Exploring the lived experiences of selected grade 9 teachers' integration of indigenous knowledge in their science lessons in the Western Cape province.

by

Athandile Magade

Student number: 4416280

Supervisor: Dr K Booi

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DECLARATION

I, *Athandile Magade,* declare that the thesis entitled **"Exploring the lived experiences of selected grade 9 teachers' integration of indigenous knowledge in their science lessons in the Western Cape province."** is my original work and has never been submitted for any degree or diploma to any higher learning institution previously. Proper acknowledgment and referencing of all sources consulted and/or directly quoted has been made and list of sources has been given in the reference section of this thesis. This work has been undertaken according to the ethical guidelines and procedures of University of Western Cape. I attest that the work submitted is my own original work and contribution. I accept full responsibility for the content and the results of the present study.

Signature: **Date:** 12 May 2025

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DEDICATIONS

I lovingly dedicate this work to my late mother.

Though you are no longer here with me in the flesh anymore, your spirit, courage and love continue to guide and inspire me every day. I feel your presence in every step I take, and I know that you are watching over me with so much pride. This success is not mine; but yours as well. Thank you for your unwavering belief in me, especially during those moments when I struggle to believe in myself and uncountable sacrifices you have made so that I could stand where I am today. Thank you, Mother. I will honour you with pride in all I what do and carry your strength with me into this unforgiving world.

ABSTRACT

This study investigated the lived experiences of Grade 9 Natural Sciences teachers with the infusing of Indigenous Knowledge Systems (IKS) in their teaching. Anchored in a phenomenological research design and drawing from Giorgi's analytic approach to data analysis, the study sought to gain insight on how teachers conceptualise, make sense of and work with the inclusion of IKS in a knowledge world that is predominantly constructed and constituted by Western scientific knowledge. Unstructured interviews were conducted with six teachers who were purposively selected, and their stories were analysed in detail to find the central themes and connections. The findings indicate that teachers recognise the cultural significance and the educational relevance of IKS but experience some challenges to integrate Indigenous Knowledge System effectively. The challenges include limited time (due to curriculum pace), lack of clear teaching approaches, lack of support by the Department of Education and the non-existence of a professional development focusing on Indigenous Knowledge System. Because of these constraints, some teachers integrate Indigenous Knowledge System informally and at times conduct oral conversations with traditional knowledge holders on Indigenous Knowledge System for personal experiences. The findings of this can study contribute to proactive integration of KIS in the science curriculum as it argues for more cultural and contextually relevant pedagogical approaches. The study recommends focused curriculum revision, ongoing professional development of teachers, and shared partnerships with Indigenous Knowledge System holders for effective integration of IKS in Natural Sciences education. These are the efforts necessary to establish equitable and cultural-responsive science education in South Africa. At the end, the research contributes to transformation of science education, and demands attention to more holistic, contextualised teaching practices.

Keywords: Indigenous Knowledge; Natural Sciences; integration; grade 9 curriculum; phenomenology

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ACRONYM	DESCRIPTION
ATP	Annual Teaching Plan
CAPS:	Curriculum Assessment Policy Statement
CAT:	Contiguity Argumentation Theory
DoBE:	Department of Basic Education
DoE:	Department of Education
IK:	Indigenous Knowledge
IKS:	Indigenous Knowledge system
NCS:	National Curriculum Statement
NMU	Natural Meaning Units
OBE:	Outcome based education.
RNCS:	Revised National Curriculum Statement
PGCE	Postgraduate Certificate in Education
TAP:	Toulmin's Argumentation Pattern
TEK:	Traditional Ecological Knowledge

