners. The next theory is Collateral Learning Theory (Jegede, 1997) which will relate to border-crossing as explained by Aikenhead (1996).

2.2.4 Collateral Learning Theory

In recognition of the border-crossing that Indigenous learners have to do between the sub-cultures of the home into the sub-culture of science in school, Jegede (1997b) proposes the Collateral Learning Theory. This theory recognizes that an Indigenous learner exposed to modern science in school may hold two conflicting or opposing worldviews simultaneously (Jegede, 1997b). Collateral learning theory is used to explain how a student harmonizes the conflict resulting from traditional worldview and that of science (Jegede, 1997b; Fakudze, 2004). This harmonizing of conflicting schemata can be placed within the Third Space Theory framework, where an alternative worldview is sought in which both worldviews negotiate through the conflicting ideas and can co-exist. According to Jegede & Aikenhead (1999, p. 52), there are varying degrees to which conflicts interact with each other, and the degree to which these conflicts are resolved. There are four types of collateral learning which represents these varying degrees. Below is an explanation of these four types and has been adapted from Jegede & Aikenhead (1999) and Fakudze (2004).

- **Parallel collateral learning**: conflicting schemata do not interact at all. In a South African science classroom, this would imply that one view or domain of knowledge is recognized in the classroom, for instance Western science is recognized while the domain of Indigenous knowledge is ignored.

- **Secured collateral learning**: the conflicting schemata consciously interact and the conflict is resolved in some manner. This could mean that, if Western and Indigenous knowledge systems were both acknowledged and interacting in the classroom, though their epistemological basis would differ in terms of "the cause of lightning", for example, both explanations would be recognized, but the Indigenous explanation, for example, wouldn't be adequate to explain the phenomenon. While the Western scientific explanation would rely on empirical data and observations, Indigenous knowledge systems would explain it in terms of a different view or feeling, which was informed by knowledge passed on orally from an elder of how to make predictions of the weather (Khupe, 2014, p. 8).

- **Dependent collateral learning**: schemata from one view or domain of knowledge challenge another from a different worldview or domain of knowledge, to an extent that permits the student to modify existing schemata without radically restructuring the existing worldview or domain of knowledge. Here, the Western-inspired concept of "Evolution" in science could challenge an Indigenous "Africanized" view of ancestors, God and Christianity to explain the formation and development of life on Earth. If presented with explanations that could explain this concept from both epistemological bases, the learners will be allowed to accommodate both the new and existing explanations.

- **Simultaneous collateral learning**: fits between parallel and dependent collateral learning. It is a situation in which learning a concept in one domain of knowledge or culture can facilitate the learning of a similar or related concept in another milieu. This would suggest that Western and Indigenous knowledge systems in the science classroom are both respectively acknowledged within their limitations, and instead inform and develop from each other.

Collateral Learning Theory relates to cognitive border crossing in that, according to Jegede & Aikenhead (1999, p. 52), "A learner who needs to move into the culture of science, s/he requires

an effective use of collateral learning with a heavy reliance on successful cultural border crossing into school science." In other words, cognizance of a learner's traditional and Indigenous sub-culture and how it may conflict with the sub-culture of science is needed for these conflicts to be harmonized when the learner crosses between these sub-cultural borders. Furthermore, these two theories suggest the reaching of a middle-ground between two conflicting worldviews and epistemologies by using what is good in a learner's cultural, Indigenous background, while at the same time allowing them to benefit from Western science; and to avoid the total assimilation into Western science and the total rejection of Western science (Jegede & Aikenhead, 1999, pp. 52, 53).

In the process of successful border crossing and collateral learning, the role of the teacher is important since learners' worldviews of science are influenced by the worldviews of their teachers (Ogunniyi, 2007). Jegede & Aikenhead (1999) urge teachers to become "cultural brokers". This means that a teacher will help the learner in negotiating, scaffolding and mediating border-crossing and to avoid suppressing their traditional, indigenous worldview, and assimilating learners primarily into a Western view of science. Jegede & Aikenhead (1999, p. 55) define a teacher as a cultural broker as someone who "will guide pupils between their life-world culture and the culture of science, and help them resolve any conflicts" through dialogue. They also advocate for a "cross-cultural science curriculum" in which a science teacher as cultural broker is sensitive to the identity of learners and who appropriates knowledge and values of Western science and places it into a view that has relevance for learners (p. 55). In the context of South Africa, it is worth questioning whether science teachers with Indigenous backgrounds themselves will need to be exposed to collateral learning first in order to resolve their conflicts before engaging in collateral learning with Indigenous learners in the science classroom. Cognitive border-crossing and collateral learning are examples of theories that can be understood within the framework of Third Space.

Fakudze (2004) applied Cognitive Border-Crossing (Aikenhead, 1997), Collateral Learning (1997) and the Contiguity Learning Hypothesis (Ogunniyi, 2002) in her research with indigenous learners who took science as a subject. She found that her findings confirmed the theories, but that learners' worldviews were greatly influenced by their belief in witches, curses and ancestors to explain certain phenomena in science. This border-crossing did not always result in successful border-crossing to the sub-culture of science or resolve the conflicts.

Fakudze (2004) therefore found it necessary for further investigation and clearer articulation of the cognitive processes involved in the various categories of border-crossing.

Similar findings like Breidlid (2002; 2013) and Fakudze (2004) were revealed by Ogunniyi (2007). He did research with science teachers. Ogunniyi (2007) used a practical argumentation course (PAC) in his research with science teachers. He used PAC for introducing a group of teachers to the process of implementing a science curriculum, for an intellectual and dialogical space for teachers to voice their opinions and concerns; for teachers to interrogate the curriculum more closely, and to enhance teachers' understanding of NOS and IKS and how these two systems can be taught alongside each other (Ogunniyi, 2007). An example of one of the issues regarding religion and science was brought forth through PAC in this study. The extract below of one the teachers in Ogunniyi's study show how they accommodated both views on religion and the scientific concept of Evolution.

> As a science teacher I see the evidence and believe that there is some validity in the theory of evolution. As a Christian I believe that everything in this universe is controlled/ guided by a celestial or spiritual entity I call God… so Big Bang and evolution is the work of God (teacher participant in Ogunniyi, 2007).

Ogunniyi (2007) saw the participant's view as construing the scientific and the religious accounts of the universe as complementary worldviews. He further states that such an interpretation depends on an appropriate context or phenomenon to which it can be applied. The extract from the participant is one example of how a conflict in worldviews was resolved, though such a resolve will not always be the case. Ogunniyi (2007) concluded from his study that to succeed in integrating Indigenous knowledge in science, the religious views of teachers and learners, which is a critical component in Indigenous knowledge systems, need to be respected. A method of achieving this is through dialogue and argumentation that acknowledge the conflicts and validity in both Western and Indigenous epistemologies.

This section discussed the theoretical framework and used the theories of Third Space (Bhabha, 1994), Border-crossing (Aikenhead, 1997) and Collateral Learning Theory (Jegede, 1997b). All three theories are concerned with the negotiations of conflicts between Western and Indigenous science in a science classroom, and how these conflicts can be resolved and co-exist within an Indigenous learner's worldview.

In the next section I highlight several South African studies that relate to this thesis, with regards to the challenges and possibilities when it comes to the inclusion of indigenous knowledge systems in science.

2.3 South African literature

Several studies have shown that the inclusion of Indigenous knowledges is not a view shared among Indigenous teachers and learners. However, there have been studies that show the opposite and show how teachers can implement and mediate the inclusion of Indigenous knowledges.

Webb (2013) carried out a study which involved a survey that was distributed to high school teachers, learners and community members around four sites of the Eastern Cape. The participants were given an open-ended questionnaire which sought to gain information about what elements of Indigenous knowledge were important for the children to learn in science and why, as well as what kind of Indigenous knowledge could be included in the science curriculum and how. The findings revealed that the participants felt that there were a number of elements of Indigenous knowledge that could be included in the science curriculum which related to issues such as Indigenous technology, health (traditional healers), witchcraft and lightning. Webb (2013) also found that social justice and the quest for equality, especially among community members, was the main reason for including Indigenous knowledge and to correct the injustice imposed to them in the past. With that said, however, there were also strong arguments against the inclusion of Indigenous knowledges in the science curriculum, because it was seen as primitive. Another finding worth highlighting in Webb's study is that he found there were few links made between Xhosa Indigenous knowledge and science and how it could contribute to understanding the subject of science, other than the relevance to context.

In light of this, Stears (2008) revealed a somewhat similar finding when she conducted a study with primary school learners to find out what they found as relevant topics to include in a science module. They were asked to write a story about a topic in science and how Indigenous knowledge could relate to it. Her study was conducted in an urban impoverished community in the Western Cape of South Africa. She found that learners' sub-culture of poverty clouded their

views on Indigenous knowledge that could relate to science. Through her study, Stears (2008) highlights even more the complexity of border-crossing, where the worldview of these urban Indigenous learners is not grounded on the general Indigenous epistemological basis, but a worldview grounded on poverty.

Similar to Webb (2013) Khupe (2014) worked with a Zulu Indigenous community in a rural area of KwaZulu Natal in South Africa where she conducted a transformative participatory research. Like Webb (2013) she worked with community members, science students and teachers from the only local high school, and elders who were the custodians of traditional knowledge. Her study was also guided by questions such as what kind of Indigenous knowledge could be included in a science curriculum and how could the inclusion of Indigenous knowledges, held by the participants in her study; contribute to reach the goal of transformation and equality set by the South African curriculum. She found that her study contested findings by Webb (2013) where some Indigenous teachers and learners were against the inclusion of Indigenous knowledges. Her study revealed that the participants, the students in particular, celebrated their culture and expressed willingness to learn more. Like Breidlid (2002; 2013), Khupe (2014) found that the knowledge in Mqatsheni included a strong sense of belonging to place, expressed through knowing the history of land, and a strong sense of identity conveyed through language. Khupe (2014) concluded that the integration of science education in rural areas such as Mqatshni, depended on dialogue between teachers and community members, as well as support for teacher professional development. In similar research, Meyiwa, Letsekha & Wiebesiek (2013) conducted a participatory research with primary school science teachers in rural Eastern Cape of South Africa. During their research, the researchers worked together with teachers in order for teachers to participate in the planning, research and the implementation of concepts related to Indigenous knowledges, as well as learning and teaching support materials (LTSM) related to Indigenous knowledges. Their research is an example of how researchers and teachers in South Africa can work together in order to promote Indigenous knowledges in the classroom.

Hewson (2012) also provided insight into possibilities of inclusion when she conducted research with Basotho traditional Healers in Lesotho, and Xhosa traditional Healers in the Western Cape of South Africa. Her study was also focused on what these traditional healers thought of the inclusion of Indigenous knowledges, and what and how elements of it could be included in a science classroom. From group and individual interviews held with the traditional

healers, she found that despite colonialism and modernization, the Traditional healers' worldviews were similar and were not changed due to these powerful forces. They treasured the knowledge and values of their traditional cultures. The traditional healers in her study also expressed that not all elements of Indigenous knowledge can be included in a science curriculum and that some of the research that they conduct themselves, need to be kept private and sacred. This highlights one of the challenges in implementing Indigenous knowledge in a school curriculum. Although Hewson (2012) and the former authors have highlighted possibilities of inclusion, they also emphasize that it is not an easy task considering that Indigenous knowledge is not an agreed-upon concept among all Indigenous peoples of a group, and that cultural diversity within South Africa poses a problem to the implementation of Indigenous knowledge, which Hewson (2012) in particular highlights.

When it comes to the issues of language Probyn (2006) found that when teachers and learners shared an Indigenous mother tongue, the teacher code-switched in Grade 8 science classrooms to help learners understand scientific concepts. In the context of Mathematics, Setati, Adler, Reed & Bapoo (2002) found teachers who also resorted to code-switching between the learners' mother tongue and English. However, even with systems being in place that allows freedom to parents to choose the langauge of instruction, it does not seem to be a possiblity in reality, nor does an indigenous langauge seem to be the preferred langauge of instruction among parents. Botha & Breidlid (2009) found that Xhosa-speaking parents in the Eastern Cape wanted their children to be taught in English instead of their mother tongue of isiXhosa in primary school. Their findings confirm the hegemonic role of English in South Africa, despite its problematic nature in the cognitive development of Indigenous learners. However, another reason why indigenous languages like Xhosa and Sotho are not used in the classroom is because of the lack resources, and lack of development of terminology for various subjects in these languages (Brock-Utne, 2001; Ranaweera, 1975). The cognitive challenges associated with the language of learning and teaching (LoLT) among indigenous learners, could be one of the contributors to academic failure (Ranaweera, 1975).

This chapter discussed the theoretical framework and literature review in relation to border-crossing between Indigenous knowledge systems and Western knowledge. The first section provided a historical lens through which to understand the marginalization of Indigenous knowledges. The second section provided a theoretical framework and focused on negotiating

epistemological conflicts for the co-existence of two worldviews. The theoretical framework was discussed in relation to the Third Space Theory, Cognitive Border-Crossing and Collateral Learning. I also provided insight into several studies that have been done in the South African context regarding indigenous knowledge systems' integration in science. The next chapter presents the Methodology Chapter of the thesis.

3. METHODOLOGY

This chapter discusses the methodology that was used for the research. The chapter begins by discussing the research within a particular research paradigm and design. I discuss the research process in three phases. I interject with a discussion of the research methods I used before discussing phase three, where it is best suited to discuss. The discussion of each phase begins with how it was originally planned before the research and then it goes into how it actually occurred during the time of data collection. After the discussion of the three phases of the research, I highlight the ethical considerations and discuss the issues related to reliability and validity. I also explore the data analysis process after the data was collected. I end the chapter with the gaps and limitations to the research methodology.

3.1 Research paradigm and design

The study is placed in an interpretive paradigm, because the research sought to understand and interpret the teachers' and learners' worldviews. Interpretive research, according to Stake (2010), is an investigation that relies heavily on researchers defining and redefining the meanings of what they see and hear. Cohen, Manion & Morrison (2011, p. 17) also state that "the central endeavour in the context of the interpretive paradigm is to understand the subjective world of human experience". Important in our interpretations is the role of context and situation, because these provide a background to the research. The context of the study is necessary for the interpretations we make (Stake, 2010).

With the interpretive paradigm I used a qualitative research design. The qualitative research design is informed by the key concepts in the research questions posed in the introduction chapter. The key concepts in the research questions are a) knowledge that is embedded in curriculum documents and b) the worldviews of indigenous teachers and learners who, as subjective beings, give insight into their individual experiences (Cohen, Manion & Morisson, 2011). The methods used in the qualitative research design were aimed at answering the research questions. The methods will be discussed in 4.5.

In the following sections I will discuss the first phase of the research process in reference to access and choice of research location and participants.

3.2. Research process, phase one: Research location and access

I planned to carry out the research at two high schools in a township in Cape Town called Gugulethu. The research location was based on convenience since I was familiar with the area, because I had worked and visited there before (Cohen, Manion & Morrison, 2011).

Cape Town is the capital in the Western Cape of South Africa and the education government is known as the Western Cape Education Department (WCED). From the WCED website I located information from the education management information system (EMIS) which provided profiles of the schools in different metropolitan areas in Cape Town. I identified two high schools in Gugulethu where the subject of Life Sciences was taught. After identifying the two schools I went through a process where I had to gain permission from the research department at WCED to enter the schools and carry out the research. This involved sending an email to the relevant authority at the research department at WCED describing my research and the period in which I planned to carry it out. Permission was granted on 4 August 2016 (*see Appendix A*) and I gained access to the schools on 16 August 2016. Access was negotiated through written letters to the principals at each school.

Though I was granted access to both schools, one of the Life Sciences teachers at one school could not participate due to her heavy workload and time constraints as a result of upcoming school examinations. She was the only Life Sciences teacher at the school and therefore I decided to focus only on one school where I had access to more Life Sciences teachers.

The final research school was a secondary school in the township Gugulethu which translates as “our pride” in English (StatsSA, 2011). Gugulethu is 15 km from Cape Town and emerged when black South Africans were removed from areas such as District Six during Apartheid. During the research period it was observed that Gugulethu was a very busy area and highly populated. The narrow streets were dominated by minibus taxies which seemed to be the busiest activity during the day to take people to and from shopping centers, whether in Gugulethu, or other surrounding areas. It is classified as 100% urban by Statistics South Africa (StatsSA, 2011, p. 5). The population is predominantly “Black African” and makes up 99% of the population in Gugulethu (StatsSA, 2011). In terms of language, isiXhosa is the mother tongue of the majority of the population (88.6%), English (3.6%) second, Sesotho (1.9%) third and Afrikaans (1.7%) fourth.

3.3. Research process, phase two: Sampling of participants

As I have stated above my choice of sampling involved finding teachers and learners who belonged to the Xhosa or Sotho indigenous group and who taught and studied Life Sciences as a subject. Thus, my sampling strategy was a non-probability sampling strategy, because I purposively selected the sample (Cohen, Manion & Morrison, 2011). According to Cohen, Manion & Morrison (2011, p. 156) in purposive sampling the sample is "hand-picked on the basis of their judgment of their typicality or possession of the particular characteristics being sought". I planned to sample one Life Sciences teacher in each of the two schools and a focus group of six to eight Grade 11 Life Sciences learners in each school, but because of the reason expressed earlier, I decided to focus on one school instead of two. Learners in these grades are usually between the ages of 15 to 16. I planned this sample because Grades 10-12 are the grades where Life Sciences are taught and because I personally preferred learners in higher grades who I assumed would be able to express and articulate their thoughts better than those in lower grades.

I ended up having access to three Life Sciences teachers. The three teachers at the school taught Life Sciences to different grades.

In 2016, the research school had 1031 learners enrolled from Grade 8 to Grade 12. In Life Sciences, 197 learners were enrolled in Grade 10 and 131 learners in Grade 11 (WCED, 2016). The Language of Learning and Teaching (LoLT) was officially identified as English (WCED, 2016). It was found through conversations with the teachers that the learners who were enrolled in the school came from the different surrounding areas of Gugulethu, such as Khayelitsha (the largest township in Cape Town) or Nyanga (the neighbouring township).

One teacher was absent during my time of data collection and, therefore, the final sample consisted of two Life Sciences teachers - one Grade 10 and one Grade 11 teacher, and two focus groups - one with Grade 10 learners and one with Grade 11 learners, each consisting of six learners which were selected purposively (Cohen, Manion & Morrison, 2011) by the two Life Sciences teachers. I asked the two teachers to each pick six learners – a mixture of boys and girls - they thought could articulate and express their thoughts well. The table that follows shows the participants of the research. I provided them with pseudonyms to give them anonymity. Teacher A taught Grade 11 Life Sciences and had 8 years teaching experience and

5 years experience in teaching Life Sciences. Teacher B had 28 years experience in teaching Life Sciences. The learner participants came from Xhosa and Sotho backgrounds.

Table 3.1: Sample of participants

Participants	
Teacher	Experience
Teacher A (T_A) Xhosa	5 years Life Sciences teaching experience
Teacher B (T_B) Xhosa	28 years Life Sciences teaching experience
Focus Group 1	Focus Group 2
Learner 1 (L1) Sotho	Learner 7 (L7) Xhosa
Learner 2 (L2) Sotho	Learner 8 (L8) Xhosa
Learner 3 (L3) Xhosa	Learner 9 (L9) Xhosa
Learner 4 (L4) Sotho	Learner 10 (L10) Xhosa
Learner 5 (L5) Sotho	Learner 11 (L11) Xhosa
Learner 6 (L6) Sotho	Learner 12 (L12) Xhosa

3.4 Position as researcher

I consider myself an insider since I was familiar with the research location and have knowledge on the general set-up in schools and how they are run and managed in the Western Cape (Cohen, Manion & Morrison, 2011). Access to the schools was also gained easily as I will discuss below. However, my role as an outsider became apparent when I started interacting with the participants, because I came from a different ethnic or racial group than the participants. Because I was unfamiliar with the worldviews of the teachers and learners and only had knowledge obtained from literature and informal conversations with friends from indigenous backgrounds, my role as outsider depended on the research participants who had key information about what I was researching which allowed me to find information from a different point of view. I also came to the school as a researcher and therefore my role in the school during the time of data collection was separate from the roles of the rest of the teachers and learners.

3.5 Research Methods

I considered the research methods to be employed to be the most adequate in terms of answering the research questions related to understanding teachers and learners' worldviews. The data collection methods employed during the study was that of focus groups interviews with the learners and semi-structured interviews with teachers. I also planned a Documentary Analysis of the Life Sciences CAPS document and a Life Sciences textbook.

3.5.1 Focus group interviews

Focus group interviews were planned because it would allow for a more collective view or interpretation (Cohen, Manion & Morrison, 2011). Focus group interviews produce data derived from a group process in a focused manner. As a result, participants influence each other, opinions change, and new insights emerge (Krueger, 1998). According to Robson (2011, p. 294), focus-groups are a highly efficient technique for qualitative data collection since the amount and range of data is increased by collecting from several people at the same time. The aims were to facilitate communication, promote an exchange of ideas and experiences and give learners a sense of safety in expressing conflicts or concerns (Robson, 2011, p. 295).