TABLE OF CONTENTS

CHAPTER ONE: OVERVIEW OF THE STUDY

1.1. Introduction

The inclusion of Indigenous Knowledge (IK) into South Africa's National Curriculum has been a contentious topic (DoBE, 2012, O'Hern & Nozaki, 2014, Breidlid, 2013, 2012). The resistance by different individuals with varied thoughts on the knowledge that ought to be integrated is among the main barriers against integrating IK into the science curriculum within schools (Hodson, 2009). In post-apartheid South Africa, education transformation has aimed at addressing past inequalities through emphasising relevance, inclusivity, and epistemic plurality within education curricula. The development and implementation of CAPS (Curriculum and Assessment Policy Statement) was, through its development and implementation in 2011, a bold step towards investing science education resources towards addressing national imperatives of transformation and social justice (Department of Basic Education, 2011). Based on this education framework, the incorporation of Indigenous Knowledge Systems (IKS) into science education was seen as a strategy that would embrace African cultural and intellectual legacies (Le Grange, 2020). These legacies, as recognised by African worldviews and problem-solving experiences through indigenous perspectives, have continued to serve as practices of local communities and that of African societies through time (Le Grange, 2020).

However, despite its incorporation into education, many classrooms continue to be dominated by Western epistemologies, which continues to impede the meaningful realisation of epistemic plurality and genuine curriculum transformation (Blackie, 2024). Recent research shows that the incorporation of IKS into science education is imperative towards addressing issues of educational equity and epistemological justice (De Beer & Kriek, 2021; Sibanda & Molefe, 2023). Science education has traditionally favoured Eurocentric systems of knowledge, presenting Western science as universal and objective, as opposed to local or Indigenous systems of knowledge, thereby causing cognitive dissonance for Indigenous learners, who are unable to connect scientific facts to their practical experiences (Mavuru & Ramnarain, 2021).

By integrating Indigenous Knowledge Systems (IKS), science education is not merely adopting a new pedagogy but is, through this initiative, engaging in a broader project of decolonisation that seeks to challenge and dismantle the hierarchical system positioning Western science as superior (Le Grange, 2020). Through this initiative, the incorporation of IKS into Natural Sciences education becomes an initiative that is aligned and leans towards a larger project of decoloniality of education on the African continent, towards aiming for more inclusive and context-sensitive knowledge production (Le Grange, 2020).

Unfortunately, even these policies are gradually trying to tackle the injustices, but these policies lack effective implementation in schools. Teachers also play an important part in deciding whether IK is effectively assimilated into science or if IK is simply added superficially with references to their cultures in science class. There is sufficient empirical support that indicates that science teachers have had inadequate belief, skill, or subject matter to fully integrate IK with Western Knowledge Systems effectively (Ramnarain, 2018; Vokwana & Ngcoza, 2022). All these aspects cumulatively result in the marginalisation of Indigenous Knowledge in science education, resulting in the reduced transformative potential of the curriculum. This is especially true when considering Grade 9 Natural Sciences as a part of this issue. Grade 9 is considered a transitional phase within the education system of South Africa, bridging general education and specialised subjects that are taught as a part of the Further Education and Training (FET) phase of education (Department of Basic Education, 2011). At this point, learners are required to develop basic scientific literacy and link scientific concepts to their immediate environment and culture (Department of Basic Education, 2011).

Yet, as research shows, many teachers have difficulty implementing inquiry methods that incorporate Indigenous concepts concerning ecosystem, climatic patterns, and plant diversity (Sefoka & Chuene, 2025). It is for this reason that research into teachers' experiences is essential, as these experiences, beliefs, and practices shape policy implementation at a teachers' practical, day-to-day level. Recently, there has been growing research that has documented teachers' views on integrating IKS, and these studies have highlighted conflicting views on curriculum goals and classroom implementation. It is believed by many teachers that the value or validity of IK is lower compared to Western science, based on the curriculum outcomes, along with the contents of the textbooks, which emphasise the European perspective on science, according to De Beer (2021).

Furthermore, Mavuru & Ramnarain (2021) have stated that, although many value the inclusion of the IKS system within the teaching of science, there is some questioning with regards to the learners' level of understanding of the IK ideas, according to CAPS guidelines. These studies demonstrate that teachers require more than changes at the curriculum level and that comprehension of practitioners' experiences, as well as their operating environment, is necessary for paradigm shifts, especially within the diverse settings of science education in South Africa (Nkosi, 2022). However, due to its complex nature, it is pertinent that a phenomenological study be used as a means of examining Grade 9 teachers' experiences of implementing IKS content integration within their Natural Sciences classes. By doing this, phenomenology becomes a means of exploring the meanings people attribute to their experiences, thereby enabling research to develop insight into teachers and their experiential experiences, consisting of emotional, contextual, and subjective elements of their work life (Creswell & Poth, 2018). Again, this research acknowledges that teachers themselves possess potential as transformative forces within their classrooms and can develop more effective ways of implementing means of content integration based on their experiences (Le Grange, 2020). Additionally, this research is a development of decolonial pedagogy, arguing that more emphasis be placed on local systems of knowledge and learner identity as means of scientific inquiry (Le Grange, 2020). Moreover, this study is framed within other discourses on education transformation and culturally responsive education on the African continent. Researchers, such as Hlatshwayo and Fomunyam (2019), and Ramnarain (2020), identify that for truly transformative changes to occur within education, there would need to be not only changes within content but changes within the pedagogical stance of educators as well. Teachers need to be enabled and empowered to connect learners through inquiry, dialogue, and reflection, connecting scientific ideas and concepts, and community bodies of knowledge, practices, and sustainable issues.

Additionally, this study is placed within other discourses on transforming education and culturally responsive education on the continent of Africa. Thus, experiences of teachers have played an essential role in determining challenges and facilitators of pedagogical transformation within science education culture of south of Africa. In conclusion, this research is an answer to a call that has been made repeatedly concerning research that can help bridge the gap that exists between policy ideals and classroom implementation regarding the integration of IKS into science education. By adopting this research and its target population of Natural Sciences Grade 9 teachers, it is possible to capture the human side of the curriculum development and implementation process, as these teachers respond and implement Indigenous Knowledge Systems studies into science education. Through this research, new perspectives can be developed on implementing a form of science education that is more just and reflective of South Africa's diverse intellectual heritage, ultimately promoting a more inclusive and equitable education system for all.

1.2. Background of the study

South Africa was an apartheid country since 1994 when a governing body which allowed widespread segregation in many fields of life abolished it. In South Africa, for example, education was divided along racial lines during the apartheid era (Harley & Wedekind, 2004; Ogunniyi & Mushayikwa, 2015), limiting the number of students from non-white communities who could enrol in courses like Life sciences, Physical sciences and Mathematics as well as including rules prohibiting university students from enrolling in institutions that were not designated for their racial groupings.

However, since 1994, political developments in South Africa have resulted in numerous drastic alterations in educational environments (Jansen,1998). Previously homogeneous classrooms became more complex as racially segregated apartheid laws were overturned, reflecting the multi-racial makeup of the post-apartheid society. Unfamiliar environment forced science educators to adopt innovative teaching strategies that considered the varied backgrounds of their students (Lee, 2003).

Unfortunately, teachers were unprepared for handling such multicultural classroom situations (Ogunniyi & Mushayikwa, 2015). The post-apartheid government implemented a number of revolutionary education reforms that needed teachers to change teaching approaches, further entrenching pre-existing issues (Christie, 1999). For example, teachers needed to connect Indigenous knowledge (IK), which had even been disregarded as valuable knowledge within previous curriculum, with students studying science.

The Curriculum 2005 (C2005), based on what was at that time called the Outcome-based Education (OBE) came into operation in 1997 (DoE, 1997). Curriculum 2005 was not like the apartheid curricula which were teacher-centred but student-centred. The apartheid curricula were different from C2005 in that it was learner- centred rather than teacher-centred. Additionally, it switched the emphasis from a behaviourist to a constructivist philosophy of education (for full detail see Koopman, 2017). This implies that the educator was expected to go from being the sole authority in the science classroom that promoted rote learning, as was the case under apartheid with its racially biased curriculum, to being a facilitator and co-constructor of knowledge with the learner. Additionally, analytical analysis and independent research learning were to take the role of rote learning, which was the norm in South African classrooms during the apartheid era. The post-apartheid curriculum has experienced multiple modifications between 1997 and 2012 (Department of Education [DoE], 2002, 2004; Department of Basic Education [DBE], 2011) in response to multiple critical comments (Jansen, 1998; Maodzwa-Taruvinga & Cross, 2012). These revisions include the Revised National Curriculum Statement (RNCS), the National Curriculum Statement (NCS) and the most recent Curriculum and Assessment Policy Statement (CAPS).