I planned the focus group discussions in order to gain insight into how learners' worldviews were constructed. Focus group interviews were also planned as a way of triangulation and to strengthen the data I would obtain from the interviews with the teachers. When planning the focus group interviews I had to be mindful of the possibility that learners might be hesitant to have a discussion with me or with other learners and therefore I sat in on some of the teachers' lessons before the time so that the learners could become familiar with my face.

I used an interview guide during the focus group interviews to cover specific topics. The planned questions were subjective and personally worded, but were guided by the literature on previous studies similar to my own, to a certain extent. This was also the case with the teacher interviews.

I considered a using a translator, but I assumed that the teachers and the learners had proficiency in English since English is used as the language of learning and teaching (LoLT) from Grade 4 and therefore decided not to use one for the research.

3.5.2 Teacher interviews

I planned interviews as a method because it would enable a conversation between myself and the teachers, and enable the teachers to discuss their interpretations of the world in which they live and the particular matter at hand (Cohen, Manion and Morrison, 2011). I planned the interviews in order to get an understanding of what constituted the worldviews of the teachers. The interview, according to Cohen, Manion and Morrison (2011), allows for greater depth than other data collection methods. Interviews, according to Stake (2010) are used for purposes such as obtaining unique information or interpretation held by the person interviewed. Rubin and Rubin (2005) compare the interview to a conversation. Conversations and interviews are similar in that two speakers take turns to talk. However, there are some differences between ordinary conversations and in-depth interviews. In both ordinary conversations and interviews, questions and answers follow one another logically. Participants work out ways to acknowledge when they understand, ask questions or look puzzled when they do not clarify ambiguities on request. However, qualitative interviews are more focused, more in-depth, and more detailed than ordinary conversations, because one person does most of the questioning and the other does most of the answering (ibid.). An obvious difference between interviews and normal conversations is that the researcher needs to keep a record of what was said for later analysis. One gap or limitation in my research is that I did not use Indigenous methodology during my data collection even though my research is focused on Indigenous knowledge systems. I will discuss this limitation at the end.

One semi-structured interview per teacher was planned. This would help to capture the essence of teachers' thoughts on their worldviews. Interviews are also a way of triangulating the data and strengthening the validity of the findings (Cohen, Manion & Morrison, 2011). Individual interviews yield significant amounts of information from an individual's perspective, but may be quite time-consuming. Therefore, an interview guide was developed in order to identify appropriate open-ended questions that were asked during each interview. (Hancock & Algozinne, 2006, p. 39). The semi-structured interviews meant that I would ask specific questions to the teachers, but would allow some space for their own elaborations. Cohen, Manion & Morrison (2011) and Hancock & Algozzine (2006) say that, semi-structured interviews are particularly well-suited for qualitative research in that the questions are pre-determined but flexibly worded and, provide tentative answers.

3.5.3 Documentary Analysis

I planned a Documentary Analysis of the Life Sciences CAPS document and a Life Sciences textbook in order to assess how the curriculum addresses the inclusion of different worldviews and epistemologies. A document analysis would "provide access to and facilitate insights into the kinds of assumptions that underlie policy reforms… and reveal some of the contradictions and tensions that are inherent in a policy" (Cohen, Manion and Morrison, 2011, p. 248, 250). The two data sources used for the documentary analysis were the Life Sciences CAPS curriculum (DoE, 2011) and the textbook titled "Study and Master Life Sciences Learner's Book Grade 11" (Gebhardt, Preethlall, Pilly, & Farham, 2012). I will elaborate on the documentary analysis in 3.7.

3.6 Ethical considerations

In order to ensure that the research is conducted in an ethically acceptable manner I was guided by Cohen, Manion and Morrison (2011) in how this can be achieved.

I ensured that informed consent is given from the relevant people involved which included the school, the teachers and the learners. As a requirement in the process of seeking permission, the relevant people were provided with information about the study, as well as their rights as participants. These rights included their freedom to remain anonymous as well as their right to withdraw at any time during the research. I also refrained from using data in the study that will be of a compromising nature to the participants.

Throughout the research process, I tried to remain professional, but I also aimed to provide space for building a trusting relationship with the participants in the study as a form of gratitude for sharing their views and experiences for the purpose of the study. However, given the time constraints attached to the research period and that of the school's hectic schedules, this proved to be a challenge.

3.7 Research process, phase three: Teacher interviews, focus group interviews and Documentary Analysis

In the previous section I described the research methods that I planned to use. In this section I discuss the process before and during the interviews.

Before starting the focus group interviews I asked the two Life Sciences teachers to identify six learners who they thought would be able to take part in a focus group discussion. I asked them to identify the learners based on whether they were well-spoken or articulate in their thoughts. The focus group interviews with the learners took place on 13 and 14 September 2016. The Grade 11 focus group was on 13 September and the Grade 10 focus group on 14 September. I arranged with the learners to meet after school in an empty classroom that I had arranged with one of the teachers. All learners showed up on both days for the focus group interviews. I was very happy that they could give me their time. Before we started each focus group interview, each of us introduced ourselves and told each other a little bit about ourselves to make the setting more comfortable for the learners and for myself. Snacks were arranged for the meeting which the learners chose to eat at the end of the focus group interviews. As I showed in the earlier table, the Grade 11 focus group consisted of five Sotho learners and one Xhosa learner, and the Grade 10 focus group consisted of only Xhosa learners. We sat in a circle in the classroom and I gained permission from the learners to audio-record our interviews with my cell phone. After the focus group interviews I transcribed it.

The teacher interviews took place on the 20th and 21st of September 2016. I arranged to meet with each teacher individually at a time they preferred. Teacher B was also a Grade 12 Life Sciences teacher. She had a hectic schedule as she was involved in moderation of exam papers as well as setting it up and invigilating during the exam. These were duties aside from having to give classes. The interview was arranged during Teacher B's free period in the deputy principal's office. Teacher A had similar challenges and she had preferred to have the interview during one of her class periods. Both interviews were audio-recorded and consent was given in writing by both teachers.

The aim of the focus group interviews and teacher interviews was to gain insight into the teachers' views on indigenous knowledge systems and its role in the teaching and learning of

Life Sciences. The aim was also to understand how the teachers' worldviews were similar or different to the worldviews in the Life Sciences curriculum.

I also did the Documentary Analysis of the Life Sciences CAPS document and textbook. Life Sciences is one of the approved subjects in the NCS. Prior to 2006, Life Sciences was known as 'Biology'. It is one of the subjects learners in Grades 10-12 can specialize in. It has a time allocation of four hours per school week (DoE, 2011). The CAPS define Life Sciences as "the scientific study of living things from molecular level to their interactions with one another and their environments" (p. 8). Life Sciences has four knowledge strands which make up the framework of the Life Sciences Curriculum. These are: 1) Life at the Molecular, Cellular and Tissue level, 2) Life Processes in Plants and Animals, 3) Environmental Studies and 4) Diversity, Change and Continuity. Each strand is sequenced in a particular order and contains the content that needs to be learned during each of the four school terms. The table below represents the guide for the Document Analysis. I used a guide from Mnguni (2013) and Schiro (2008) for the Documentary Analysis. I adapted the guide based on my own research.

Table 3.7 Guide for Documentary Analysis (guide adapted from Mnguni, 2013)

Purpose of Analysis	Data sources	Questions that guided analysis
To answer RQ1: How does the current Life Sciences CAPS address the concepts of "Indigenous knowledge systems" and "worldviews"	- Life Sciences CAPS document - Grade 11 Life Sciences Learner' book	- What kind of discourse is used in the LS curriculum? - What subject knowledge is used in relation to IK and worldviews? - How does instruction take place in LS in terms of language?

3.8 Validity and reliability of research methods

Validity has long been a key issue in debates over the legitimacy of qualitative research; if qualitative research studies cannot consistently produce valid results, then policies, programs, or predictions based on these studies cannot be relied on (Miles and Huberman, 2002). The first concern of most qualitative researchers is with the factual accuracy of their account – that is, that they are not making up or distorting the things they saw and heard.

In relation to the validity and reliability of research methods I had to take cognizance of the threats that these methods held. A few threats to this study will be named, and how I attempted to rule out these threats.

Drawing inaccurate or incomplete conclusions

From the interviews, I faced the threat of drawing inaccurate or incomplete conclusions. Therefore, I attempted to make detailed and field notes, as well as detailed transcripts of the audio-recordings.

Domination of views by one or two learners

In the focus group I faced the threat of extreme views that may predominate and bias being caused by the domination of the group by one or two people (Robson, 2011). To eliminate that threat I attempted to probe individual answers from each member in the group.

Generalization of results

Thirdly, the results may be difficult to generalise as they cannot be representative of the wider population who find themselves in similar contexts. Therefore, I could only form and report an opinion or assumption based on each teacher and learner's experiences in the particular school. But, I can make claims to generalisability on the basis of choosing a school that was typical to what was described in the literature. Maxwell (1996, p. 115) refers to this as "face generalisability".

Imposing my own framework of meaning

I also faced the threat of imposing my own framework or meaning, rather than understanding the teachers and learners involved and the meanings they were trying to convey (Maxwell, 1996). Therefore, I had to be aware of my position as researcher and my subjective thoughts on Indigenous knowledge systems. I sought feedback and re-assurance about my conclusions from the teachers I was studying.

Reactivity

The last threat is concerned with reactivity, a term Maxwell (1996, p. 91) describes as the influence of the researcher on the setting or individuals studied. In other words, reactivity refers to the influence the researcher has on the behaviour of the teachers or learners when they know they are being studied. According to Maxwell, the goal is not to eliminate the influence but to understand it and to use it productively. To use that threat productively means that I could only form an interpretation and draw an inference from what I heard from the teachers and learners

which could be considered to be their true thoughts and behaviour at that particular time of the interviews.

3.9 Data Analysis

The data were analysed and interpreted in order to answer the research questions. Qualitative data analysis requires the ability to process information in a meaningful and useful manner (Robson, 2011). The process of data analysis for this study can be described in stages.

The first stage required me to transcribe the audio recordings of the focus group interviews and the teacher interviews. I applied a strategy of open-coding to the transcriptions in the second phase of data collection. During this phase of open-coding the transcriptions were read and re-read and given initial codes that were my initial interpretations of the collected data (Robson, 2011). In the third phase of data analysis I produced axial coding to the initial codes. According to Strauss (1987), axial coding will lead me to an understanding of the central phenomena in the data in terms of the context and the conditions which gave rise to it. Axial coding also helped me produce categories. During this stage the codes from the focus group interviews, teacher interviews and documentary analysis were brought together to look for patterns in the data. The categories were developed based on codes that were similar and corresponded or contrasted with one another. The last stage was selective coding where themes were produced and the categories which were produced in axial coding were the sub-themes. The themes were created to interpret and describe the categories and the patterns within the themes (Robson, 2011). The purpose of the themes is to conceptualize or form a storyline for the findings of the research. In this study, similar to Khupe (2014, p. 53) I analyzed the data on worldviews through identifying emerging themes as well as through drawing on constructs from literature (e.g. Breidlid, 2013; Dei, 2002, 2012; Hewson, 2012; Ntuli, 2002; Odora-Hoppers, 2002).

3.10 Limitations and gaps

I aimed to observe the lessons of the Life Sciences teachers, because I believe it would have added richness and help to triangulate the data. However, because of the time constraints the teachers faced in terms of changing schedules and considering that my research took place during the examinations and assessment period of the school, I had to eliminate observation as an official research method. Instead I used the times I could sit in during the class periods for

the learners to become familiar with my face. However, as an outsider I did not have enough the time to build solid relationships with the participants (Cohen, Manion & Morrison, 2011).

One of the limitations to my research is that I did not use strategies associated with Indigenous methodologies per se, as advocated by Chilisa (2012), Keane, Khupe & Seehawer (2017), Lavallée (2009) and Smith (1999). I am aware that my research methods and thesis are more in line with a Western-influenced discourse which immediately assumes a power hierarchy over the topic and participants in the research (Smith, 1999). In an attempt to eliminate this power hierarchy to a manageable degree, I do not regard the research as "examining" or "researching" the indigenous participants, but as sharing their insights, knowledge and experiences.

This chapter was dedicated to the methodology that informed my research. The research is placed within a qualitative interpretive paradigm which made use of focus group interviews, teacher interviews and a documentary analysis. I discussed issues in relation to ethics, trustworthiness and reliability, the data analysis process as well as the limitations and gaps in the research. The next chapter presents the analysis and discussion chapter.

4. ANALYSIS AND DISCUSSION

In the methodology chapter I discussed the analysis process that was used to divide the findings into themes and categories. During the analysis process I combined the findings from the documentary analysis with the findings from the interviews and the focus group interviews. The findings were analyzed in order to answer the research questions which guided the aim of the thesis, which is twofold: a) to explore the extent to which the worldviews of the Xhosa and Sotho teachers and learners matched the worldviews of the Life Sciences curriculum, and b) to what extent a difference in worldviews causes problems in teaching and learning. The discussion in this chapter is dedicated to four themes (4.1-4.4).

In 4.1 I compare the epistemology of Life Sciences to the epistemology of indigenous knowledge systems described in the curriculum and textbook, and how it compares to the definition of indigenous knowledge systems given by the teachers. In 4.2 I discuss the epistemological borders that teachers and learners have to cross based on a difference in worldviews between the Life Sciences curriculum and textbook, and the indigenous participants. In 4.3 I discuss the marginalization of indigenous worldviews based on the heterogeneity among the indigenous participants, and based on the lack of documentation in the Life Sciences curriculum and textbook. In 4.4 I discuss the linguistic borders that the participants have to cross from their mother tongue to English in the Life Sciences classroom. In 4.5 I present my final interpretations of the findings.

In the discussion of each theme I will show the extent to which the Life Sciences curriculum and textbook correlate with one another, as well as the extent to which the findings from the focus group interviews and teacher interviews correlate with the curriculum and textbook. Additionally, in discussing each theme I will refer and relate it to the theory and literature which was discussed in chapter two (*see page* 22). Thus, the theory, literature and findings from the documentary analysis and interviews will be discussed simultaneously.

The two data sources for the documentary analysis were the Life Sciences CAPS curriculum (DoE, 2011) and the textbook titled “Study and Master Life Sciences Learner’s Book Grade 11” (Gebhardt, Preethlall, Pilly, & Farham, 2012).

It is worth mentioning that as I have mentioned in the previous chapter (*see section 3.8,* "*domination of one or two learners"*), in the focus groups I faced the threat of certain learners dominating during the discussion. While I tried to eliminate the threat by probing individual answers from each learner, there were learners who had less to say. The specific learners are L5 in focus group 1 and L12 in focus group 2. Therefore, their voices will not come across frequently in the discussion of the findings. The excerpts I chose to include were chosen for the purpose of meaning and clarity. I support the excerpts by providing the number of participants and their codes (e.g. L1 or L2) that had a similar view as the view expressed in the chosen excerpt.

Before proceeding into the categories it is important to pay attention to the specific aims of the Life Sciences curriculum as they are stated in both data sources (DoE, 2011; Gebhardt, Preethlall, Pilly & Farham, 2012). The Life Sciences curriculum has three specific aims:

> Specific Aim 1 deals with learners acquiring the knowledge and theories surrounding processes in Life Sciences.
> Specific Aim 2 deals with learners acquiring and using skills such as carrying out investigations to test phenomena and processes in Life Sciences.
> Specific Aim 3 deals with appreciating and understanding the history, importance and application of Life Sciences in society.

It is stated in the Life Sciences CAPS document that "within each of the aims, specific skills or competencies have been highlighted that learners need to acquire, but that these skills or competencies cannot be assessed separately" (DoE, 2011, p. 18). These skills for each Specific Aim are outlined in the Life Sciences CAPS document as well as in the textbook. The textbook gives a brief and summarized version of these skills and can be seen below (Gebhardt, Preethlall, Pilly & Farham, 2012, p. 8).

Table 4.1: Specific skills associated with each Specific Aim

Specific Aim 1: Knowing Life Sciences	Specific Aim 2: Investigating phenomena in Life Sciences	Specific Aim 3: Appreciating and understanding the history, importance and application of Life Sciences in society
Apply knowledge of Life Sciences in new and unfamiliar contexts by: *Applying knowledge in new contexts* *Using knowledge in a new way* **Analyze, evaluate and synthesize scientific knowledge, concepts and ideas by**: *Analysing information* *Critically evaluating scientific information* *Recognizing relationships between existing knowledge and new ideas* *Identifying assumptions* *Categorizing information*	**Design/ plan investigations or experiments by**: *Identifying a problem* *Hypothesizing* *Selecting apparatus* *Identifying variables* *Planning an experiment* *Suggesting ways of Recording results* *Understanding the need for replication or verification*	**Apply knowledge of Life Sciences in new and unfamiliar contexts by**: *Applying knowledge in new contexts* *Using knowledge in a new way* **Analyze, evaluate and synthesize scientific knowledge, concepts and ideas by**: *Analysing information* *Critically evaluating scientific information* *Recognizing relationships between existing knowledge and new ideas* *Identifying assumptions* *Categorizing information*

It is notable that the skills associated with Specific Aim 1 and Specific Aim 3 are identical and deals with the acquisition of knowledge, whereas the skills in Specific Aim 2 deals with the learning and application of practical skills used in Life Sciences. It is stated that activities should be designed during teaching and learning that will allow learners to acquire the specific skills (Life Sciences CAPS; 2011). Although such classroom activities are not visible in the Life Sciences CAPS document specifically, there are activities available in the textbook that relate to the acquisition of skills associated with each Specific Aim (Study and Master Life Sciences Learner's Book Grade 11; 2012, p. vii). These specific aims are important and I will refer to

them where it is applicable in the discussion of the categories. I will now turn to the discussion of the first theme.

4.1. The epistemology of Life Sciences

In the introduction chapter (*see page* 4) I discussed that one of the aims of the reformation of the education system in South Africa was to pay homage to the African Renaissance movement advocated by former president Thabo Mbeki (Breidlid (2013) and Green (2012). I also stated that the inclusion of Indigenous knowledge systems in subjects such as science was one of the ways of reaching this aim. During the documentary analysis was found that although the Life Sciences curriculum and textbook address the concepts of Indigenous knowledge systems and worldviews, science is still defined from a Western-Universalist point of view and less from a multiculturalist point of view. I also found that the worldviews of the Xhosa and Sotho teachers and learners as described during the interviews, are largely absent in the Life Sciences curriculum and textbook. In the next category (4.1.1) I discuss the Universalist definition of science based on certain criteria advocated in Life Sciences, and in the second category (4.1.2) I discuss the indigenous worldviews of the participants and compare it to the worldview in Life Sciences.

4.1.1 The Universalist definition of science

The findings suggest that the Life Sciences curriculum and textbook are built on science understood through Western notions which Jegede (1997a) says "uses objectivity to unravel reality". It was found that both the Life Sciences CAPS document and the textbook leans towards this Western view. According to Goduka (2012), a particular epistemology uses specific criteria in order to claim it as knowledge and reality. The definition of science in the CAPS document shows the criteria for Life Sciences:

> To be accepted as a science, it is necessary to use certain methods for broadening existing knowledge… The methods include formulating hypotheses… carrying out investigations and experiments as objectively as possible to test these hypotheses (Life Sciences CAPS; 2011, p. 8).

The specific skills that learners are required to learn stipulated in Specific Aim 2 are: "Following instructions, handling equipment or apparatus, making observations, recording data, measuring, interpreting, designing and planning investigations or experiments, identifying and controlling variables..." (DoE, 2011, p. 15). These methods of experimentation and formulating hypotheses referred to are in line with a modern view on the nature of science (NOS). Dei (2012), Higgs (2006) and Jegede (1997a) suggest that a modernist view on NOS relies on empiricism to validate science. The aforementioned skills in the Life Sciences CAPS document were restated in the textbook (Study and Master Life Sciences Learner's Book Grade 11; 2012, p. 7).

More evidence is provided in the textbook which emphasizes my assertion that the Life Sciences curriculum is built on a modern view on science when it gives a detailed discussion of the "inductive" and "deductive" reasoning that scientists use to inquire about nature. The textbook states that during inductive reasoning observations are made and data collected and analyzed and evaluated, like the formulation of the "cell theory", which is a generalization (Study and Master Life Sciences Learner's Book Grade 11; 2012, p. 3). In the textbook, inductive reasoning is linked with deductive reasoning and it is stated that during deductive reasoning, scientists look for reasons for generalizations such as the cell theory, during which they predict a hypothesis and carry out investigations to test the hypotheses (p. 3). Furthermore, the textbook states that:

> The methods, results and conclusions [of inductive and deductive reasoning] are evaluated and debated through the publication of findings in journal articles, and at conferences… before the scientific community accepts the new knowledge as valid… The scientific community can accept the new knowledge only if such knowledge is produced through certain accepted methods which lend themselves to replication (Study and Master Life Sciences Learner's Book Grade 11; 2012, p. 3).

Neither the CAPS document nor the textbook state anything in terms of the methods used in Indigenous knowledge systems.

These definitions of science in the two data sources are in opposition to how Alters (1997) explains the development of science when he states that that there is not one agreed-upon view of the criteria used to validate science since all cultures and traditions contribute to science.

Indigenous knowledge systems do not necessarily fit into the Universalist definition of science provided in the two data sources, because it is based on a different epistemology. The excerpt above from the textbook about the "acceptance by the scientific community" relates well to what Onwu & Mosimege (2004) call "gate-keeping" devices of science which gives the impression that Indigenous knowledge can only be talked about if it fits into the sphere of science if it can be tested as described above.

Indigenous knowledge systems in Life Sciences

A multiculturalist view on science acknowledges that there is more than one reality on how science is produced (Alters, 1997; Cross, 2006; le Grange, 2004a).

In the Life Sciences CAPS document, "Indigenous knowledge systems" and "worldviews" are addressed simultaneously in Specific Aim 3: "The third aim of Life Sciences is to enable learners to understand that school science can be relevant to their lives outside of school and that it enriches their lives" (DoE, 2011, p. 17). Within the aim it is also stated that:

> The content provides the context for learning about various aspects of science in society. Science should therefore be taught in an integrated way in order to both enhance the subject and clarify the relationship between the subject and society i.e. Indigenous knowledge systems that relate to a specific topic, related history of scientific discoveries and the applications of science in everyday life (DoE, 2011, p. 17)

Specific Aim 3 as it is stated in the excerpt above is also reiterated in the Life Sciences textbook (Study & Master Life Sciences Learner's Book Grade 11; 2012, p. 2). The excerpt and its acknowledgement of history capture Hewson's (2012) statement that "different cultures develop from the particular histories and geo-graphic movements… of a group". However, an understanding of what both data sources mean by "Indigenous knowledge systems" is lacking in concreteness and specificity.

Although there is vagueness in the general understanding of what the CAPS document and the textbook mean by "Indigenous knowledge systems", a clearer understanding is gained in terms of "worldviews". The excerpt below relates well to Indigenous knowledge systems as a

"plurality of knowledges" based on the physical locality of place (Breidlid, 2013; Dei, 2002; Higgs, 2006).

> Sub-aim (3.2): The relationship between Indigenous knowledge and Life Sciences:
> All knowledge stems from views on how the world works. One of the differences between modern science [and technology] and traditional, Indigenous knowledge systems is that they have their origins in different worldviews. Learners should understand the different cultural contexts in which Indigenous knowledge systems were developed (Life Sciences CAPS; 2011, p. 17).

"Worldviews" as defined above addresses the fact that there is a difference in worldviews based on different cultural contexts. The concept of "cultural contexts" relates to Breidlid (2002) and Khupe's (2014) notions of "place" which suggests that "Indigenous knowledge systems" have a strong connection to physical locality. When the CAPS document acknowledges the difference in worldviews between modern science and traditional Indigenous knowledge systems, it acknowledges different realities in the production of science due to different cultural contexts (Alters, 1999; le Grange, 2004a). However, besides the mention of different cultural contexts, the CAPS document does not provide further elaboration on the basis of this difference. The concept of "worldviews" was absent in the analysis of the textbook.

During the interviews, when the teachers and learners were asked what they thought "Indigenous knowledge systems" meant, the learners were not familiar with the term and could not define it. The teachers' responses can be seen below:

> I think Indigenous knowledge is cultural knowledge, for instance, you don't have to go to school for it (Teacher A)

Teacher B, on the other hand, referred to Indigenous knowledge as having certain values attached to it in the Xhosa culture. These values included preservation and valuable use of trees and plants.

> Indigenous knowledge is good, because it involves values. You know there are values involved to know about the environment as well (Teacher B).

Teacher A's mention of "cultural knowledge" relates to how Shizha (2010) described it as knowledge that is born from a particular cultural perspective and which children grow up learning in their communities. Teacher B's description of Indigenous knowledge systems is in line with Hewson (2012) who refers to how Indigenous people appreciate the value attached to plants for various reasons, such as medicine. The teachers' responses also correlate with how Indigenous knowledge systems and worldviews as described in the Life Sciences curriculum and textbook, especially in relation to Indigenous knowledge systems being related to culture. However, one cannot establish how Indigenous people interpret the world and on which assumptions they base their realities (Goduka, 2012).

The findings from the focus group interviews and teacher interviews provide a clearer insight into the assumptions that inform the worldviews of the Indigenous participants, particularly those of the learners. The learners' responses were more indicative of what constituted their worldviews. The teachers, on the other hand, offered more insight into the teaching and learning process when it comes to Indigenous knowledge systems. In the next category I discuss the worldviews of the learners and teachers, and how it compares to the worldview in Life Sciences.

4.1.2 Conflicting worldviews: religion versus empiricism

Various authors have emphasized the fact that not all Indigenous groups are homogenous (Green, 2012; Ogunniyi, 2007; Onwu & Mosimege, 2004; Khupe, 2014; Semali & Kincheloe, 1999). This was observed from the get-go of the interviews with the teachers and learners. However, Hewson's (2012) notion of a "general African worldview" of God and ancestors suffices in the discussion of this category, because although the participants do not necessarily have homogenous worldviews, their worldviews are constructed based on spirituality and religion. I will compare the Indigenous worldview to the Christian Indigenous worldview next.

The Indigenous worldview

Dei (2012), when discussing Indigenous knowledge systems, refers to the "indigene" as a holistic form of knowledge, where it becomes impossible to separate the mind, intellect, soul and the spirit. He also states that "we become whole persons with a connection to a past, present and future" (Dei, 2012, p. 131). Spirituality came forth as a main assumption that constituted

the worldviews of the participants, especially the learners' connection to ancestors. For many of the participants (L2, L3, L5, L6, L7, L8, Teacher A) in the interviews, their ancestors played a primary role in being Xhosa or Sotho. I provide excerpts from L6, L7, L8 and Teacher A.

According to L6 in Focus group 1, if you believe in ancestors, the Sangoma (traditional healer) will be there to help you solve your problems with messages received from ancestors.

> The ones who believe in the ancestors are the ones who also believe in traditional medicines or healers. Because before you can become a traditional healer, you are being called by your ancestors (L6, Focus group 1).

> L8: … Because before you can become a traditional healer, you are being called by your ancestors. Like, if I'm a healer and you're a patient, if you step in my door, you have to take off your shoes before you step in my door in order to communicate with the ancestors properly.
> L7: Like, the ancestors tell them (traditional healers) you have to go and collect this plant on the mountain.
>
> (Focus group 2)

However, Teacher A said that although she believes in ancestors, she does not believe in traditional healers.

> I practice customs. I don't believe in traditional healers exactly, but I do have that belief in ancestors (Teacher A).

This suggests a heterogeneous Indigenous worldview among the participants in terms of the connection between traditional healers and ancestors. I will discuss the heterogeneous Indigenous worldview in 4.3.

I highlight the concept of ancestors' link to traditional healers as described by the participants above, because it highlights the learners' link to spirituality. The concepts of spirituality and ancestors are excluded from the Life Sciences curriculum and textbook. My interpretation is in accordance with Dei's (2012) explanation of scientism, which suggests that science is produced through positivism and that knowledge is dichotomized from the spiritual or metaphysical ways of understanding life (Dei, 2012, p. 127).

The participants also performed certain rituals in honour of ancestors such as slaughtering a cow when someone dies and making umqombothi (African beer), according to L5, L12, L7 and L8, because it is a sign of respect to the ancestors.

> L12: The one thing that makes me Xhosa is because of my religion. Maybe when you are burying someone you must kills the goats.
> R: Why? What does that mean?
> L7: I think you're sacrificing, you sacrifice for the ancestors.
> L8: It's where families come together and you slaughter a cow. We slaughter for our ancestors and spread blood
>
> (Focus group 2)

Other rituals that were highlighted include a girl becoming a woman, according to L3 and a boy becoming a man according to L6, in the traditional Xhosa and Sotho sense of the words. I will return to question the validity of these rituals in science in 4.3.

Ancestors are intrinsically linked to rituals and how Indigenous people interpret phenomena in nature (Dei, 2002; Fakudze, 2004). For example, according to L1, L2 and L8 if you do not respect your ancestors you can become sick or die. I will return to the aforementioned belief in the discussion of 4.2. These rituals, belief systems and worldviews, according to Dei are important to the younger generation for "cognitive understandings and interpretations of the social, physical and spiritual world" (Dei, 2002, p. 21).

The findings from the interviews reveal that the higher power of the Xhosa and Sotho Indigenous groups is not necessarily ancestors for all the participants. Three of the participants highlighted their belief in God as interpreted in the Christian sense instead of ancestors. I discuss this next.

Christian Indigenous worldview

> L7: There are Xhosa people who don't believe in slaughtering a cow. They believe in praying.
> L8: Those people are called '*umahlubi'*. Sometimes some people, even though we are all Xhosa, believe in Christianity and some people believe in the ancestors.

The concept of Christianity, like the concept of ancestors, is absent in the Life Sciences CAPS document and textbook. Below are the participants who have a Christian Indigenous worldview.

> I'm a Christian, I believe in my ancestors, but… what we believe in is that if someone is dead he is dead, but that their soul is among us… I believe everything is possible with God. (L4, Focus group 1).

L11 below believes in Christianity and reads the Bible. He believes that ancestors exist the way it is portrayed in the Bible and not to be worshipped in daily life.

> I don't believe in ancestors that much, because I am a person who reads the Bible. And in the Bible you don't find people believing in ancestors, but they don't talk about going to the Sangomas and traditional healers (L11, Focus group 2).

Teacher B stated that she practiced the Christian religion of Seventh Day Adventist and that she did not believe in ancestors, because ancestors was something that was not there, but that she believed in traditional healers to a certain extent.

> R: Do you believe in traditional healers and ancestors?
>
> TB: No, especially the ancestors. Traditional healers I would say partly, because of the natural medicines that they use. But the ancestors, we don't entertain that, because it's not there in the Bible… we are more inclined to what is said in the Bible (Teacher B).

When comparing the Indigenous worldview with the Christian Indigenous worldview, one can establish that there is also heterogeneity in the participants' belief in ancestors and God. Nevertheless, it is clear that spirituality as understood from the point of view of Christianity, is also an assumption on which the three participants above base their worldviews. They assume that God is the higher spiritual entity which can help solve their physical and spiritual problems. As Khupe (2014) and Ranger (1987) explained, although Christianity was initially a Western concept used during colonization in missionary education, the spiritual aspect of God has become more associated with many groups in Africa, particularly among Indigenous groups. I concur with Breidlid (2013) who states that "Christianity has, to some extent, been incorporated into the Indigenous belief systems where the territories that these belief systems occupy are not

mutually incompatible". Therefore the participants in this study also "transcend what can be termed Indigenous identity" (Breidlid, 2013, p. 90). Hence, even for the participants who have a Christian Indigenous worldview, there is a discrepancy between their worldviews and the worldview of Life Sciences.

Both concepts of ancestors and God highlighted by the participants relate to the fact that the Indigenous worldview is not only based on empirically proven methods. Their assumptions about reality are based on the uncut boundaries and intrinsic connections between ancestors, God, man, nature, cultural rituals and customs (Dei, 2012). These intrinsic connections show the spiritual and holistic nature of the participants' Indigenous worldview and epistemology (Khupe, 2014; Odora-Hoppers, 2002).

Transcending identities and parallel worldviews

In terms of transcending identities (Breidlid, 2013), the argument can be made that even though the teachers' and learners' worldviews in relation to spirituality is absent in the Life Sciences CAPS document and textbook, their mere exposure to Life Sciences in school, forces them to reconstruct their identities by accommodating both types of knowledge systems: the traditional knowledge system and the knowledge system promoted in Life Sciences. Skeie (1998) (in Breidlid, 2013) also refers to the exposure to different worldviews as developing a "transversal identity" which suggests an identity which is continually being reconstructed when confronted with the plurality of society.

Returning to the earlier responses where I discuss the Christian Indigenous worldview, it is evident in the responses of L4 and L11, that although they are more strongly inclined to the belief in God, they do not dispute the idea of ancestors. In addition, although Teacher B believes in God and disputed the idea of ancestors, she "partly" believes in the value of traditional healers. More learners (L2, L6, L7, L8) reiterated a similar worldview.

R: So what I understand is that there is God, there are the ancestors, then there are the Sangomas and Nyangas and then there are also medical doctors in the hospital? So, what do you believe?

L2: I believe in all of them.

L6: But it's like, something will work for you if you believe in it. If you don't believe in it it's not going to work for you.

(Focus group 1)

L7: Sometimes there are situations where you go to the doctor who can't see the problem that you have. You go to the traditional healers and then they can tell you what you have.

(Focus group 2)

The responses from the participants above can be considered a parallel worldview where the learners and the teachers accommodate two worldviews simultaneously. The problem is that in Life Sciences, one worldview is recognized more than the other. I will refer to this problem in 4.2, 4.3 and 4.5. The difference in worldviews suggests an epistemological wall between the worldview of the Life Sciences curriculum and textbook, and the worldviews of the Indigenous teachers and learners.

The next theme discusses the epistemological borders that teachers and learners have to cross based on this epistemological wall.

4.2. Crossing epistemological borders

In this theme I will highlight the types of borders that the participants have to cross when faced with a conflict between spirituality and empiricism in certain topics in the Life Sciences classroom.

4.2.1 Cognitive border-crossing and collateral learning

In this section I will show that in cases where the Life sciences curriculum and textbook do draw from Indigenous knowledge systems, it leaves out the aspect of spirituality associated with it. To show this I will use examples of five topics in Life Sciences to illustrate border-crossing with the help of the theory discussed in chapter two. Three of the examples (4.2.1.1 "Traditional healing", 4.2.1.2 "Sustainable development", 4.2.1.3 "Traditional biotechnology") are taken from the textbook. The last two examples (4.2.1.4 "Evolution" and 4.2.1.5 "Cause of illness or death") were brought up during the focus group interviews and teacher interviews. In the discussion of each example I will use the theory of cognitive border-crossing (*smooth-, managed-, hazardous-, and impossible border-crossing*) by Aikenhead (1996). I will also relate

it to collateral learning theory (*parallel-, secured-, dependent- and simultaneous collateral learning*) by Jegede (1997b) (*See theoretical framework, chapter two*).

I will now turn to discussing the first example of subject content which is "traditional healing".

4.2.1.1 Traditional healing

The topic of traditional healing I will discuss in relation to *smooth border-crossing* and *hazardous border-crossing*.

According to various authors (Breidlid, 2002, 2013; Dei, 2012; Hewson, 2012; Khupe, 2014) traditional healing plays a prominent role in the Indigenous worldview. Hewson (2012) in particular highlights that traditional healers have in-depth knowledge of herbal and animal-based medicines. The Life Sciences curriculum and textbook draw from Indigenous knowledge systems because both data sources include the example of traditional healing. Traditional healing was also a central concept during the focus group interviews and teacher interviews. I will first discuss the findings from the documentary analysis and then relate it to the findings from the interviews.

In the Life Sciences curriculum and textbook, traditional healing is discussed under the topic "Biodiversity and environmental sustainability". The CAPS document and the textbook therefore correlate with one another in terms of the topics; but the textbook gives a clearer and in-depth discussion on the topic of biodiversity and environmental sustainability.

The textbook highlights how Indigenous peoples in South Africa attach value the earth's natural state. In reference to the medicinal use of plants, the textbook refers to the San hunter-gathers (the first or original Indigenous groups in South Africa) and their knowledge on the use of plants for medicinal and edible purposes (Gebhardt, Preethlall, Pilly & Farham, 2012, p. 370). Below is a picture from the textbook of the plants used for medicinal purposes in Indigenous knowledge systems. The textbook did not specify their medicinal value.

Figure 4.1: picture from textbook depicting three examples of medicinal plants.

According to the textbook, these San-hunters are very familiar with the natural patterns and processes of plants and animals in their environment.

> Harvesting Indigenous plants for medicinal and other purposes has been part of our Indigenous knowledge system for hundreds of years. Elders in rural villages will tell you how they were taught by their parents to, for example, remove medicinal bark from trees in tiny vertical strips and then move away from that tree to allow healing (Gebhardt, Preethlall, Pilly & Farham, 2012, p. 370).

What is particularly prominent in the excerpt is the mention of "Elders", "tell you" and "taught by their parents" which confirms Dei (2012) and Khupe's (2014) understanding of how Indigenous knowledge systems are passed on orally from generation to generation for survival purposes.

From the interviews, the teachers and learners highlighted that traditional healers have extensive knowledge of plants. Similar to what Breidlid (2002) found, the learners distinguished between two types of traditional healers, a *Sangoma* and a *Nyanga*. According to learners (L2, L6, L7 and L8), these traditional healers serve functions such as interpreting a dream using bones, solving problems or healing you from illnesses using plants as medicine. L6 said:

> The Sangoma doesn't give you any medicine, the Sangoma will give advice. The Nyanga, when you go there, you go, "Sir, I have a problem. I have stomach pain." He or she will just say "take this and this, use it like this and this (L6, Focus group 1).

In focus group 2 they had the same to say about traditional healers:

> They use bones to tell you what the problem is and the plants they use as medicine. Like the ancestors tell them you have to go and collect this plant on the mountain." (L7, Focus group 2).

> Traditional healers communicate with the ancestors. Like, maybe if I'm sick or they try to get some help, they have bones to communicate with ancestors. Like, they pray and have their own way of how they communicate with ancestors. Sometimes the medicine is shown by the ancestors (L9, focus group 2).

While the learners said that they did not cover traditional healing, the teachers said that they covered the topic of the medicinal value of plants in Life Sciences. According to Teacher A she did not think the topic was covered in the Life Sciences curriculum and textbook enough.

I will now relate the topic of traditional healing to *smooth border-crossing* and *hazardous border-crossing*.

Smooth border-crossing

The fact that the findings from Life Sciences curriculum and textbook and the findings from the interviews correlate with one another show that the border-crossing between the Indigenous worldview and the scientific worldview can be smooth. Smooth border crossing, according to Aikenhead (1996), means that the learners' worldviews are similar with the scientific worldview of traditional healing in Life Sciences and they can resonate with the subculture of science. In this sense, the teaching and learning experience of the participants is enculturating since an aspect of their worldview is accommodated in the Life Sciences curriculum and textbook, and in the classroom. An enculturating learning experience, according to Fakudze (2004) means the school science is in line with the Indigenous learners' identities.

The subject content is more familiar and accessible to the learners and the learning process less alienating (Onwu & Mosimege, 2004). The way the Life Sciences CAPS document and the textbook use the notions of traditional healing and the way the learners talked about their belief in traditional healing applies to the principles of CHAT, which Botha (2009, p. 60) says

suggests ways in which Indigenous learners can practically cross cultural borders in order to draw from their traditional knowledge and the formal Western knowledge.

When one considers the fact that many of the participants associated ancestors Traditional healing, traditional healing can also be an example of *hazardous border-crossing*.

Hazardous border-crossing

According to Hewson (2012) African populations consult traditional healers for physical problems, but also for psycho-spiritual problems. According to four learners, the traditional healers receive dreams from their ancestors. As L6 said, the Sangoma, unlike the Nyanga, gives spiritual advice. L6, L7, L8, L10 said that the traditional healers need to interpret dreams sent by ancestors so that they can offer the necessary help to those who consult them for help. L8 made a similar statement when she stated that "If in your dream, your grandfather who died long ago, appeared, then you call your elders and tell them about your dream. Then there are people who can interpret that dream and then it is okay" (L8, focus group 2).

My interpretation is that the exclusion of ancestors in the discussion of traditional healers in the Life Sciences curriculum and textbook is because in modern science, the spiritual aspect has been undermined (Delanty, 2000 in Breidlid, 2013) and the secular has been isolated from the spiritual (Taylor, 2006). With the exclusion of ancestors from the discussion of traditional healing in the Life Sciences curriculum and textbook, an aspect of the learners' worldviews concerning traditional healing is denied in Life Sciences. The fact that only the empirical aspect pertaining to traditional healing is recognized while the religious element of ancestors highlighted by the participants is ignored, is an example of parallel learning where the conflicting schemata do not interact at all in the Life Sciences classroom (Jegede, 1997b).

Aikenhead (1996) states that during hazardous border-crossing learners usually submit to the view of science as portrayed by experts, because their own Indigenous worldviews are not validated in the classroom. Because the participants' Indigenous worldviews regarding ancestors is excluded they assimilate into empirically approved notions of traditional healing portrayed in the Life Sciences curriculum and textbook.

Hazardous border-crossing is also implied when Teacher B mentioned the urban worldview of the Indigenous learners living in townships. According to Teacher B in rural areas in the Eastern Cape you'll find fields of plants like aloe plants which help to cure wounds:

> You'll find when you go to the Eastern Cape, there are fields of aloe plants. Most of them grew up in an urban area, you know? Take for instance a learner who was born in Khayelitsha (the largest township in CapeTown), where it is rare to have plants in the yard... to them it might not make sense (Teacher B).

Her view suggests that although the learners were familiar with the fact that traditional healers used plants, they did not have much exposure to it, unlike learners who live in rural areas who Khupe (2014), for example, states has a stronger sense of knowing the history of land due to place, in contrast to what Webb (2013) found among his urban participants. Thus, to a certain extent, based on Teacher B's excerpt above, the learners in this study relate to what Stears (2008) found among her participants in an urban impoverished community: that the learners' sub-culture of poverty clouded their views on Indigenous knowledge that could relate to science.

The next section also relates to plants in relation to sustainable development.

4.2.1.2 Sustainable development

The topic of sustainable development is discussed in relation to *managed border-crossing* and *secured collateral learning*.