One of the curriculum adjustments introduced after 1994 within the thrust toward removing the Apartheid-legislated segregated education system was the abolition of two ethnically disparate education ministries and the establishment of a single national ministry (Christie, 1999). The consequences of the Bantu Education Act of 1953, which effectively exclude a majority of black people from being a part of the country's economic, political, and societal life, were also examined, specifically given how they continue to be experienced within the unfair South African education system (Christie & Collins, 1982; Jansen & Tylor, 2003; Giliomee, 2005).

Indigenous knowledge was dismissed as useless throughout the colonial era and under apartheid, thus it was never included in the science curriculum in schools (Diwu & Ogunniyi, 2012; Koopman, 2018). This issue has been managed in the new democratic South Africa since the introduction of the first post-apartheid curriculum, C2005, and all other revised curricula that have followed, with Indigenous Knowledge being integrated in the school science curriculum. The Curriculum and Assessment Policy Statement includes "valuing Indigenous Knowledge into the classroom" as one of its guiding concepts (DBE, 2012). Additionally, the CAPS's Specific Aim 3 focuses on incorporating Indigenous Knowledge into the science curricula (Diwu & Ogunniyi, 2012; DOE, 2011). This Specific Aim concentrates on the student's understanding and enjoyment of how scientific knowledge can improve their lives and how it relates to the scientific content (curriculum) (DOE, 2011). Native knowledge gives students the chance to properly comprehend science (Ogawa, 1995; Semali & Kincheloe, 1999). Zinyeka, Onwu, and Braun (2016) contend that a student may decide against studying science if they feel that it conflicts with their cultural values and scientific principles. One cannot overestimate the importance of bridging the epistemic gap between science and Indigenous Knowledge in the classroom.

Constructivism, as a theory of learning, insists that by interacting with children, adults, and the world, students construct knowledge from what is known previously and enhance cognitive abilities. Most scholars and educators agree that learning must take into account the history and culture of a learner due to an aspect of effective teaching that utilizes students' previous knowledge (Sherman & Sherman, 2004; Holiday, 2000; Hewson & Hewson, 1982). Indigenous knowledge elements such as previous knowledge are different among and within cultures, which makes consideration of them essential so that all relevant details are incorporated into curriculum at an appropriate time (Hodson, 2009).

According to De Beer & Whitlock (2009), the science curriculum represents Western worldviews that may be alien to some learners because it always ignores social interaction in the real world of the learner. This is further emphasised by scientists who believe that the performance and success of a learner in learning activities is adversely affected by culture (Hodson, 2009). This is because it is believed that Indigenous Knowledge restricts and contradicts scientific thinking, and the science curriculum seems to have neglected it. When referring to a group of people who make up a community, the term "Indigenous" indicates a level of localisation, a pattern of fixed locations of a given people, characterised by their sharing of cultural elements (Semali & Kincheloe, 1999). Indigenous Knowledge offers science students a plethora of prior knowledge, and when it is ignored, learning becomes more difficult (Zidny et al., 2020). Local knowledge, cultural values, and societal balances are all impacted by the current science curriculum. Indigenous wisdom is passed down across various cultures from one generation to the next (Battiste, 2002). Education is a complex phenomenon that is not just closely related to formal education. Indigenous students will be able to comprehend the material completely and be on par with their Western peers if Indigenous Knowledge is incorporated into the science curriculum. It is believed that including Indigenous Knowledge into the science curriculum, a student's prior knowledge and experience might be the basis for a science lesson (Aikenhead & Ogawa, 2007). A learner's experience and prior knowledge might therefore be a source of scientific knowledge when considered holistically (Koopman, 2018). According to De Beer and Whitlock (2009), incorporating Indigenous Knowledge into the scientific classroom has the potential to promote meaningful learning and bridge the gap between science education paths acquired in the community and in schools.