The example of border-crossing in sustainable development could be when the Western worldview of urbanization and industrialization conflict with the Indigenous worldview of keeping the earth's natural resources sacred (Breidlid, 2013; Hewson, 2012; Ntuli, 2002). This is highlighted in the Life Sciences curriculum and textbook and was also mentioned by Teacher A and Teacher B during the interviews. I will show the findings of the documentary analysis first, and then relate it to the findings from the interviews. Lastly I discuss these findings in relation to the theory.

The content relating to environmental sustainability for grade 10 and Grade 11 relates to Specific Aim 3 which covers Indigenous knowledge systems and human impact on the environment. The content for Grade 10 in the CAPS document talks about biodiversity in general and particularly in southern Africa (DoE, 2011, p. 35). The content for Grade 11, however, delves deeper into the loss of biodiversity due to human practices and its impact on nature due to habitat destruction, such as modern farming techniques, urbanization, deforestation and loss of wetlands and grasslands. Additionally, the CAPS document talks about the sustainable use of the environment in Indigenous knowledge systems (Life Scienes CAPS, 2011, p. 52). The CAPS document merely lists the topics related to sustainable development, but the textbook provides more information.

The textbook highlights how Indigenous peoples in South Africa attach value to the earth's natural state. In the textbook it is explained how Nguni chiefs set aside large areas of land as their personal hunting grounds and states that no member of the community was allowed to harvest or hunt in those areas (Gebhardt, Preethlall, Pilly & Farham, 2012, p. 370). This speaks to the value the Nguni chiefs related to preservation of the earth's resources. The textbook also compares this example of preservation to that of modern game reserves that protect the diversity of wildlife and ecosystems in areas that are close to human settlements.

While the textbook highlights the preservation of the earth's natural resources by Indigenous peoples like the Nguni chiefs, the textbook also discusses the impact of human practices such as deforestation on biodiversity. On the one hand, the textbook states modern agricultural practices, like the building of golf estates and the invasion of alien plants have been causing deforestation as well as damaging and loss of Indigenous plant species in many areas in South Africa (Gebhardt, Preethlall, Pilly & Farham, 2012, pp. 316-317). On the other hand, the textbook also states that over-exploitation of trees and shrubs for traditional medicines are also some of the causes of deforestation (Gebhardt, Preethlall, Pilly & Farham, 2012).

During the interviews, Teacher A and Teacher B also mentioned the loss of biodiversity as a result of industrialization and urbanization. This is what Teacher B had to say:

> Plants are valuable, you know? The cutting down of trees is something where now it's an urban thing where people are now looking for a place to stay. In rural areas they use the dry wood if the wood is no longer growing and to make a fire they would use that. So it's very rare to just

> cut down trees and all that… Because they believe that some of these plants or trees they can use as medicine (Teacher B).

I will now relate the topic of sustainable development to managed border-crossing and secured collateral learning.

Managed border-crossing

The findings from the documentary analysis correlate with findings from the interviews which suggest an example of managed border-crossing (Aikenhead, 1996). Managed border-crossing is when the learners' worldviews are different from the science worldview which requires the border-crossing to be managed. The difference in worldviews is not necessarily seen as an obstacle, but an opportunity for learning something new. Western practices such as industrialization and urbanization conflict with the Indigenous worldview of "sacredness of the earth" (Breidlid, 2013; Ntuli, 2002). The border-crossing between the two conflicting worldviews can be managed through secured collateral learning.

Secured collateral learning

In secured collateral learning, the conflicting worldviews consciously interact and the conflict is resolved in some manner (Jegede, 1997b). Because classroom observation was eliminated as a research method, I do not have evidence to suggest that secured collateral learning took place in the classrooms of the Life Sciences teachers. However, the fact that the conflict is mentioned in the two data sources as well as by the teachers, I suggest and discuss my interpretations.

In secured collateral learning, teachers and learners can be opened up to the possibility where the Western worldview of exploitation of resources can draw from the Indigenous worldview of keeping the earth's natural resources sacred. Sustainable development refers to how human, social and economical development can occur without running the risk of depleting the earth's natural resources needed for humankind to survive. South Africa, one of the most economically developed countries in Africa, has become a contributor to global warming and still has a long way to go in terms of sustainable development (Breidlid, 2013, p. 92). If the Life Sciences curriculum considered and implemented Indigenous knowledge systems more effectively alongside Western knowledge, through secured collateral learning, the Indigenous teachers and learners can be motivated to have a dialogue where they discuss these conflicts and possibilities surrounding sustainable development (Jegede, 1997b).

I will discuss the topic of traditional biotechnology next.

4.2.1.3 Traditional biotechnology

The topic of traditional biotechnology is discussed in relation to *simultaneous collateral learning*. The example was found in the Life Sciences curriculum and textbook, and was also brought up during the interviews. I first discuss the findings of the Life Sciences curriculum, then the textbook and lastly the findings from the interviews, after which I discuss it in relation to the theory.

In the Life Sciences CAPS document, traditional biotechnology relates to Specific Aim 3 since the content fell under the topic "Applications of Indigenous Knowledge Systems and Biotechnology" (DoE, 2011, p. 28). For Grade 10, the CAPS document states that the content is related to medical biotechnology, e.g., which deals with immunity, vaccines, antibiotics and blood transfusions. For Grade 11, the CAPS document states content that relates to the role of anaerobic respiration in the industry such as beer brewing and bread making. There is a difference in the content for Grade 10 and Grade 11 in relation to traditional biotechnology in the CAPS document. This could be due to the fact that in Grade 10, a general understanding is covered in terms of content relating to Indigenous knowledge systems; whereas in Grade 11, the content becomes more specific (DoE, 2011). The textbook gives a more elaborate account than the CAPS document of traditional biotechnology.

The example in the textbook focused on the making of "*umqombothi*" (African beer) and is also discussed under the topic of "traditional biotechnology" (Gebhardt, Preethlall, Pilly & Farham, 2012). African beer is used as an example of alcoholic fermentation and anaerobic respiration (Gebhardt, Preethlall, Pilly & Farham, 2012, p. 83). The example of "Amasi" (fermented milk) was used under the same topic.

In the textbook, modern scientific terms are used to describe the process of fermentation and traditional beer-making, while an Indigenous language is used to define the tools or apparatus. The picture that follows is taken from the textbook and illustrates two women making umqombothi.

Figure 1.1.58 Two women making traditional beer (*umqombothi*)

Figure 4.2: picture from textbook illustrating the making of umqombothi (African beer)

During the interviews, the learners (L1, L3, L7 and L8) also talked about the making of umqombothi during the performance of cultural rituals and ceremonies. L8 specifically said that the making of traditional food like samp and beans, maize meal and umqombothi are what makes her a Xhosa.

> We cook food like samp and beans, maize meal, and the African beer, umqombothi (L8, focus group 2)

Teacher A also confirmed that they covered "the making of umqombothi" during the discussion of anaerobic respiration. However, she did not elaborate.

> In some textbooks… we were doing anaerobic respiration and *umqombothi* (African beer) … it's an example of anaerobic respiration. Plus… there are Indigenous plants in there… It's not enough. It just touches on it a little bit (Teacher A).

The findings from the documentary analysis and the interviews therefore coincide and shows that the CAPS document and textbook incorporated elements of Indigenous knowledge systems. The example of umqombothi and the scientific concept of anaerobic respiration also relates to *smooth border-crossing* to a certain extent in that the worldview of *umqombothi* in the Life Sciences curriculum and textbook relates to the indigenous worldview of the

participants. However, I will discuss the example of umqombothi in relation to *simultaneous collateral learning*.

Simultaneous collateral learning

The example of umqombothi and Amasi speak to the constructivist theory pointed out by Jegede & Aikenhead (1999) and Onwu & Mosimege (2004) (*see theory chapter*). These authors advocate for familiarity with contexts to make learning of new science concepts better. Simultaneous collateral learning, according to Jegede (1997b) refers to a situation where learning a concept in one domain of knowledge can facilitate the learning of a similar concept in another domain of knowledge. Learners can apply their knowledge of umqombothi which they associate with cultural rituals and practices, to the scientific concepts of fermentation and anaerobic respiration. By relating the example of umqombothi to the process of fermentation and anaerobic respiration, the curriculum reaches the aim of how science can be applied to everyday life and local contexts (Life Sciences CAPS; 2011, pp. 17, 28).

The next two examples of topics in Life Sciences were not found during the documentary analysis of the Life Sciences curriculum and textbook, but came forth during the interviews with the teachers.

4.2.1.4 Evolution

The topic of evolution shows the conflict between the Indigenous worldview and the Western-Universalist worldview clearly. I will discuss this topic in relation to *impossible border-crossing* and *dependent collateral learning*.

In the interviews, both teachers were vocal about the confusion and conflicts they faced when teaching the learners about evolution. According to the teachers, the learners had many questions when it came to the issue of the existence of life and how life evolved. Neither of the teachers mentioned the ancestors when discussing this topic, but referred to the learners' exposure to God and the Bible. Therefore, the excerpts from the teachers below strengthens the various authors' notion that Christianity has become Africanized (Delanty, 2000; Ranger, 1987 in Breidlid, 2013).

> The conflict comes in that chapter of evolution. When you have to tell about the history of life and the formation of earth; then they (the learners) tend to go to the Bible. It confuses them. As a result, even for us as teachers it's hard to explain exactly what is happening. I usually say to them we must put away the Bible and focus on science only, because some questions I cannot answer (Teacher A).

> It is very confusing for the learners. I separate evolution in a scientific way, but when it comes to the Bible, I don't mix the two, because they are two different things… If I introduce evolution to the learners I always say that evolution cannot be compared to what is said in the Bible, because in the Bible there are no changes whereas science changes every now and then. So when I'm teaching them they shouldn't even quote what is in the Bible, because it is two totally different things (Teacher B).

From the findings I infer, with the help of Webb (2013), that the teachers are placed in a dilemma where the science worldview and the traditional worldview collide which causes challenges to teaching and learning in Life Sciences.

I will now turn to discussing the conflicts that the teachers mentioned and relate it to impossible border-crossing and dependent collateral learning.

Impossible border-crossing

The topic of evolution highlighted by the teachers is an example of *impossible border-crossing*. Impossible border-crossing, according to Aikenhead (1996) refers to a situation where the Indigenous worldview of the learners is inharmonious with the worldview of Life Sciences. According to Aikenhead (1996) learners are assimilated into the subculture of science and their conflicting worldviews regarding "the creation of earth" is not resolved in the Life Sciences classroom. This seems to be true since both teachers confirmed that they separated science from religion when faced with questions from the learners. One can also see a type of contradiction in Teacher B's response when she said that even though she did not mix science and religion, she did, in a sense, have a biased view towards Christianity when she said that "nothing can compare to what is said in the Bible".

The conflicts the learners face during impossible border-crossing is also an example of parallel collateral learning (Jegede, 1997b) where the empirical notions of evolution are recognized in Life Sciences, while the religious notions of God as the creator is excluded from Life Sciences. However, the impossible border-crossing can be resolved through dependent collateral learning.

Dependent collateral learning

Dependent collateral learning, according to Jegede (1997b) refers to a situation where two worldviews challenge one another to an extent that allows teachers and learners to modify their worldviews where both explanations - Evolution and God as the creator - , are accommodated in their worldviews. An example of how such a conflict can be resolved is seen in Ogunniyi's (2007) use of the practical argumentation course (PAC) among a group of science teachers where the teachers were open to voice their opinions and concerns and interrogate the curriculum more closely. One of Ogunniyi's (2007) informants, for example, showed how he accommodated both his views on science and religion with regards to the topic of evolution (*See theory chapter*).

According to Jegede & Aikenhead (1999) in order for any type of collateral learning to take place which allows learners to modify their conflicting worldviews, the role of the teacher is important. The teacher needs to act as "cultural broker" who help the learners to not suppress their Indigenous worldview or assimilate entirely into the Western worldview of Evolution. In order for this to happen the teachers need to open learners up to a dialogue in the classroom and allow them to talk about the conflicts they are experiencing. Ultimately, such a dialogue in dependent collateral learning should aim to provide learners with a learning experience which help them to use what is good in their religious, Indigenous worldview while still being open to Western explanations of evolution. From the interviews with the teachers it is clear that they have not initiated such a dialogue. The fact that Teacher A said that she did not know what to do or say, and the fact that teacher B said that she separated evolution from the Bible because they are two different things, addresses Shizha's (2010) thoughts. According to Shizha (2010), because formal schooling and formal science suggests that teachers and learners follow a prescribed and standardized curriculum, teachers only focus on the subject matter prescribed and predetermined by the state (Shizha, 2010, p. 135). This leads me to think that the teachers need to be exposed to dependent collateral learning first, before becoming the cultural brokers to learners.

The last example of border-crossing and collateral learning was also brought forth during the focus group interviews.

4.2.1.5 Cause of illness or death

The last example of border-crossing and collateral learning I discuss in relation to *impossible border-crossing* and *secured collateral learning*. The topic of "the cause of illness or death" speaks to how Indigenous people incorporate their social and natural wellbeing with that of their cosmos and spiritual world (Shizha, 2010). This topic was not found during the documentary analysis, but was brought forth during the focus group discussions when learners discussed ancestors. In both focus groups, the learners were of the opinion that if traditional healers did not accept their calling from ancestors, they would be punished through illness or death.

According to L9 in focus group 2, if traditional healers did not accept their calling by ancestors, they would become sick (*see Appendix G, focus group 2*). Similar thoughts were expressed in focus group 1.

> L1: I believe in 'amagquiga' (Sangoma). My mother was not one of them, but she got into accidents everywhere she went.
> L6: She had like a bad curse.
> L1: But my mother refused to be that Sangoma. Everywhere she went she got into accidents. She even got sick. She went to the hospital then she started to do that work… I see now that she has done that work, she is doing better.
> L2: You can even die if you don't do it.

Fakudze (2004) also found that even through being exposed to scientific explanations in the science classroom to explain the phenomena in science, the learners in her study resorted to explaining phenomena through the lenses of messages from ancestors (*see theory chapter*). In the analysis of the Life Sciences CAPS document and the textbook, there was no mention of punishment or bewitchment from ancestors as the cause of illness. What is included in the CAPS document and the textbook is the cause of infections and illnesses such as cancer or HIV as understood from a scientific point of view; such as how it is caused, how it is spread, the

symptoms associated with it, and how it can be medically treated (DoE, 2011, p. 26, 47; Gebhardt, Preethlall, Pilly & Farham, 2012, p. 41, 270).

Impossible border-crossing

The belief in punishment from ancestors as the reason for the cause of illness, conflicts with the Universalist explanation in the Life Sciences curriculum where only empirically proven explanations are given for the cause of illnesses (Dei, 2012; Higgs, 2006; Jegede, 1997b). This conflict is an example of impossible border-crossing where the Indigenous learners who believe that illness is sent by ancestors, resist a transition to the worldview of science where empirical facts are used to justify illness. This is also an example of *parallel collateral learning* where the two conflicting explanations of illness do not interact at all since the spiritual aspect of ancestors is not accommodated in the Life Sciences curriculum. The conflicts learners face through impossible border-crossing can be resolved through a process of *secured collateral learning*.

Secured collateral learning

If the learners are exposed to secured collateral learning (Jegede, 1997b) they are provided with explanations of "death" or "illness" from an Indigenous point of view, and from a Western point of view, and the two conflicts can consciously interact. Through secured collateral learning, the learners are encouraged to not suppress their worldview concerning ancestors, and they are also provided with an opportunity to come to a valid understanding for the cause of illness which can either modify their existing Indigenous worldview, or keep it as it is (Ogunniyi, 2007). Here, the role of the teacher as cultural broker is also important to mediate learners into process of modifying their existing worldviews regarding the role of ancestors in the cause of illness or death.

In this theme I discussed the epistemological borders that the learners have to cross between their Indigenous worldviews to the worldview in Life Sciences. The next theme discusses the marginalization of Indigenous knowledge systems.

4.3 Marginalization of Indigenous knowledge systems

In the previous themes I discussed the epistemological difference between the Life Sciences curriculum and the worldviews of the Indigenous participants. I also explained the

epistemological borders that they have to cross from the subculture of home to the subculture of school for which I used certain topics from the documentary analysis and the interviews. In this theme I discuss the aspect of marginalization of Indigenous knowledges in Life Sciences further. I explore this in the context of heterogeneous Indigenous worldviews. I also explore this marginalization in terms of the rituals in relation to religious aspects that have been excluded from the Life Sciences curriculum and what this means for learning.

4.3.1 Heterogeneous Indigenous worldviews

In this section I argue that one should be cautious in claiming that all Indigenous knowledge worldviews are linked to ancestral beliefs, or even traditional healing, as Onwu & Mosimege (2004) state. There is no doubt that Indigenous knoweldges have been marginalized and that it is taking long to establish elements of it as legitimate science in school curriculum. But based on the heterogeneous Indigenous worldview among the participants, one of the reasons for this marginalization could be because the elements that have been seen as constituting Indigenous knoweldges, like ancestral beliefs and traditional healers, is not a homogenous worldview among the Indigenous people from the same group.

In the first theme (4.1.2) I highlighted that the participants stated that a certain spiritual element should be accounted for to explain certain occurrences in the natural world. For example, the learners' attributed ancestors to "the cause of illness". However, the participants did not agree on the spiritual element that constituted their indigenous worldviews. Some participants' worldviews are built on the assumption of ancestors, while others' worldviews are built on the assumption of God. The belief in traditional healers is also divided, although most of the participants have a stronger tendency towards the belief in traditional healers than ancestors.

I will reiterate the findings discussed in 4.1 to show what I mean. L4, L11 and Teacher B believe in Christianity, but not in ancestors. L4 and L11 believe in medical doctors but not in traditional healers, while Teacher B did. For example, L4 said: "I believe, like, if I feel a pain, I can go to the doctor, the medical doctor, not a spiritual doctor or a Nyanga to tell me my problems". Similarly, Teacher A believed in ancestors, but not traditional healing. This shows that there is inconsistency in whether the participants believe that ancestors are linked to traditional healing.

However, it is worth considering that this divided belief system of Indigenous knowledges could be the result of Western colonization of the mind (Ngũgĩ, 1981), especially among urban people. People in urban townships like Gugulethu, are more prone to Western and modern tendencies when it comes to education. This was confirmed by L8 L9, L11 and Teacher A during the interviews. For example, Teacher A, when asked what she thought could be included in the Life Sciences curriculum, she said:

> Most people promote Western culture and science, and it seems they don't even promote traditional ways at all. It seems impossible to change, because even us, the elders, tend to choose Western, because it's easier (Teacher A).

This view of Teacher A relates to Shizha's (2010) argument that an academic African is assimilated into Western intellectual authoritarianism without concern about growing African Indigenous knowledge systems. I say this, because although Teacher A mentioned that there are some Xhosa remedies that can be useful in Life Sciences, she did not expand on other values that can be included.

While learners like L7, L8, L9 and L11 in focus group 2 said that there are certain aspects of Indigenous knowledge systems that can be included in Life Sciences, the same learners also said that it would be difficult since not everyone shared the same beliefs. However, they did not expand on the academic difficulties associated with a difference in beliefs (*See Appendix G, focus group 2 transcription*).

The heterogeneous worldview among the participants may seem like a minor argument in understanding the borders that learners have to cross which I discussed in 4.2. But I argue that in order to understand the greater argument of border-crossing, it is necessary to consider this heterogeneous worldview in the issue of the marginalization of Indigenous knowledge systems in science. My interpretation is that Indigenous knowledge systems are not only marginalized because of the superiority of Western science, but, based on the findings of this research, also because of the lack of consensus regarding Indigenous knowledges among Indigenous people. In agreement with Webb (2013) the findings also suggest that based on this marginalization, the learners as well as the teachers are subtly unaware of the link their Indigenous worldviews have in Life Sciences and the probability that the exclusion of their holistic indigenous worldviews in Life Sciences could be a key contributor to academic failure. I argue that they

are more aware with regards to the value of plants which can be included, but less aware of the conflict of spirituality in Life Sciences.

4.3.2 The marginalization of Indigenous rituals in Life Sciences

In the first theme I highlighted that the Indigenous worldview of the participants is holistic in nature and the boundaries between knowledge that is used for science is intrinsically related to the rituals and customs they perform (Dei, 2002; Ntuli, 2002; Odora-Hoppers, 2002; Khupe, 2014). For example, four of the learners (L2, L5, L7, L9) referred to the fact that they slaughtered a cow for the ancestors when someone died and would make umqombothi (*see 4.1.2*). The informants in Breidlid's (2002) study, also mentioned the importance of making umqombothi as a sign of respect. What is absent in the Life Sciences curriculum and textbook is the symbol that umqombothi represents during such ceremonies.

While the symbol behind the slaughtering of a cow and the making of umqombothi is excluded from the Life Sciences curriculum and textbook, it is questionable why it is excluded. Of course the cultural rituals are important to what makes the participants Xhosa and Sotho, as the majority of the participants explained (*see 4.1.2*), but it is questionable whether this is applicable in the Life Sciences curriculum. It is questionable whether this symbolic meaning is necessary in the subject of science and whether it will be more applicable in a different subject such as Arts and Culture or Life Orientation, for example. The example of the holistic nature of indigenous worldviews in terms of spirituality attests to the complex intricacies surrounding Indigenous knowledge systems, science, religion and culture in South Africa. The boundaries of Indigenous knowledge systems are not as clear-cut as the boundaries in a Universalist view on science (Odora-Hoppers, 2002). The complexities regarding the exclusion of certain elements of Indigenous knowledge systems relates to Cross (2012) who says that "the nature of science and the cultural contexts such as those found in Africa, represents a further set of challenges [and that] it is important to recognize the contested nature of science when developing a curriculum" (Cross, 2002, p. 12, 13). This, perhaps, could be one of the challenges as to why Indigenous knowledge systems have not been fully utilized in the South African curriculum.

4.3.3 The need for documented co-existence in Life Sciences

It is highly probable that the marginalization of content on Indigenous knowledge systems in the Life Sciences curriculum and textbook could also be due to its lack of documentation (Onwu & Mosimege, 2004; Shizha, 2011).

The findings suggest an obvious need for Indigenous knowledge systems to be developed more so that it can be placed at a higher hierarchical level than its current position, especially considering that both knowledge systems – Indigenous and Western – can develop from each other when it comes to learning, as I discussed in the previous theme (4.2).

Teacher B shared a similar sentiment:

> It would be proper if Indigenous knowledges could be included in the syllabus… maybe even save our biodiversity in a way … but it needs more research where you can go to such a culture, where you research to find out what you need to include in the syllabus … (and) what you would love your children or the next generation to know about the values or knowledge that wasn't there or addressed (Teacher B).

Teacher B made a point which agrees with arguments in literature about the inclusion of Indigenous knowledge systems in science teaching. According to Teacher B, inclusion of Indigenous knowledges in science curricula can contribute to the saving of our biodiversity, but if we wanted Indigenous knowledges to feature more prominently in science teaching, careful consideration needed to be taken about what needed to be included about Indigenous knowledge systems, similar to what is suggested by the Third Space Theory (Kulua, 2009; Semali & Kincheloe, 1999). The Third Space theory suggests that there is a need for Western and indigenous knowledge systems to interact and co-exist through a negotiation and resolution of conflict between the two knowledge systems. Through a negotiation of conflicts between the Western and Indigenous knowledge systems in the Third Space, both knowledge systems can evolve and contribute to saving biodiversity. Therefore, in relation to Teacher B's response, Semali & Kincheloe (1999) are right to suggest that indigenous knowledge systems should not be "romantized", but some of the values inherent in indigenous knowledge systems should be carefully considered if it is going to be placed alongside Western knowledge.

As I stated earlier in 4.1, although both worldviews are accommodated in the Life Sciences curriculum and textbook, the Western worldview features more prominently. Considering the richness in the learners' responses regarding their Indigenous beliefs of ancestors, rituals and customs, there is a cultural dissonance (Shizha, 2010) between the students' cultures and the Life Sciences curriculum. What is missing is a method of teaching and learning that combine the two (Shizha, 2010).

It is also worth considering that if a documented co-existence is called for, we take away some of the criteria on which the indigenous epistemology is based, which is the transferral of knowledge in oral fashion (Odora-Hoppers, 2002; Khupe, 2014).

In the next theme I discuss linguistic border-crossing.

4.4 Linguistic border-crossing

> R: So, what makes you Xhosa? Maybe you can give me a sentence.
> L9: For me it's the language in our home.
> L8: What makes me Xhosa is because of my culture, my language, my lifestyle

The inference I make from the excerpts above is that Ngũgĩ wa Thiongo (1981), Cummins (2000) and Gibbons (2003; 2006) are right to state that language not only being a carrier of words, but that it also forms an intrinsic part in our identities. For the participants in this study, language was a strong carrier of identity. The issue of language was an important topic during the interviews. The discussion on English, Xhosa and Sotho and their uses in the Life Science classroom brought about various responses in the focus group interviews and teacher interviews.

In this theme I discuss the linguistic borders that learners have to cross in addition to the epistemological borders. This theme is important in the discussion of border-crossing between the sub-culture of home and the sub-culture of science, because language plays such an important role in cognitive development (Brock-Utne, 2001; Biseth, 2008; Cummins, 2000; Gibbons, 2003; 2006). In this theme I will dedicate the discussion to the role of language in Life Sciences, the cognitive challenges learners face as a result of the language of learning and teaching (LoLT), the teaching strategies that the teachers use in the Life Sciences classroom, as

well as the colonial legacy of English. I will relate the findings from the documentary analysis to the findings from the teacher interviews and focus group interviews.

4.4.1 Language in Life Sciences

In this section I will start by discussing the findings from the documentary analysis first and then relate it to the findings from the interviews in the next section.

One of the factors that guided the documentary analysis was the issue of language and how the Life Sciences curriculum and textbook addressed it. The Life Sciences CAPS document addresses the issue of language and states that teachers must be aware that many learners in the Life Sciences classroom will come from backgrounds where the Language of Learning and Teaching (LoLT) is not their mother tongue and that these learners should be given opportunities to develop their language skills in the context of Life Sciences (p. 19). It is not stated how teachers can give such opportunities. The Life Sciences CAPS document and the analyzed textbook are available only in English and Afrikaans. The textbook did not state anything in terms of the LoLT.

Although the Life Sciences CAPS curriculum recognizes that many learners come from backgrounds where their mother tongues are not the same as the LoLT, I think that the complexities surrounding such a linguistic mismatch are euphemistically addressed and under-stated. Again, although the issue is addressed theoretically, the Life Sciences CAPS document has not provided enough clarity in terms of how teachers can teach one of the most linguistically demanding subjects in situations when neither they, nor the learners have the LoLT as their mother tongue (Gibbons, 2003; 2006; Pell & Manganye, 2007). One cannot deny the possible cognitive challenges associated with learners who do not have freedom to mother tongue education in such subjects, and the academic power given to those who do have such freedom (Biseth, 2008; Brock-Utne, 2001; Probyn, 2006). The cognitive challenges were brought out during the interviews and are discussed below.

4.4.2 Cognitive challenges associated with learning Life Sciences in English

During the data collection I found that the textbooks and the notes written on the chalkboard were in English, as well as the learners' workbooks. According to Gibbons (2003; 2006) and

Pell & Manganye (2007) science is one of the most linguistically demanding school subjects. The lack of terminology for science in African languages is associated with poor academic performance (Pell & Manganye, 2007). The findings from the interviews suggest that the use of English to teach Life Sciences was challenging. The challenges that were highlighted by the participants speak to the under-development and absence of Xhosa and Sotho terminology in science (Brock-Utne, 2001; Ranaweera, 1976). The majority of the participants (L1, L2, L3, L6, L7, L8, L10) highlighted that although English is necessary when placed in the context of international and global career fields, if they were taught in their mother tongue, they would understand better. These answers were given after I asked how they would feel if they were taught in Xhosa or Sotho. Below are responses from two learners in focus group 2.

> L7: I think it would make a difference. Like most learners can't understand English properly. So if someone reads a question from a question paper, he or she doesn't understand, because it is written in English. If it is written in Xhosa, that person will understand it.
>
> L2: To add to what L7 has said, I think it would be good for us to understand. Sometimes in the exam room the question paper is written in English. Maybe sometimes you would understand if the question was written in Xhosa, but that's just because the question is written in English. That's why you answer wrong.
>
> (Focus group 2)

Teacher A and Teacher B expressed a similar feeling when asked how they think they would feel if the LoLT was Xhosa.

> I think it would be okay, because it would be in their own language, you know? Because I think most of the time the problem is the language… We have such a challenge at times, because in a hospital you'll be dealing with various languages and the terminology where you have to explain it in is English. But now if Life Sciences was taught in Xhosa and even the textbooks were in Xhosa, maybe it will make much more meaning for them to understand the content (Teacher B).

These thoughts above are in line with thoughts expressed by Ranaweera (1976, p. 423) who says that because of the special difficulties related to science like the absence of technical terms, textbooks and proficient teachers, the development and progression of science education is hindered. The academic difficulties associated with a lack of terminology for science in African languages was reiterated by the participants below. This time the issue of the lack of

terminology was expressed more from an emotional or frustrated point of view than a cognitive point of view.

> L6: But some of us, we don't know English, okay, and everywhere we go we study in English, but we don't even have a chance to study this subject using our own language. Wouldn't it be great if we knew what the word 'alveolar' was in Sotho? I just want you to answer me; wouldn't it be great, if, like, you knew these words in Sotho or in Xhosa? Can you please answer the question?
>
> L2: It would be great
>
> L4: You are saying, if you were not forced to be taught in English, in what language would I like to be taught? … I would choose my mother tongue, because I would understand it better.

The issue of teachers whose mother tongue was not English was raised by the learners. One learner in particular said that because their teachers were not proficient in English, they performed poorly. She said: "In our schools we are Xhosa. In our schools there are only black teachers and Afrikaans teachers. There are not white teachers that can teach better English in order to understand" (L1, focus group 1).

When relating the findings from the interviews to the findings from the documentary analysis, it is obvious that the language issue is under-stated and under-addressed in the Life Sciences curriculum and textbook, because it undermines the cognitive challenges associated with learning Life Sciences in a different mother tongue highlighted by the learners in the previous excerpts.

Like the epistemology of Indigenous knowledges, Indigenous languages are marginally addressed in Life Sciences and neglects the academic difficulties associated with the majority of Indigenous learners who have to learn Universalist-informed Life Sciences through a former colonial language, English (Brock-Utne, 2001).

The next section discusses the strategies that teachers use in terms of language when they teach Life Sciences.

4.4.3 Code-switching

Strategies teachers can use to teach Life Sciences to learners whose mother tongue is not English is not discussed in the Life Sciences curriculum or textbook, but was discussed in the interviews. The lack of resources and terminology available in Xhosa and Sotho for Life Sciences (Pell & Manganye, 2007; Ranaweera, 1976) leads to teachers resorting to alternative strategies to teach Life Sciences, such as code-switching.

Although English is considered to be the official language that is used in the classroom and in textbooks, it was observed during the lessons that I sat in of Teacher A and Teacher B, that the teachers, for the majority of the lessons, taught in Xhosa and the learners asked questions in Xhosa, with few scientific terms coming through in English. According to the teachers and learners, code-switching between English and Xhosa happened in order for learners to understand the subject matter better.

R: But in what language does your teacher teach?
L3: Xhosa and English
L2: She teaches in English, but translates to Xhosa so you can get it.
R: Okay. And you are Sotho, but she teaches in Xhosa?
Some: Yes

The above excerpts show that although there were Sotho-speaking learners in the class, code-switching only happened between Xhosa and English, not Sotho and English (This presents another challenge to Sotho mother tongue speakers, but I will refrain from dedicating a discussion to that challenge in this thesis). Teacher B also confirmed her use of code-switching.

> Code-switching – it's when you mix English and you take a little bit of Xhosa. Now why do I do that? You'll see that the learners, sometimes they don't understand exactly what you are saying or they don't have the background of what you are teaching… I'm not an English-speaker, and, I'm not good at explaining exactly. If I did explain with only English and they don't understand again, I have to code-switch (Teacher B).

Similar to what Setati, et al. (2002) found in Mathematics classrooms, Probyn (2006) also found, in her study in Grade 8 science classrooms, that code-switching between English and Xhosa was a necessary teaching strategy in order for learners to comprehend the subject matter

of science. While it is possible to consider the teachers' use of code-switching as an official strategy in the Life Sciences classroom, it is questionable and somewhat mind-boggling why a former colonial language is used as an official language of instruction when all the participants have an Indigenous language as a mother tongue. It is questionable since research by various authors show the good correlation between mother-tongue education and academic achievement (Cummins, 2000; Gibbons, 2003 2006; Tshotsho, 2013).

4.4.4 The legacy of English as colonial language

While this thesis is primarily concerned with the issue Indigenous knowledge systems and Life Sciences, the language issue is as important since it is the medium through which the knowledge is taught. The knowledge or epistemology and the language through which it is carried, is a power structure in itself (Brock-Utne, 2001; Cummins, 2000; Gibbons, 2003; 2006).

From the findings from the interviews, it seems that there are also learners who carry the colonial legacy, some by choice and some by force, because English is associated with an educated future. Many of the participants (L2, L4, L8, L11) associated English with better education opportunities. The participants' responses overlapped, because although they understood better in Xhosa, they want their education to be in English.

In relation to many Africans who tend to choose the Western epistemology, according to Odora-Hoppers (2002) and Ogunniyi (2002), many Africans also tend to choose English above their mother tongue when it comes to education. Similar to the participants in this study, Botha and Breidlid (2009) also confirmed the hegemonic role of English. They found that although parents in the Eastern Cape had the opportunity to choose the language in which their children could be taught in, they chose English above Xhosa.

Without diverting from the issue of the relationship between Life Sciences, language and cognitive development entirely, it is worth highlighting that the language issue in itself raises many issues regarding poor academic performance among the Indigenous participants when they compared it to "white" learners' better academic performance.

> L1: I have a question. Why, people who are white, they don't learn Xhosa, but we learn their language? … I have this thing, long time ago, it was Apartheid. But when it was

Apartheid, the president was a white person, now our president is a black president. Why couldn't we learn Xhosa and our dictionaries would be Xhosa? There is no change. We don't see the things change. We only changed presidents.

L2: This is like 2016. We are not going to repeat things that were done in 1976. We have to move with time.

(Focus group 1)

The excerpt by L1 suggests a sense of illusion and confusion about the language in education situation in South Africa. While it is not within the scope of this thesis to discuss political issues in education at length, the responses by the learners regarding the inequality and uncertainty they felt regarding the language in which they were taught in, speaks to the strong lingering political reality of inequality among blacks in South Africa who live in urban townships like Gugulethu. The year 1976 that L2 was referring to in the excerpt above refers to the Soweto Uprising in 1976 when students protested against receiving education in Afrikaans in 50% of their subjects after which, in 1979 the Education and Training Act reduced mother tongue education from eight years during Bantu Education, to four years of mother tongue education in the primary school and a choice of English or Afrikaans thereafter (Brock-Utne, 2001; Webb, 1999).

The previous excerpts again relates to how Stears (2008) talks of the urban and impoverished worldview where the learners above feel that they are deprived of certain educational opportunities afforded to 'whites'. Perhaps Brock-Utne (2001, p. 118) is right to say that choosing an Indigenous language like Xhosa or Sotho as the language of instruction, "a language people are familiar with and which belongs to their cultural heritage would redistribute power from the privileged few to the masses."

In this theme I highlighted the linguistic borders that the participants have to cross in addition to the epistemological border between their Indigenous worldview and the worldview of Life Sciences.

4.5 Cognitive border-crossing: a final interpretation

Cummins (2000) discusses the importance of recognizing the learner's identity, which is embedded in language and knowledge, for cognitive development. However, as can be seen from the epistemological borders that the learners have to cross (*see 4.2*) and considering the

fact that the learners are taught in English, their identities are largely denied in Life Sciences. This suggests double border-crossing learners have to make. The learners cross epistemological borders from the Indigenous worldview to the Western-Universalist worldview in Life Sciences. They also cross linguistic borders from their Indigenous language isiXhosa or Sesotho to English. Bernstein's explanation of "restricted code" is applicable here. He uses "restricted code" to describe the process of learners from working class homes, in this case, learners from Indigenous backgrounds, who have to cross between two cultural codes which are different from each other: the codes at home and the codes at school (Bernstein, 1971). According to Berstein (1971), such learners are likely to fail since the knowledge and language of the Indigenous learners do not match the knowledge and language of home.

While many authors associate the process of border-crossing between the sub-culture of home to the sub-culture of science with the term "alienation" (Jegede & Aikenhead, 1999; Bernstein, 1971; Breidlid, 2013; Fakudze, 2004; Shizha, 2010; Odora-Hoppers, 2002), I am reluctant to use that term. I will explain why in the next few paragraphs, where I will discuss my final interpretation of the findings.

The findings suggest that in terms of the epistemological borders that the participants have to cross, it is seen as less of a problem to the participants than the linguistic borders they have to cross. My interpretation is that the participants have not fully made the connection, or come to understand that their Indigenous worldviews are in conflict with the Western-Universalist worldview in the Life Sciences curriculum, or that their indigenous worldviews have value in Life Sciences. This could be due to the fact that their holistic Indigenous worldviews, in terms of religion and rituals is absent in the Life Sciences curriculum and textbook, and, where Indigenous knowledge systems are addressed in these two data sources, it is done marginally.

Therefore, I am reluctant to refer to their border-crossing as "alienation" per se, because of the strength attached to the term. I argue that since the participants, like all learners in South Africa, are exposed to Western science from Grade 4 in the subject Natural Science (DoE, 2011), and their Indigenous worldview from birth, alienation is too strong a word. I make the case that learners are exposed to their indigenous worldviews which are based on spirituality, customs and rituals, from birth. They are also accustomed to the Western worldview promoted through modernization and subjects in school such as Life Sciences. Therefore, they are not alienated from their indigenous worldview, nor are they alienated in the Western-influenced classroom.

And, since authors (Dei, 2012; Odora-Hoppers, 2002; Shizha, 2010) advocate for a de-colonized curriculum where both Western and Indigenous knowledge systems are recognized for its merits and value, it suggests a need for learners to be exposed to both epistemologies.

However, what is missing is that the Life Sciences curriculum and textbook, and the teachers and learners, have not made a proper and adequate link between the two worldviews in the case of the Life Sciences classroom. My interpretation is therefore, that the teachers and learners are oblivious to the idea that Indigenous knowledge systems could have space in Life Sciences. I also argue that the teachers and the learners are unaware of the probability that a more prominent recognition of Indigenous knowledge systems could improve academic achievement in Life Sciences, because they have become accustomed to the authoritarianism of Western science and Western schooling. Based on the responses given by the participants below, I conclude that they have not thought of the issue of a difference in worldviews as a possible contributor to poor academic achievement. In part, I say this because while there were learners who said that they performed poorly in Life Sciences, they attributed it to the amount of content they have to cover, or being unmotivated or lazy. Both teachers shared similar thoughts.

> R: Okay. How do you perform in Life Sciences? What do your grades look like? You don't have to tell me if you don't want to.
>
> L3: They are okay, but I want to achieve more.
>
> R: But why do you think you're not achieving the way you want to achieve?
>
> L2: Life Sciences has a lot of work so if you don't focus…
>
> L3: And another thing is, like, when we do Life Sciences, we're like, this scope is too much and that gets into our heads. When we get home we have to study a lot of work and that interrupts our mind and we think we're not going to get this. So, that's what we normally do. When we get a scope we think, Oh, I know that part and then we skip it. Start with the ones that we don't know. So we are the ones playing with our minds.
>
> (focus group 1)

Learners in focus group 2 shared similar thoughts

> L7: I don't perform so good, but I try my best.

L8: I'm not perfect, like everyone else, but I'm trying my best.

R: Why do you think you're not performing the way you want to perform?

L7: I think I'm too lazy. Life Science needs someone who reads books so much, having time.

L9: I don't know. I am trying.

(focus group 2)

Similarly, Teacher B attributed the learners' poor academic performance to the heavy course work and content they have to cover in Life Sciences.

R: How do the learners perform in Life Science?

TB: Their performance, why is it not improving as such? It does improve in time. It's only that there is a lot of work, on the content, they have added a lot. And how they've tried. They cannot master everything. It's too much.

These findings therefore suggest that the Life Sciences curriculum and textbook cause the assimilation of teachers and learners into Western science, but are oblivious to the value of Indigenous science. Therefore I conclude that the Life Sciences curriculum, to a large extent, still represents a colonizing curriculum (Dei, 2012).

In relation to a colonizing curriculum, I turn to my final interpretation regarding the role of language in Life Sciences. Unlike the learners' lack of knowledge regarding the role or value of Indigenous knowledge systems in Life Sciences, they were more aware of the academic difficulties they faced because they were taught Life Sciences through the medium of English. However, even with acknowledging the academic difficulties they faced because they were taught in English instead of Xhosa or Sotho, many of the participants (L2, L4, L8, L9; L11, T_A. *See* 4.4) regarded it as a necessity and that there is no other option than English to succeed academically, because of the international and global recognition of English. Therefore, the issue of language, too, suggests a colonizing curriculum (Dei, 2012; Ngũgĩ,Shi 1981).

The findings and discussion brings me to question the seriousness of education in South Africa to develop a de-colonized curriculum where teachers and learners' identities are accommodated in science education, which could lead to better academic achievement, and eradicate the

inequalities, which are currently reproduced through science education and hegemonic languages.

5. CONCLUSION

In this thesis I explored the extent to which the worldviews of Grade 10 and Grade 11 Xhosa and Sotho teachers and learners matched the worldview of the Life Sciences curriculum and textbook. Through findings that were obtained through a documentary analysis of the Life Sciences curriculum and textbook, focus group interviews with learners and individual interviews with two teachers, I was able to establish the aforementioned.

The findings suggest that there is a discrepancy between the worldview of the Life Sciences curriculum and textbook, and the worldviews of the Xhosa and Sotho participants who taught and studied Life Sciences. The main discrepancy between the two worldviews is the spiritual element that constitute the participants' worldviews such as the role of ancestors and God, which are intrinsically connected to traditional healers (according to many of the participants), the rituals and customs they perform as Xhosa or Sotho, as well as how they interpret natural phenomena. While the Life Sciences curriculum and textbook do accommodate the empirical elements of the participants' indigenous worldviews in relation to traditional healing, and the fermentation process associated with making umqombothi (African beer), the spiritual elements of their worldviews that are in conflict with Life Sciences is excluded. Additionally, the heterogeneity among the indigenous participants regarding spiritual aspects related to their indigenous worldviews could be a possible reason for the marginalization of indigenous knowledge systems in Life Sciences.

The 2015 results of the Trends in International Mathematics and Science Study (TIMSS) show that South Africa came in at the near bottom of 57 countries. The 2017 Africa competitiveness report by the WEF ranked South Africa last in mathematics and science education quality. This has been the third year in a row. Looking at the overall education system, the WEF report states that South Africa finished 137 out of 139 countries. If the results of TIMMS and WEF are anything to go by, a serious need for transformation in South African science education is called for. It is noteworthy that the results of TIMMS and WEF are based on questionnaires and surveys that use assessment criteria associated with Western countries. These assessment surveys and tools for the assessment of science is therefore an indicator of the domination of Western systems in South Africa.

While there are many possible reasons for the poor academic achievement among science students in South Africa, such as poor teacher training or lack of educational resources, one thing that is worth exploring is the issue of epistemology in science. The findings suggest that the current curriculum and assessment policy (CAPS) of South Africa illustrates the hegemonic power of Western epistemologies and the marginalization of Indigenous knowledge systems in Life Sciences. The problem related to the dichotomy between Western and Indigenous epistemologies is premised primarily on the education in South Africa where the disparity of academic achievement between the different racial groups in South Africa is still apparent, which show that the majority of learners, who belong to black indigenous groups, perform poorer academically than learners who belong to the smaller white population group (*see introduction chapter, page 5*).

The findings suggest that, if the epistemology in Life Sciences is to be considered as a contributor to poor academic achievement among black indigenous learners, there is a need for a more serious and in-depth review of the conflict and possibilities of a co-existence of Western and indigenous worldviews. The next section broadly discusses possibilities for the way forward.

5.1 The way forward

The findings discussed in this thesis suggest the urgency for the development of a science curriculum where teachers and learners' identities, in terms of their spirituality and in terms of cultural values and customs, are brought together.

Such a science curriculum will not only aid on a cognitive-intellectual level, but also on a socio-political level which will to some extent eradicate the power structures hidden in science education that have historically afforded those with the epistemological and linguistic capital with more social and economic power (Breidlid, 2013; Brock-Utne, 2001; Odora-Hoppers, 2002; Shizha, 2010).

The development of such a science curriculum will depend on the relationships between schools, teachers, learners and community members to build relationships and solidarities with each other, in order to rebuild and recover indigenous knowledges (Dei, 2012; Khupe, 2014).

What the findings also suggest is the need for science teacher training that will aid in teachers becoming cultural brokers and mediate the affirmation of learners' indigenous identities while simultaneously resolving the conflicts in their parallel worldviews and develop a positive co-existence of Western and indigenous worldviews. Such training should also help teachers and learners to resist assimilation into the Western worldview of science and the suppression of their own, but recognize the scientific value inherent in both worldviews.

5.2 Limitations to thesis

While I set out to reach the aim and objective of the thesis, there are limitations to the research which should be considered for improvement.

The research sample was restricted to the Xhosa and Sotho indigenous participants who lived in urban Gugulethu. Therefore, a generalization of the results should be cautioned against, since research findings from different indigenous groups in South Africa, who live in different contexts, might produce findings that counter the findings of this thesis.

There was inconsistency in my research sample since in both focus groups there was a mixture of Xhosa and Sotho learners of Grade 10 and Grade 11. There is a possibility that a homogenous sample of only Xhosa or only Sotho, and only Grade 10 or Grade 11 learners, could have produced different results. In the same breath, individual interviews with each learner in the focus group could have provided richer data.

In relation to producing richer data, there are several methods and tools that, in hindsight, could have added to the findings. These methods include a more detailed plan that established when the concepts of indigenous knowledges (discussed in 4.2), were taught by the teachers, for the purpose of observation, with the help of a video recorder.

Lastly, in light of the possibility for future research on indigenous knowledge systems in Life Sciences, it is worth considering placing it in the sphere of indigenous research methodologies that in many ways are different to the discourse in Western educational research.

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Appendices

Appendix A: Letter to WCED research department

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Tel: +27 021 467 9272
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Private Bag x9114, Cape Town, 8000
wced.wcape.gov.za

REFERENCE: 20160804 –2960
ENQUIRIES: Dr A T Wyngaard

Ms Eloise Fortuin
15 Jakaranda Avenue
Bredasdorp
7280

Dear Ms Eloise Fortuin

RESEARCH PROPOSAL: INDIGENOUS VERSUS WESTERN WORLDVIEWS IN THE LIFE SCIENCE CLASSROOM

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 08 August 2016 till 30 September 2016

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: 04 August 2016

Appendix B: Research permission letter to research school

The Principal
Research School
Gugulethu
City of Cape Town

Dear …

Request to carry out research in your school

I am a student at Oslo and Akershus University College of Applied Sciences in Oslo, Norway. I am in the process of completing my Master's thesis in Multicultural and International Education. I wish to ask your permission to conduct my research in your school.

In my research, I am interested in understanding how Grade 10 Life Sciences teachers understand and teach 'indigenous knowledges' as stipulated in the Life Sciences curriculum. I would appreciate it if they could participate in my research and share their knowledge, views and insights. I will attempt to make minimal disruptions during the teaching and learning time, and will find times which are suitable to both teachers and learners.

If at any time you would like me to provide deeper explanations or clarify any uncertainties, I will make myself available to do so. Thank you in advance for your consideration and support. Please find the letter of approval from WCED included.

Yours sincerely

……..
Eloise Fortuin (Ms)

Appendix C: Information letter to participants

Dear [teachers and learners]

Thank you so much for agreeing to do the research with me. I can't explain to you how much it means to me. I am very grateful, because without your knowledge and insights I won't be able to complete my research. I hope that I can learn more from you and do something good with my research. I would just like to tell you what I am interested in and what I need your insights and help with before I do the interviews. You can read through it and think about it before the time.

I am interested in the topic '*Indigenous knowledges*' in the Life Sciences. I would just like to know how you understand '*indigenous knoweldedge*' and what you think it means. What was your experience like teaching [and learning] the topic and what did you cover during those lessons. I am also interested to know whether the Xhosa or Sotho culture is related to 'indigenous knowledge' and how. Do you think that there are certain aspects of the Xhosa or Sotho culture that can be included in the topic of 'indigenous knowledge'? Do you think that there are certain aspects of the Xhosa culture that are in conflict with some of the topics covered in the Life Science curriculum?

In what language do you teach [or learn] Life Science? Is it challenging in any way. If so, how is it challenging? How do the learners [you] perform in Life Sciences? Do you think there is a big difference between what the learners [you] are taught in Life Science curriculum, how they experience the topics and expectations in school, and what it is like at home?

Many, many thanks.

Eloise

Appendix D: Consent form to participants

Consent form for teachers and learners

Please write your name and your signature if you agree to take part in my research. I will record our conversation for myself, but your name and the information we share in the interview will be anonymous.

Name: Signature:

_____ _____

Appendix E: Interview questions for teachers

Thank you for agreeing to do the interview with me. I appreciate it very much. The interview will be audio-recorded and I will include some of your responses in my research. I will notify you when I have completed my thesis and send you a copy of it as soon as possible.

1. How long have you been a teacher?

2. How long have you been teaching Life Science?

3. Do you like teaching Life Science? Why or why not?

4. In what language do you teach Life Science? How do you find teaching in Life Science?

5. In what language is the content in the textbooks? In what language do you write exams?

6. As I have told you, I am interested in the topic ‘indigenous knowledge’. How do you understand ‘indigenous knowledge’?

7. What topics does the Life Science curriculum cover about ‘indigenous knoweldge’?

8. What do the textbooks you use say about ‘indigenous knowledge’?

9. Do you consider the Xhosa or Sotho culture to be ‘indigenous’? What makes it indigenous?

10. Do you practice any religion? What is your religion?

11. Do you believe in ‘traditional healers’ and ancestry?

12. What make you Xhosa or Sotho?

13. Do you think that there are certain aspects of the Xhosa culture, like traditional healing and the use of certain plants and natural remedies that can be included in the Life Science curriculum? Why or why not?

14. How do you find teaching in English?

15. Do you do practical experiments in the Life Science curriculum? How do the learners like the experiments that you do?

16. How do the learners perform in Life Science?

17. How do you think the learners would feel if they were taught in Xhosa only – if their textbooks were in Xhosa and they could write exams in Xhosa.

18. How would you feel if you could teach in Xhosa only – and if the exams and textbooks were in Xhosa?

19. Do you think that there is a conflict in what learners are exposed to at home, in terms of their culture, and what they are taught in school in the curriculum? How do learners relate to the curriculum? Do you think they find it challenging or not? Why or why not?

20. Do you think that there are certain aspects of the Xhosa culture that is in conflict with the Life Science curriculum?

21. How do you find being a Xhosa, speaking Xhosa, but to teach Science in English?
22. How do you feel about the fact that OBE and CAPS is trying to include more 'African' aspects and features in the curriculum? Do you think that OBE and CAPS has done a great job in doing that? Why or why not?

Appendix F: Interview questions for learners

Thank you for agreeing to do the research with me. I am going to record our conversation and maybe use some of your responses.

1. How old are you?

2. Do you like Life Science? Why or why not?

3. Why did you choose Life Science as a subject?

4. How do you perform in Life science? Why or why not?

5. What makes you a Xhosa or Sotho?

6. How many languages do you speak?

7. In what language does your teacher teach? In what language is your textbook? In what language do you write in your book and in your exams?

8. How do you like to be taught in English?

9. What language do you speak at home? How would you feel if you were taught in Xhosa and if your textbooks were in Xhosa?

10. Can you remember what you did about indigenous knowledge? What can you remember about it?

11. Do you think to be Xhosa or Sotho is indigenous? Why or why not?

12. Do you practice any religion? Do you believe in traditional healing and the ancestors? Why or why not?

13. How do you understand ‘indigenous’? What is ‘indigenous’?

14. What kind of practices is part of the Xhosa culture?

15. Do you think that some of the aspects of your culture can be included in Life Science?

16. Do you get homework for Life Science? Do your parents help you with your homework? Why or why not?

17. What do you want to become when you grow up? Do you want to do anything with Science? Why or why not?

18. What do you do when you go home in the afternoon? Do you have any responsibilities at home?

19. What is a ‘traditional healer’ or a sangoma? Do you believe in them? Why or why not?

Appendix G: Transcriptions

Transcription of focus group 1

Before starting the focus group interviews I asked the Life Science teachers to identify six learners who they thought would be able to take part in a focus group interview. I asked her to identify learners based on one or two of the following criteria: they had to perform well in Life Science academically and they had to be well-spoken. Six learners in Grade 10 and six learners in Grade 11 were identified. I arranged to meet the Grade 10 learners on a Wednesday and the Grade 11 learners on a Tuesday after school. We met in a classroom for which I gained permission. Before we started the focus group interview, each of us introduced ourselves and told each other a little bit about ourselves to make the setting a bit more comfortable for each other. Snacks and drinks were provided for the meeting which learners chose to teat at the end of the focus group interviews.

Focus group 1 (Grade 11)

R: So, do you like Life Science (LS)?

All: Yes

R: Why do you like it?

L3: Because it teacher us about our environment and the way it cooperate and about how our organisms in our systems are connected together and how they need each other to function well.

L2: It teaches us to protect ourselves like if you're smoking, things like that.

L6: And you also have to know like, if you're doing thin, you're going to get the consequences from this, because LF teacher us how. It's a platform where we not only get to know the good side of these things. Then, during the years, like any day outside of the school. It's then we experience… If you know that "if I learn this at school, then if I do this, I'm going to get the consequences of this. And it's just like my friend (L2) said; if you know that if you learn this at school, like you are going to smoke, my lungs are supposed to get this kind of oxygen and this and this and that, if I smoke, definitely something wrL3 will happen.

R: Is there anyone who doesn't like LS? All of you like it?

All: Yes.
R: But why did you choose LS instead of another subject?

L4: I chose LS, because I always wanted to be something like a doctor or dentist or nurse or do a course in nursing at university.

R: Okay. Do you know which university you want to go to?

L4: Yes, I know. I want to go to CPUT or UCT:

R: Yes, both are very good.

L1: I chose LS because I got interested in how you get diseases and how things get into your body, what happens to your body.

L2: I chose LS because it teacher us about the basics of life and how it teachers us to prevent things in your body like infections and diseases. And, I also wanted to be a home nursing or a chemical engineer. That's why I love science.

L3: The reason why I chose LS it because in the environment where I'm in, like, I saw many people who have lack of knowledge according to how they must operate their bodies and how they must protect their bodies. So I chose LS so I can play a very good example to my family and my siblings who are coming after me. LS is very important because it is the main subject that people must choose. So that they can have more information to change the environment.

L6: I chose LS, because people, they intend to look where there are other things. Working like this job or that job, but the thing is, you have to start to know yourself first. I had the chance to learn LS, because I had to know my body, the consequences of what is happening in my body. But in terms of other subjects like Accounting, I don't get to know that is going on in my body. I can only get to know from the doctor or somebody, but if I know LS I can know. I don't have to go to the doctor because I know what to do.

R: And you, L5ard?

L5: I chose LS because it helps me on the career that I want to do, because I want to be a medical engineer and I need to know what my body looks like.

R: Okay. So, do all of you guys want to go into a science career or direction?

All: Not sure

R: Okay. How do you perform in LS? What do your grades look like? You don't have to tell me if you don't want to.

L6: Pretty good.

L3: They are okay, but I want to achieve more.

R: But why do you think you're not achieving the way you want to achieve?

L2: LS has a lot of work so if you don't focus…

L6: If you don't focus, if you just missed that one part you will miss the whole part.

L2: No one here said they like reading. We said we like watching tv. If you're not going to focus, you're not going to get great marks. You need to catch up. Like, if we do a part on environment, you need to go study it.

L3: And another thing is, like, when we do LS, we're like, this scope is too much and that gets into our heads. When we get home we have to study a lot of work and that interrupts our mind and we think we're not going to get this. So, that's what we normally do. When we get a scope we think, Oh, I know that part and then we skip it. Start with the ones that we don't know. So we are the ones playing with our minds.

R: Okay. So how many languages do you speak?

L4: I speak three.

L6: Sotho, Tswana, Zulu, Xhosa and English, but I also try a little bit of Sepedi.

L4: Sotho, Xhosa and English.
L1: Sotho, Xhosa and English. I tried Shona.

L3: I speak Xhosa, English, Zulu and then Sotho.

L5: Me, I speak Shona, English, Tswana, Sotho and a little bit Afrikaans.

R: Oh. I'm Afrikaans. I speak Afrikaans and English. Afrikaans is my first language and then English, an a few words in Xhosa and then a sentence in Sotho. I know how to say 'I love you' in Sotho.

L2: I also want to learn Afrikaans, but I told myself it's hard.

R: But in what language does your teacher teach LS?

L3: Xhosa and English

L2: She teaches in English and if you don't understand she translates to Xhosa so you can get it.

R: Okay. And you guys are Sotho, but she teaches in Xhosa?

All: Yes

R: And can you write in Xhosa too?

All: No.

R: but when she explains you understand?

All: Yes.

R: And the textbooks? Is that in English or Xhosa?

All: English

R: Do you find it difficult that it's is in English or is it okay? How do you feel about the fact that your textbooks are in English and the teacher teaches in English and not in Xhosa?

L3: I think it's okay. Because you'll find that sometimes if the words are written in Xhosa, they have that, it's not easy to find the meaning. But if it's written in English, it's easy, because Xhosa is very deep, you know?

L6: But the thing is, you can say that it's written in English… But some of us, we don't know English, okay, and everywhere we go we study in English, but we don't even have a chance to study this subject using our own language.

R: You mean like you don't have a subject where you learn in Sotho?

L6: We learn LS in Sotho, you know. We are just forced to learn in English, because, like, everywhere we go we have to know English. If we don't know English then…

R: Do you think that's a good thing or a bad thing?

L4: It's not a bad thing.

L2: It's not a bad thing…

L4: English is not a bad thing, because if you don't know English, then you cannot connect with other people. Like, most people know English, because English is compulsory. English is an additional language to our schools. Maybe, I'm making an example: He's Sotho, I'm Xhosa. I don't know Sotho, she doesn't know Xhosa, but in English we can both understand.

L2: Like other, like in Sotho or Xhosa, there are deep words that we cannot even pronounce in English. So if we study LS in Sotho, there are other things we are going to skip, because we don't understand, you see? Like, if I'm talking to you, I cannot speak in Sotho, I cannot speak about lungs in Sotho, because you are not going to understand. So you have to learn in English.

L3: And another thing is, if we study LS in our languages, it would be difficult for us when we are going to Grade 12, because if we are Grade 12, we're only going to write common papers and so we'll find a word like 'alveolar', but in Xhosa it is 'alveolarsi', and then you'll get confused, so I prefer English.

L6: But, wouldn't it be great if we knew what the word 'alveolar' was in Sotho? Wouldn't it be great?

L3: Like in LS textbooks? Look at the back, I would turn there.

Tsep: No, I just want you to answer me; wouldn't it be great? If like you knew these words in Sotho or in Xhosa? Can you please answer the question?

L2: It would be great.

L4: It would be great.

R: Say English wasn't compulsory, how would you feel if you could be taught in Xhosa or Sotho and not in English? How would it make you feel?

L4: You are saying, if LS was, you were not forced to be taught in English, in what language would I like to be taught?

R: Yes.

L4: I would choose my mother tongue (MT), because I would understand it better.

R: Okay.

L4: Even if you write it's going to be in your MT, because you've chosen it.

L6: You're going to know, like, what is this in Sotho? You're going to be taught in the process. But the thing is, from Grade R to Grade 12 we've only been taught in English. So that's the thing. Why do you think it would be difficult? If like, kids from Grade 1 are taught in Sotho, they are going to understand more than us.

L3: It's like, I'm not disagreeing with what you are saying, but what I am saying is that, when you are done with your career path, you have to work with different people who speak different languages, then you will get caught in the middle of something big, you know? And another thing is, you will not know what to do, because you did not want to learn the basics of English when you were young and it would be difficult for you to learn when you are old. As they say: 'You have to teach a child when it is still young.'

L2: The thing is that us as learners who don't understand. In education there are three things: it's me as a learner, my parents and the teacher. If I'm taught in English and I want to know it in my own language I can go and ask my parents 'what is this in Sotho?'. I can't do LS in Sotho and I want to be taught in English by my parents. I have to know. My parents are not educated, but they got me an opportunity to be educated so that if they have something like forms to fill in, I have to be the one who teaches them. So if we are taught in Sotho, there's no one who is going to understand.

R: Okay, I get it.

L6: I get the point.

L3: I get it. You see, president Zuma is Zulu. Like it would be shame if President Zuma was there are made speech in Zulu. You'll get confused. It would be better to speak English. And it would be better if President Zuma had to make an argument with another country and he speaks Zulu.

L1: I got a question. Like, why people who are white, they don't learn Xhosa, but we learn their language?

R: Yes. Have you guys thought about the way she is saying it? How does that make you feel that you only have the choice of English, but others have the option to be taught in their MT?

L2: It doesn't sit well, but there's nothing we can do.

L3: and it depends on the department of education.

R: But how does it make you feel?

L6: I heard some invention on the radio, like you can speak your MT and the translator will translate. SA is one of the lowest educated countries in Africa. This invention was made there in China for 2018 FiFa World Cup. There will be many different countries. So if they are going to speak in Chinese we will hear in English. If inventions like that were produced here in SA and being experienced in schools it would be great.

R: Anyone else want to say something?

L1: I have this thing. LL3 time ago, it was Apartheid. People who were talking Xhosa or Sotho, they were not allowed to learn English or Afrikaans. But when it was Apartheid, the president was a white person. Black people were being pulled. Then, now our president is a black president. Why couldn't we learn Xhosa and our dictionaries would be Xhosa? There is no change. We don't see the things change. We only changed presidents.

R: Do you guys agree with her?

L2: This is like 2016. We are not going to repeat things that were done in 1976. We have to move with time. And if we want to move with time, and as she is saying now, it's like she's competing because the president was a white person. So if our president was doing the same thing he is repeating the things that were done.

L6: but, the thing we had back then, we had cultures and stuff.

L2: There's still cultures right now.

L6: Yes, but the way we do cultures in these day is not the same way we used to do back in the day. So what I am saying is, if we continue to do things the way that we do, we intend to forget what our old grandfathers and ancestors did those days. You see, they fought for Apartheid and all that stuff, using culture. They had to push. So in these days what do we have now?

L2: But the thing that we don't understand is they were not fighting for us to be taught things in our own language, but they wanted us to have our own languages in school, and not for everything to be Xhosa or Sotho. They wanted all these eleven languages. They wanted our own languages to be part of other languages.

R: Last one and then we move on.

L1: In our schools we are Xhosa. To our schools there are only black teachers and Afrikaans teachers. There are not white teachers that can teach better English in order to understand. There are other children who are struggling even in English. They are failing in English.
R: So you're saying that Xhosa learners in Xhosa schools are struggling in English?

L1: There are only black teachers teaching English in Xhosa schools.

R: So, how can it be improved?

L2: That must be a motivation enough. If the people who are still failing English, why don't they want to learn to come back and make a change to like, and teach those people who don't understand? Don't repeat history, man.

L3e: I think why we only have black teachers at the school is because the government is the one who hires the teachers. So what the government does is, he puts the teachers there that the learners will be able to talk to if there is something that they don't understand. For example, if you go to a Xhosa school and if you put an English teacher in front of a Grade R learner, the learner is going to be afraid because she's not going to be used to talking in English. She is going to be used to talking in Xhosa. And only when the learner grows, she will be able to speak English.

R: So you guys have mixed feelings about the whole situation?

All: Yes.

R: but you don't feel lik… Does it make you feel offended?

All: No.

L3e: But there are schools that offer subjects that are based on our cultures, you know.

L6: But at the end of the day, we only have black school in this township. And when you go to town there are only white schools. Like I also feel like why can't there be mixed teachers? The way I see it, only black teachers teach black kids and only white teachers can teach white kids.

R: Is that how you feel?

L6: Yes.

R: Okay. So now I'm going to ask: what makes you Xhosa and what makes you Sotho? I am Xhosa, because…

All: talks/ mumbles

L3: What makes me Xhosa is because of the way I present myself in front of my people and because of the way I act.

R: How do you present yourself?

L3: Like, I present myself as that Xhosa girl. I give my name, my surname, my clan name, all of that. That makes me Xhosa.

L2: What makes me Sotho is that I love my culture and participating if there is heritage day or cultural days. I love those things.

L4: I'm a Sotho girl, because I love my culture. My mother is not a Sotho. My mother is a Xhosa and my father is a Sotho. I love Sotho most, because Sotho is a culture, it's a culture I feel like it's more interesting and it has more dignity than other races. My mother is a Xhosa,

she understands Sotho, but responds in Xhosa. And what makes me love my culture is that whenever I want to wear my Sotho attire I can wear it. I am not ashamed. I can put that blanker on me even if it's 38 degrees.

L1: What makes me Sotho? I am both Sotho and Xhosa. My father is Xhosa, my mother is Sotho, but I like Sotho more than Xhosa, because in Grade 1 then I started in Sotho schools then I grew up in Sotho. I love that culture when they dance their traditional dance.

L5: What makes me Shona is that in our country, especially in June, there is a time that we must spend in the bush. So now they say that if you die in June, July and August, you must go to the bush and get the meat, because it is part of respect.

R: Respect for who?

L5: Respect or my grandmother that is in the bush. They can't go there another time.

L2: It's part of our religion or culture.

L5: And also, In November, no one is supposed to be married in November. That is what my parents taught me. No one is going to get married in November. If you are going to get married in November you are going to get arrested.

L4: Your story is L4ilar to ours. At 12:00 in the day, there should be no washing on the line.

R: Why?

L4: I don't know why, I've been asking my grandfather.

R: Every time?

L4: Every time. No matter what you are doing. Five minutes to twelve, whatever you are doing, if you were sleeping, you have to go outside and take all the washing in the home. Then, after 17:00 you can go outside and hang your washing again.

R: Okay? That' interesting. But you don't know why?

L4: We don't know why.

L6: We have to keep on asking until they tell us. What makes me a Sotho guy is that I like my culture. I like being Sotho. Sotho is one of the most interesting cultures, because you've got Sotho singers and dancers. Like, no offence to other cultures, Sotho is the best. I have to present myself as a Sotho.

L3: Another interesting thing about Xhosa is that we get to learn the core values of a woman. Like what a woman should do, what a woman must not do.

R: Like what for example?

L3: Like, for example, they have a ritual for you called 'indonjani'. Like, during that time you are supposed to stay in the house in the corner, you must not show your face. They put

something on you, and on the day before, they will put you inside the ‘kraal’, then you have to go outside and take off all your clothes and be naked in front of everyone to show that you are proud of your culture and then they will pour water on top of you. There are only men inside the rom and outside of the kraal.

R: Oh, really?

L3e: Yes, and then they will put a blanket over you once you are done.

R: Do all Xhosa women have to do that?

L3: Some, but then they do it differently. Some do it for a week, some do it for three days, but in my home it takes seven days to do it.

R: So do you do it here in Gugulethu?

L3: No, Eastern Cape.

R: Interesting. Do you guys have other interesting examples?

L6: In Sotho you have to go to initiation school. Like this year I went there and then came back. I can’t do the same things that I did last year. I can have fun, but I have to respect myself. I can’t be fighting and things like that.

R: So, are you guys religious?

All: Christian

R: So, I don’t know this, so you guys have to help me. Do you guys believe in ancestors?

All: Yes.

R: Okay. So you guys have to tell. Me. What is the difference/ is there a difference between ancestors and Christianity or do they go together?

L6: In order to… If you believe in both of them… In the Bible they tell us that Jesus died and he rose up. And the ancestors and the grandfathers, like, you can go there and ask them for advice.

L2: Like guidance.

L6: Guidance and stuff. How, like, with my mom or father, can you please help me…

R: So you have to speak to the ancestors?

L6: and they come into your dreams.

R: Okay?

L4: I'm a Christian, I believe in my ancestors, but I am not religious according to my… I think, okay, it's uh, I don't want to say it's a must, because we don't believe in religion. If like, if your father died, then you dream that he is thirsty, we don't believe in that. If he is dead, how will he actually drink that umqombothi. You see? We believe that if my grandmother died and I don't even know her… If my mother dreamed that her mother was shouting for help that she is cold, we are not going to like do some rituals and cook for everyone and tell everyone that I dreamed of my mother. What we believe in is that if someone is dead he is dead, but that their soul is among us.

R: Anyone else? So you have to tell me, like Sangomas or traditional healers, what kind of things do they use? Do they use plants?

L2: Yes, they use plants.

R: So what do they use it for?

Thsep: There is a Sangoma and there is a Nyaga.

R: Oh, what's the difference?

L6: A Sangoma, if you believe in your ancestors right, you're going to go there and say you need help. Then the Sangoma will be like: yes, I have been waiting for you. Then he will have a bag and in that bag will be bones. Those bones, like, he or she will receive a message from our ancestors and tell you, like, your ancestors, will tell him. What is the problem, like what you should do; you should do this or that… And the Sangoma doesn't give you any medicine. The Sangoma will give advice. Then Nyanga, when you go there, you go, 'Sir, I have a problem. I have stomach pain.' He or she will just go 'take this and this, use it like this and this.'

R: So, like a herbalist?

All: Yes.

R: Who doesn't believe in Sangomas or Nyangas? Why or why not?

L4: I believe everything is possible with God. I don't believe, like, if I feel a pain, I can go to the doctor, the medical doctor, not a spiritual doctor or a Nyanga to tell me my problems.

L6: That's where you lose your culture, because a doctor, you know, like, doctors they take some chemicals and mix them and tell you to use it. But when you go to the mountain, for those medicines and present it to those people, they tell you no, O don't want to use that. So they go to the medical doctor and use pills and stuff that is expensive.

L1: I believe in 'amagquiga' (Sangoma). My mother was not one of them, but she got accidents everywhere she went.

L6: She had like a bad like, like a curse.

L1: Then, she got this message from someone who is a Sangoma saying she must do a ritual for her mother, her mother is calling her to be a Sangoma too, but his mother refused to be that

Sangoma. Everywhere she went she got into accidents. She even got sick. She went to the hospital then she started to do that work.

R: Sangoma?

L1: Yes, she is doing that work.

L2: You can even die if you don't do it.

R: If you don't do what?

L1: Yes, she got a house, the house was taken, and the car was taken, everything. When she got money she will not see that money again.

L3: But you can accept it, that calling, like as a Christian. Because there are other people who are Christians, but they do accept. The difference is that they do not wear the attires that the Sangomas are wearing.

R: So what I'm understanding is that there is God, there are the ancestors, then there are the Sangomas and Nyangas and then there are also medical doctors in the hospital? So, do you believe in all of them?

L2: I believe in all of them.

R: So there is not one that you will choose over the other?

L1: Because I see now that she has done that work she is doing better.

L6: But it's like, something will work for you if you believe in it. If you don't believe in it it's not going to work for you.

L2: It's not going to work.

Thsep: Because he doesn't believe in muti, but she believes in muti and traditional healers it's not going to work. Like, if I believe it, I'm going to make sure that it works.

R: So you have to believe in it in order for it to work?
So you believe in all of that as a Sotho, do you think it's included in the LS curriculum in the textbooks?

Some: No.

L6: What's included is the medical science, not the traditional science.

R: Like?

L6: Like doctors and hospitals.

L3: They don't talk about where the pills come from and how they are manufactured.

R: So you've never come across her talking about herbs?

Some: Last year we did this.

R: What did you talk about?

L6: Ms Phakela talked about a plant and the benefits of using that plant.

R: Did you like it?

L6: From my side I liked it.

L3: I liked it a lot, because one of the plants that were mentioned there is what is called Ugagisa. Yes. You normally use it when you have fever. It was mentioned there. The instructions that were given there on how to use it is the way that I use it.

R: Do you talk about Xhosa and Sotho culture in schools?

All: in our class.

R: Do you talk about it or teach it?

All: No, just the way we are talking about it now.

L2: We should. We have eleven languages. We should know them.

L3: It also interesting to know other cultures, so that you know how to behave when you interact with people from other cultures.

R: Is it difficult or not difficult for you to switch between home and school? To think that at home I speak Xhosa or Sotho and I sometimes wear my traditional clothes, but when I come to school everything is in English? How does it make you feel?

L6: We only do in school what we're supposed to do. What happens in school stays in school.

L5: I think it is not good.

R: Do you think it has an impact on your academic performance? The difference?

All: No.

R: And your parents, do they help you with your homework?

L4: If it was in Xhosa, my mom says she will help me, but if it's in English, no.

L5: If it was in Sotho, yes, but with physics and all that, no.

L1: At home they say it's a new generation, they don't know these things.

L6: They give us their support even though they don’t get it.

R: I think I covered everything. Thank you so much for your time.

End of focus group interview

Transcription of focus group 2

Before starting the focus group interviews I asked the Life Science teachers to identify six learners who they thought would be able to take part in a focus group interview. I asked her to identify learners based on one or two of the following criteria: they had to perform well in Life Science academically and they had to be well-spoken. Six learners in Grade 10 and six learners in Grade 11 were identified. I arranged to meet the Grade 10 learners on a Wednesday and the Grade 11 learners on a Tuesday after school. We met in a classroom for which I gained permission. Before we started the focus group interview, each of us introduced ourselves and told each other a little bit about ourselves to make the setting a bit more comfortable for each other. Snacks and drinks were provided for the meeting which learners chose to teat at the end of the focus group interviews.

Focus group 2 (Grade 10)

R: Do you like Life Sciences?

L9: Yes, I do, because LS teaches us about our environment, how we should live, how to take care of our health. It tells us more about who we are, about what is happening around us, about animals, yes, on living things. So we learn a lot from it.

L8: It also teaches us about our body, you know? You have to know what's happening inside you. You just can't walk. If you're not studying LS, it's hard to understand yourself. It helps us.

R: To understand your body?

L11: To add to what L8 said, it's good because you have to know the parts and functions of your body. You have to know why you need to eat healthy food.

Others: Agree

R: Why did you choose LS instead of another subject?

L7: I chose LS, because I want to be a doctor, a cardiologist. So LS teaches us about everything.

L12: I want to be a brain doctor, that's why I chose it.

L9: I also chose LS because I want to be… I'm not sure what I want to be when I'm done with my studies. But I think I want to be a nurse, so obviously, it's good to know some parts of the body and what's happening.

L10i: I chose LS, because I want to be a neurosurgeon. I want to know how the brain works.

L8: I chose LS because I found it interesting and besides LS, is an international subjects. So if you want a career that is dependent on health issues, you must have LS.

L11: I chose LS, because it teaches us about things in every day. Like what we have to do with our bodies.

R: so where do you plan on studying?

L7: We haven't decided.

R: You still have enough time. How do you perform in LS? Academically?

L7: I don't perform so good, but I try my best.

L12: Code 4 or 5.

L8: I'm not perfect, like everyone else, but I'm trying my best.

R: Why do you think you're not performing the way you want to perform?

L7: I think I'm too lazy. LS needs someone who reads books so much, having time.

L9: I don't know. I am trying. I always get code 5, code 6. For me it's not hard to study it, because my teacher is very flexible on teaching it so I don't find it really hard to study at home, because when I'm at home I try.

R: So how many languages do you speak?

L8: I speak two: Xhosa and English.

L11: Xhosa and English.

All: All of us.

R: And in what languages does your teacher teach LS?

Some: English.

L8: No, if she wants us to understand more she would translate it to Xhosa. If she finds it difficult for us to understand, she would speak Xhosa.

R: And the textbooks? In what language is that?

All: English.

R: and how do you feel about that?

L10: Sometimes I feel like, why can't the textbooks be in Xhosa, but only in English?

L8: Sometimes it helps, you know, because English is our international language, because for e.g. if you go to the USA, in order to communicate you must be able to know English. English helps.

L11: For me, I don't mind, because English is an international language which you have to know, because there is no career without English. So it's a must. But my problem is they use strong words which I don't understand. They are difficult to understand.

L7: I think it's the right thing to be taught in English, because everywhere you go you'll find English.

L10: But there are some people who are interested in other languages besides English.

R: Because for me, I had the privilege of Afrikaans textbooks from Grade 1-12. But do you think it would make a difference if your textbooks were in Xhosa and your teachers taught in Xhosa?

L7: I think it would make a difference. Like most learners can't understand English properly. So if someone reads a question from a question paper, he or she don't understand, because it is written in English. If it is written in Xhosa, that person will understand it.

L8: To add to what L7 has said, I think it would be good for us to understand. Sometimes in the exam room the question paper is written in English. Maybe sometimes you would understand if the question was written in Xhosa but that's just because the question is written in English. That's why you answer wrong.

L11: It will never make any change. Sometimes it's up to you to understand. Whether it's in English or not. It's up to you whether you want to understand or not. English books and then maybe write the words that you don't understand and then you will be able to know.

L10: It could be good, it could be bad. It could be good, because you would understand what the teacher is teaching. It would be bad, because in the other career fields you have to know English.

L9: I agree with L11, because it doesn't matter whether the information is in English. The thing is how willing you are to learn this thing. Are you really serious about knowing what words are being used. For me it doesn't matter if it is written in Xhosa or in English, because we are doing Xhosa, but you don't pass 100%. Some people understand Xhosa more than English, though they speak Xhosa.

R: How do you perform in the subject English?

L9: Our teacher doesn't teach that much. She is lazy.

L7: She only comes and gives work and then leaves.

R: And you parents? Do they speak Xhosa at home?

L8: At home we only speak English when it is compulsory, like when we have a visitor, but otherwise we speak in our MT.

R: Do you think that the fact that you are being taught in English, it has an impact on the way you perform academically?

L7: Yes, I think it has.

R: Why?

L7: Because some people don't understand English.

L10: but then you translate to Xhosa.

L7: But then when you translate to Xhosa some people will understand better.

L11: It has an impact because even if we have a question… You don't understand.

R: So, in a way it differs. It would be better if it were in Xhosa, but not necessarily, because you don't really perform well in Xhosa.
So did you teacher do indigenous knowledges (IK) with you?

All: No.

R: So, what makes you Xhosa? Maybe you can give me a sentence.

L9: For me it it's the language in your home.

L8: What makes me Xhosa is because of my culture, language, my lifestyle.

R: Give me an example of your culture and your lifestyle.

L8: Let me start with my culture. It's like on heritage day, it's called 'impaco'. It's like traditional wear. It is designed especially for Xhosa. It is a traditional dress. Also, we cook food. We cook Xhosa food like samp and beans, maize meal, and the African beer, 'umqombothi' and 'amagehu'.

L7: It's like maize meal.

L8: It's like pap and it's watery. If you have an older person like your grandmother, who has diabetics, who can't control her hunger and appetite. So if you are still cooking, you can give her that.

L12: The one thing that makes me Xhosa is because of my religion. Maybe when you are burying someone you must kills the goats.

L8: or slaughter the goat.

R: Why? What does that mean?

L7: I think you're sacrificing, you sacrifice for the ancestors.

L8: And you also do ceremonies. It's where families get together and you slaughter a cow. We slaughter for our ancestors and spread blood.

R: But what does it mean when you spread the blood?

L8: It means… If in your dream, your grandfather who died long ago appeared in your dream and then you call your elders and then tell them about your dream, then there are people who can interpret that dream and then it's okay, 'let's slaughter the cow for him or for her.' If you are going to slaughter a cow, then the bones are not going to be eaten by dogs. We are going to collect the bones and then burn them.

L7: We have different beliefs.

L8: It depends on the family.

L9: We don't share the same beliefs.

L7: The are Xhosa people who don't believe in slaughtering a cow. They believe in praying.

L8: those people are called umahlubi. Sometimes some people, even though we are all Xhosa, some people believe in Christianity and some people believe in the ancestors. The ones who believe in the ancestor are the ones who also believe in traditional medicines or healers.

L11: What makes me Xhosa is the fact that my parents and my grandparetns, they are Xhosa and they stick to the culture. They stick to the rule that if you are Xhosa, you have to marry a Xhosa.

R: What will happen if a person doesn't marry a Xhosa?

L8: You know the generations have changed. Like those things were done in the olden days. Now they are educated people. Now it doesn't matter who I marry, I have my rights. In the olden days people had to follow their culture and it was a must be. In the olden days you had to marry in the family. Like if a girl's husband died, she had to marry his brother. Like, in the olden days it was important that if you were married to wear long dresses. Nowadays, even if you go outside, you can see people wearing jeans.

L9: And adding to what she has said, when a guy has seen a girl from another family that he wants to marry, now as a guy, you need to collect all the elders and look for a relationship with that girl of that certain family. So if they go there they need to wear formal clothes and hats that have the ostrich feather and a stick to show respect to that family.

L8: It's very costly, because if you impregnate a girl before marriage, if you came to her home and ask for marriage, you have to pay first. You have to pay for damages and lobola. Then maybe you have to pay in cows.

R: Who believes in ancestors? Maybe we can go around.

L11: I don't believe in ancestors that much, because I am a person who reads the Bible. I see in the Bible, the Bible even speaks about ancestors. And in the Bible you don't find people believing in ancestors, but they don't talk about going to the Sangomas and traditional healers. The ancestors are from your family. You have the right to speak unto them, but you don't need to pay them money to speak to them.

R: So you're just a Christian?

L9: I also don't. I think it's a bit confusing for me, because I grew up in a Christian family who don't believe in ancestors, but now I've moved to live here with my aunt, so they believe in ancestors and my father was a healer. Sometimes I think… Everyone in my family are 'amagqiga'. For me it's difficult to tell them about the Bible, because they just don't believe in the Bible, but they go to church. So I'm in the middle, I don't know where do I stand. I think I believe in ancestors, next minute I believe in God.

R: Your dad was a traditional healer?

L9: He was, he died. Sometimes they say I'm going to take over. I don't want that. If you become that thing you become so crazy. I can't. sol for me, I believe in God. I am a Christian, but I don't go to church.

L8: I think for me it's also confusing, because I grew up in rural areas where you will find a few people who believe in Christianity. More people were performing their rituals, their ceremonies. So, it was hard for me to hear someone who was talking about Christianity and who talks about God, because everyone was busy with ceremonies. And you will never find even a pastor. Maybe you will find a person in a far place. In rural areas there is more experience that could make believe that ancestors are real. If, for example, someone died two months ago, you could see that person as a ghost. I am speaking from experience. So ancestors is something that is true. That you have to believe in.

L9: Yes, if you don't, you are arguing some people just get sick if they don't do what the ancestors want them to do.

L8: Bad luck comes their way.

L9: And maybe you can die. So, somehow we need to respect our ancestors.

L7: My family believes in traditional things a lot. Like, we perform rituals like every two months.

R: Like what kind of rituals?

L7: There's one called, untshiki. It's a ritual when you're welcoming a woman. Like, if your brother is getting married. So, for the ancestors to know.

L8: To welcome her in the family, yes.

R: What is the role of the ancestors and the traditional healers?

L9: Okay. Traditional healers communicate with the ancestors. Like, maybe if I am sick or they try to get some help. They have bones to communicate with the ancestors out there. Like, they pray and they have their own way of how they communicate with ancestors. So, they communicate in bones. Like, if she is a healer and I am a sick person, sometimes the medicine she gives me was shown by the ancestors and helps me.

L10: Okay, being a traditional healer you can't treat someone without burning mpepho, because you can't talk to the ancestors without burning mpepho.

R: What is mpepho?

L7: Mpepho is like a plant. You burn it and it smells.

L8: But it is like a fresh smoke, you know? In the rural areas, if you go outside in the rural areas you will smell the mpepho and it is so fresh and it heals.

L8: Ancestors they do communicate to get to the ancestors. Because before you can become a traditional healer, you are being called by your ancestors. Sometimes someone goes and sink to the sea, may he will disappear for four months without being found. Maybe we'll go to the police stations, the hospitals, but you can't see that person. After four months he will return and he will be wearing those beads with those feathers and carrying a lion's fur, and he has been called by the ancestors. Like, if I'm a healer and you're a patient, if you step in my door, you have to take off your shoes before you step in my door in order to communicate with the ancestors properly. Even if you sit down, I can tell you what your problem is before you even tell me. Where do you think I got those answers from? They even told me before you came that you are going to come with this problem.

R: So the traditional healers use bones and the plants?

L7: They use bones to tell what the problem is and the plants they use as medicine. Like the ancestors tell them you have to go and collect this plant on the mountain.

R: Like if you're sick?

L7: Traditional healers always have a lot of plants. Like they can tell that this is to heal this or that.

L8: And most of the time the ancestors communicate with the healers in their dreams. If you are asleep, your ancestors will communicate with you and you have to go and communicate with him, he's going to helps you. Then, in the morning you will take that plant and there will be someone in the morning who is coming and who wants to help. You may think that a plant is nothing, but to healers they are medicine.

L11: And then there are two types of traditional healers. There are the ones who bewitched you, and then there are ones who is really a traditional healer. And you can't even see the difference, because they are wearing the same thing and they are doing the same thing.

L7: And you get people who are fake pastors.

R: Fake pastors?

L7: Yes, they preach and collect money from people.

L8: Sometimes fake pastors will touch you inappropriately.

L11: The reason why people do those things is because of the people who allow them. There's no pastor who can just open a church without knowing that the pastor will do something good

with the church. It's like a traditional healer. It's a calling from God. God can tell you what is the problem, you don't need a traditional healer.

R: There are traditional healers but there are also doctors.

Api: The real traditional healers, if you go to them, they will give you the medicine. If that medication works, you will pay them afterwards.

R: So, like, if you had a headache, would you go to the traditional healer or would you go to the medical doctor at the hospital?

L7: Sometimes there are situations where you go to the doctor who can't see the problem that you have. So you go to the traditional healers and then they can tell you what you have.

R: Do you agree?

Some: Yes.

L8: Sometimes you'll find the medication is slow.

L9: And some medication that doctors use has the same healing power, and the same medication that you get from the healers are not mixed, like having so many chemicals. They are originals from the healers.

L11: I won't go to the witch doctor. Sometimes a witch doctor can't see what the problem is we have to them with. It's like someone has bewitched you. And then the witch doctor won't be able to return that thing they did, and then you have to go to the medical doctor.

R: Have you spoken about traditional healers in the classroom?

All: No.

R: But you believe in it?

L8: Some of us.

R: So those of you who believe in traditional healers and the plants that they use, do you think that could be included in the LS curriculum?

L7: No.

L8: But just because LS involves plants, it should be included. It should be included.

L11: I think it is important, because there is a certain plant that has those things and that it can help with certain parts of the body and that even if you go to the traditional healer, that traditional healer can give you that same plant. When you can compare what the teacher said and what the traditional healer said, then you can know if the traditional healer is lying.

L9: I'm not sure what the name of the plant is. It's more like orange and white, but it is being used by traditional healers to watch you if you have bad luck and if you have that certain disease. So it is also being used to make pills for TB…

L10: We use a plant to help for stomach ache.

L8: It also does help lower blood pressure.

R: So you've told me what makes you a Xhosa and what makes you a traditional healer and stuff, but do you ever talk about these things in the classroom?

L7: No.

L8: In Life Orientation we do, but not going in too deep.

R: Why do you think that is?

L9: Sometimes you can talk about that if we're doing like prepared oral. Sometimes you think about those things and then we talk about our cultures and how we talk about those things.

R: Like for me I didn't know about these things. So if I didn't watch tv then I wouldn't know and if I didn't have this conversation with you. Do you think that it's important for all people to know it or just your culture to know it?

L7: I think everyone should be taught it. Because maybe I will marry someone who doesn't know about traditional healers and performing rituals and then I have to know.

L8: There will be a disagreement.

L11: I disagree with what L7 said, because in life you have to choose your own choice what you want to believe. What you want to do. So I say it's not a must to know certain traditional rituals. It's up to you.

L8: Or if you're interested in it.

L9: Even tourists. If tourists come to SA, they must go and ask what is happening. What makes us Xhosa. It is not a secret. You can ask anyone what you want to know.

R: So, how does it make you feel when you have to switch from being Xhosa and speaking Xhosa at home, but you are taught in English at school and your tests and exams are in English?

L9: I don't have a problem when I speak Xhosa at home. But we have Sotho-speaking learners but we speak English with each other.

L8: here at school we have coloured teachers so we have to speak English all the time, because he doesn't speak Xhosa. As long as our teacher is Xhosa we can speak Xhosa in class.

R: Do you usually do your homework on your own or do your parents help you?

L9: It depends on the subject and if I'm struggling I will ask.

L11: I do it on my own, but if I am struggling, I ask for help from my brothers or sisters.

L7: It I'm doing Xhosa homework and there is a deep Xhosa word that I don't understand, then I will ask my parents to explain to me.

R: So you have Xhosa as a subject?

All: Yes.

R: Thank you. I think I have covered everything. Thank you for your time.

End of focus group interview.

Transcription of Teacher A

I arranged to meet with the teachers after I observed two of their lessons. Teacher B is also a Grade 12 Life Science (LS) teacher. She had a very hectic schedule as she was involved with moderation of exam papers as well setting up exam papers and invigilating during the exam. This, despite also having to teach. Therefore, it was difficult to arrange a time for the interviews. The interview was arranged during the Teacher B's free period in the deputy principal's office. Teacher A was the Grade 11 LS teacher. The interview with Teacher B took place in her classroom as she had little time to sit down for a longer interview. The interviews were audio-recorded and consent was given in writing by the teachers.

Teacher A (Grade 11)

R: Do you know what I mean with indigenous knowledge (IK)?

TA: I don't know if it's the same as I am thinking. I think IK is cultural knowledge, for instance. You don't have to go to school for it.

R: How long have you been a teacher?

TA: This is my 9th year now.

R: And how long have you been teaching LS?

TA: 5 years.

R: Do you like teaching LS?

TA: I do, I like it.

R: Why?

TA: Firstly, LS at school, sometimes we tend to lack resources like teaching aids. So when you are teaching LS, it's easier. For instance, if you are teaching about plants you can take the learners to the garden. So it's very much hands on, you understand? And the learners, if you work with experiments, they remember for longer. That's why I like teaching LS.

R: And in what language do you teach LS?

TA: In English, but I code-switch.

R: Why do you code-switch?

TA: Because sometimes code-switching, it's when you mix English and you take a little bit of Xhosa. Now why do you do that? You'll see that the learners, sometimes they don't understand exactly what you are saying or else they don't have the background of what you are teaching. So now you have to take them back, it's when you put a little bit of Xhosa, because I'm not an English-speaker, and then, I'm not good at explaining exactly. If I did explain with English and then they don't understand again, I have to code-switch.

R: But how do you think the learners would feel if they were taught in Xhosa and the texTAooks were in Xhosa? And how would you feel?

TA: It would be very hard. Xhosa is not an easy language, even for me. I can't speak pure Xhosa without mixing it with English myself. So it would be very hard.

R: And, have you covered IK in the LS curriculum? Have you taught IK?

TA: yes, in some texTAooks, because I remember in the Grade 11 LS texTAook, we were doing anaerobic respiration, and then now it's when umqombothi (African beer) and then they, it's an example of anaerobic respiration. So, plus plants. So there are plants that are indigenous plants. There are indigenous plants in there.

R: But do you think the LS curriculum focuses on IK enough or not?

TA: It's not enough. It just touches on it a little bit. It's not enough.

R: And do you think that's a good or a bad thing?

TA: It's bad, because learners need to know their background, they need to know their background and to respect their culture also.

R: Do you practice any religion?

TA: Yes. For instance, my customs. I do have. Yes, I do have. For instance, our customs and our food also.

R: Do you believe in traditional healers?

TA: No, I don't believe in traditional healers exactly, but I do have that belief in ancestors.

R: Do you think that your religion and your belief in ancestors is in conflict with science?

TA: We do have challenges, because last year I was teaching Grade 12 evolution, a part of evolution. There were so many questions about the Bible and evolution an so there is a lot of conflict.

R: How do the learners respond to that? Do they find it difficult or not?

TA: It confuses them. It does confuse them. As a result, even us teachers, it's hard to explain exactly what is happening. I usually say to them we must put away the Bible and focus on science only, because some questions I cannot answer.

R: Do you think that there are certain aspects of the Xhosa culture, like traditional healing, that can be used in the science curriculum?

TA: Yes, some Xhosa remedies can be very crucial and healthy, so yes.

R: Do you think that there is a conflict between what learners are exposed to at home, in terms of their culture and what they are taught in school in the curriculum?

TA: The conflict comes in that chapter of evolution. When you have to tell about the history of life and the formation of earth then they tend to go to the Bible. The Bible says this and that. So there's a lot of conflict.
R: Do you think that has an impact on their identity?

TA: Our learners, they tend to choose Western culture, because Western culture, it seems to be easier for them, you understand? But, I think it does affect them. I think it's important that they must know their background. Also, they must know. We must also make sure that our learners know that their culture is important, that there is not culture that is more important than their culture. So now, it is very important that we keep on motivating them about their culture and their indigenous knowledge.

R: Do you think that the education department is promoting Western culture more than indigenous?

TA: They are promoting Western culture more, because you see in that chapter about anaerobic respiration, about African beer, there was an argument there about African beer that can cause cancer and so forth. And the other people in there, they were debating, what about the brandies and all those alcohols that are stronger? So now, debates like that. Most people, they promote Western culture and then the traditional culture, it seems as if they do not promote it at all.

R: And how do you think, how can that be changed?

TA: As I see it's impossible, because as time goes by… It's impossible that it can change, because even us, the elders, we tend to choose the Western culture, so it's very hard.

R: Why do you think that is?

TA: It's easier. Western culture is most easier than our culture.

R: How?

TA: Even the way we dress. We cannot go back and dress the traditional way. So, it's easier. We all need the parties and this and that.

R: Thank you for your time.

End of interview.

Transcription of Teacher B

I arranged to meet with the teachers after I observed two of their lessons. Teacher B is also a Grade 12 Life Science (LS) teacher. She had a very hectic schedule as she was involved with moderation of exam papers as well setting up exam papers and invigilating during the exam. This, despite also having to teach. Therefore, it was difficult to arrange a time for the interviews. The interview was arranged during the Teacher B's free period in the deputy principal's office. Teacher A was the Grade 11 LS teacher. The interview with Teacher A took place in her classroom as she had little time to sit down for a longer interview. The interviews were audio-recorded and consent was given in writing by the teachers.

Teacher B (Grade 10)

R: So as you know from when I came here I am interested in LS. But I'm also interested in the link between LS and culture. So I'm trying to make the link between Xhosa as an indigenous language and culture and whether a link can be made with science. Do you understand what I'm trying to do?

TB: Now I do.

R: So how long have you been a teacher?

TB: Almost 28 years.

R: And how long have you been teaching LS?

TB: LS is would say is 28, but it has been Biology before and then I think 2010, I think, it became LS.

R: Okay. So you've always been teaching Biology?

TB: I think 2005, because 2001/2002 I've been doing LS as an ACE course at the University of Stellenbosch. I did that for two ears and immediately after I taught LS.

R: Okay.

TB: So I've been teaching Biology for quite a long time.

R: And do you like teaching it?

TB: Yes.

R: So why do you like teaching LS?

TB: I would say it's more practical and you are doing something that is visible. It's not only a theory of some kind, it is very realistic. And it deals with personal being; you know what is going on. You can be a doctor.

R: So in what language do you teach LS?

TB: In English.

R: And how do you find teaching in English?

TB: I would say it's fine for me, but now sometimes it's difficult for the learners, because there are terminology that sometimes it is difficult even now when you have to explain it in Xhosa. For them it doesn't make sense, so we have to be more practical for them to understand.

R: so how do you help them if they don't understand in English?

TB: Well, I will use diagrams sometimes, gestures, you know? They can capture the meaning or the content or whatever.

R: And how do you think the learners would feel if they were taught in Xhosa instead of English? Including their textbooks or writing their exams in Xhosa. And how would you feel?

TB: I think they would feel okay, because it would be in their own language, you know? Because I think most of the time the problem is the language. Now you find out now it's difficult and it doesn't… the content, we don't master it, because they've got another interpretation, not the meaning. They cannot get easily the meaning. But now if it was taught in Xhosa and even the textbooks are in Xhosa, maybe it will make much more meaning for them.
R: Do you think that can be something that can be implemented? Something that can be developed?

TB: It can be useful, but now it can take a long time, because you find out they will learn. I think for me, it's like in Afrikaans. If we have done LS in Afrikaans then when you have to go abroad then it becomes a problem. So we have such a challenge at times, because in a hospital you'll be dealing with various languages and the terminology where you have to explain it in Xhosa. Then sometimes… to understand the content, it would be easy for them, but the terminology, it's more Western.

R: I understand. So, how do you understand IK? What do you understand it to be?

TB: IK, I think it's good. It's good for them, for the language itself, because I think it involves values. You know, there are values involved to know the environment as well.

R: Like what kind of values?

TB: Values like how to… I think when you… There are certain plants. There is a certain plant, an aloe which is used for stomach problems or for wounds that are not being healed and all that. And at the same time, in the olden days what would happen was that, what they believed was that to use something that is natural. And they will learn at the same time not to destroy plants and all that, like burning things. Because in the olden days, it was rare to just burn the plants, destroy the aloe. And you'll find out when you go to the Eastern Cape, you would see fields where there are these plants. I would put it in that way.

R: Okay, not overusing or destroying.

TB: Plants are valuable, you know? They used to have trees. Because now they are cutting trees, because in the rural areas they use the dry wood, if the wood is no longer growing, to

make a fire they would use that. So it's very rare to just cut down trees and all that. The cutting down of trees is something where now it's an urban thing where people are now looking for a place to stay.

R: So in the rural areas it's more valued?

TB: Yes, because they believe that some of these plants or trees, they can use them as medicine.

R: So does the LS curriculum, does it include IK in the LS curriculum and textbooks?
TB: Not really, I would say, It's not that much included, except where you have to give differences between the endemic plants and animals and the alien plants, and the indigenous plants that are endemic. Otherwise, they don't draw that much on indigenous knowledge except in evolution. Even so, it's not that much.

R: And how do you feel about that?

TB: It would be proper if this could be included in the syllabus, just for them to know where they stay, so the IK, it can be much wiser, maybe even save our biodiversity in a way.

R: Do you consider the Xhosa culture to be indigenous?

TB: Yes, it is. Yes, it is.

R: Can you give me an example of the Xhosa culture and what makes it indigenous?

TB: I would say maybe, not just the language. I would say the plants. In Xhosa they say 'imbala'. There are those plants that are used when men come from the world of theirs, they would put on all that stuff in their face. So I don't know what kind of a plant is that, and the IK, like... But it needs to be mentioned to be there. Now it's a pity that I don't have that much knowledge and whatever.

R: Do you think the learners have enough knowledge of their indigenous culture in terms of the value of plants?

TB: Not that much. They don't. Because most of them they grew up in an urban area. You know, take for instance a learner that was born in Khayelitsha, where it's rare to have plants in the yard, you know. So to them it might not make sense.

R: Do you think that that has an influence on their identities? Do you think it's a problem or is it helpful?

TB: It's going to be a problem, because they would sort of be in a confusion of some kind, because they have learnt from school. You'll find out now that when they go home it's something else that is being done or said or whatever. But I think it would need now more explanation to them. Because you'll find out now our learners they are more of Western because of the urbanization. Because in an urban area you'll find out it's not only Xhosa that are there. There are Sothos, there are Tswanas, there are Afrikaans-speakers and all that, so it's a mixture. Whoever they associate with, they'll copy that culture.

I'll make an example where you'll find out in our culture as Xhosa people, when an elderly person is talking to you are not supposed to look at a person straight in the eyes, you'll find out when it comes to the other culture, the western culture or whatever. Look here, you have to do this and that, so there is a mix of some kind. Because you'll find with our culture there is more humbleness, you know. You have to be. But, you'll find out on the other side, you have to speak out what you feel, you have to express, like if you're angry, you have to show out your anger. But with us, in our culture you shouldn't. It means you are regarded as a child at the end of the day.

R: I understand. Now I also know something new, because I didn't know before.
Do you practice any religion?

TB: Yes.

R: What religion do you practice?

TB: I'm a 7th day Adventist.

R: Do you believe in traditional healers and ancestors?

TB: No, especially the ancestors. Traditional healers I would say, partly. Because of the natural medicines that they use. For instance, they use plants or whatever, because they know more of these plants. They are not healers as such or more than going to the doctor. For example, if you can use rooibos tea to cleanse. But the ancestors, we don't entertain that, because it's not there in the Bible. Because we are more inclined to what is said in the Bible.

R: Do you think that can sometimes be in conflict with evolution and things like that in the curriculum?

TB: No, it is in conflict, very much. It is very much confusing for the learners because…

R: And for you as a teacher?

TB: When I teach evolution I don't. I separate evolution in a scientific way, but when it comes to the Bible, I don't mix the two, because they are two different things. Because you'll find out it's man-made – science. But the Bible is about the creator and how those who are using… the scientists, they are also using what has been created by God. And there are so many examples because if I introduce evolution to the learners I always say that evolution cannot be compared to what is said in the Bible, because in the Bible it is there, there are no changes. It has been there for ages, and what is being said in the bible still exists. Whereas science changes every now and then. Because you cannot rely on that- so when I'm teaching them I make them, they shouldn't even quote what is in the Bible, because it is two totally different things.

R: So science is separate and the Bible?

TB: Yes.

R: How do the learners perform in LS?

TB: Their performance, but it's only that why is it not improving as such? But it does improve in time. It's only that there is a lot of work, on the content, they have added a lot. And how they've tried. They cannot master everything. It's too much.

R: Do you think that there is a conflict in what learners are exposed to at home in terms of their culture and what they are taught in school. Like, how do they relate to the LS curriculum? Do you think IK is being represented?

TB: It's not. When it comes to LS, it's more scientific. It's more scientific and the IK is not there as such.

R: But do you think that certain aspects of IK can be included in the curriculum?

TB: Yes, it can be. So that the learners can be aware of their environment. Not to know just to know, but to have that interaction in between.

R: Yes, and then I wanted to know what makes you Xhosa?

TB: I was born being a Xhosa. That's all I can say.

R: Do you have anything else that you would like to share with me with regards to LS and IK?

TB: Nothing that much. It's just interesting to know, because it would be wise or advisable to be included because really there is more science and more biology. Why I'm saying it is more scientific, it's when we talk of organisms. I'll quote one about natural selection where you'll be told now that plants or organisms they change. They don't change as such, they evolve due to the environment they are in and all hat. You know, one person might not understand it, but according to how you have been taught, you end up believing that this is what has happened, because the organisms were like this, but because they had those different characteristics, those who couldn't adapt to such an environment, they die of this. Whereas you know behind that these were not naturally selected by nature or whatsoever. That's why I'm saying it's more scientific and learners now take time to understand it. How does this happen. And then when you have to find out, to get the evidence, now they would say not, it has been happening to change or to evolve from this state to another state and this has been happening over million years. So it's very much scientific. The IK isn't there more than science. The IK is not included as such.

R: But it should be included?

TB: Yes, it can be included, it can be included, but it needs more research where you can go to such a culture, where you make a research to find out what you need to be included in the syllabus concerning this and that. Now I'm sure, what would have love your children or the next generation to know about the values or knowledge that wasn't there or addressed.

R: Thank you very much for you time.

Appendix H: Findings of documentary analysis

Findings of Document Analysis

4.1.1 Discourse	
Rectifying the past General Aims (GA) 1.3 (a, b and c)	GA (a) "promoting knowledge in local contexts while being sensitive to global imperatives" GA (b) "equipping learners irrespective of socio-economic background, race, gender, physical or intellectual ability…" GA (c) "social transformation… redressing past educational imbalances" [for] equal educational opportunities" (p. 4)
Indigenous Knowledge Systems Specific Aim 3	Specific Aim 3: "Learners must be exposed to the history of science and indigenous knowledge systems from other times and other cultures… to both enhance the subject and clarify the relationship between the subject and society i.e. indigenous knowledge systems that relate to a specific topic, related history of scientific discoveries and the applications of science in everyday life." (p. 17).
Worldviews Sub Aim 3.2	Sub-aim 3.2: "One of the differences between modern science (and technology) and traditional, indigenous knowledge systems is that they have their origins in different world views. Learners should understand the different cultural contexts in which indigenous knowledge systems were developed." (p. 17)
4.1.2 Content	
Traditional Biotechnology Knowledge strands 3 and 4 of Life Sciences curriculum	Fermentation: 'umqombothi' (African beer) and 'Amasi' (fermented milk) (Life Sciences learner's book, pp. 83-84)
Sustainable Development	Harvesting indigenous plants for medicinal and other purposes (Life Sciences learner's book, p. 370)
4.1.3 Instruction	
Language	"Teachers must be aware that they are also engaged in teaching language across the curriculum. This is important for learners for whom the Language of Learning and Teaching (LoLT) is not their home language…" (p. 19)
Skills Specific Aim 2	Specific Aim 2: Investigating Phenomena in Life Sciences by: "Following instructions, handling equipment or apparatus, making observations, recording data, measuring, interpreting, designing and planning investigations or experiments, identifying and controlling variables…" (pp. 15-16)