1.3. Problem statement

Since the inception of democracy, issues of education in South Africa have centered on the transformation of the curriculum itself, aimed at redressing inequalities of the past and adopting diverse knowledge discourses and traditions. Recent scholarship, however, has focused on issues of epistemological diversity and decolonised science education, as science education, incorporating Indigenous Knowledge Systems (IKS), has been part of the broader discourse of science education on a global scale, indicating that formal education has to move away from Eurocentric ways of knowing (Le Grange, 2020). There is, however, a strong body of established knowledge on science education, having traversed issues of accessibility and equity and having reached relevance and responsiveness, indicating that science education has arrived at this point on a firm platform of established knowledge on science education issues and practices.

Despite this progress, the application of these policies into practical classroom teaching still has many inconsistencies and challenges. Findings from empirical research have indicated that despite this policy that advocates for integration, some teachers have ignored this policy or selectively applied it, reducing Indigenous Knowledge Systems' components into a mere 'Cultural Story' (Sibanda & Molefe, 2023; Vokwana & Ngcoza, 2022). Specifically, research has indicated that some teachers of Natural Sciences, especially grade 9, are experiencing challenges of 'curriculum content, research testing, lack of resources, and large class sizes' (De Beer, 2021), ultimately providing fewer opportunities for teachers to be more innovate and develop 'creative pedagogic and assessment approaches that facilitate and stimulate the incorporation of IK systems into science inquiry' (Ramnarain, 2018). Additionally, as indicated within available literature, many teachers still lack 'theoretical and practical applications that would facilitate IK Systems' incorporation into science inquiry' (Investigating Indigenous Knowledge Awarenes, 2024).

There is, however, a significant lack of research emphasising and focusing on teachers' experiences as they incorporate IKS into their science education offerings (Mavuru & Ramnarain, 2021). In many of these studies, researchers merely focus on curriculum investigations, policy formulation, and learner outcomes without really probing into and examining teachers' personal perspectives on and experiences regarding the incorporation of indigenous knowledge into science education (Mavuru & Ramnarain, 2021). Teachers are the key agent of implementation and transformation, and grips on their perspectives regarding science and indigenous knowledge, as well as their practical experiences, are essential before any changes can be made (Nkosi, 2022).

Furthermore, apart from this, the larger discourse on pedagogic transformation and epistemological diversity draws attention to the imperative of this research initiative itself. There is a growing emphasis that, when bringing IKS into science education, it is neither a matter of addition nor a form of pedagogical innovation that challenges Western science's typical discipline divisions, moves away from borderline concepts of system and paradigm interactions, and seeks dramatic changes in teaching and learning methods (Le Grange, 2020; Blackie, 2024). Teachers need pedagogical orientation changes, necessitating development of culturally supportive pedagogical methods and designing learning modules that help interface worldviews of the Indigenous and science communities through inquiry science education. But most of these courses are still based on science paradigms and, as such, grossly lacking relevant pedagogical alignment for imperative epistemic justice and culturally sustaining science education (De Beer & Kriek, 2021). In this way, this research initiative draws attention to a second gap, highlighting that it is not only essential to investigate teachers experiences, but also that pedagogy itself requires transformation in response to the growing incorporation of Indigenous systems into science education.

Based on these identified research gaps, namely, the gap between policy and practice, a lack of emphasis on empirical experiences of teachers, and a need for pedagogical innovation, this research proposes filling this interlocked gap and contributing towards this end. Specifically, this research targets Grade 9 Natural Sciences teachers because this is a phase of great importance for learners' conceptual development, and because grade 9 classrooms are sites of great importance for epistemological/cultural bridging (Sefoka & Chuene, 2025). By adopting a phenomenological research paradigm, this research sets about determining, at great descriptive and subjective detail, experiences of Natural science teachers as they attempt combinations of IKS into their lesson plans, classroom activities, and assessment tasks. By these experiences, this research aims at making sense of, through these experiences, learners' concepts of indigenous knowledge, experiences of combinations, and any inhibiting and facilitating factors they encounter as they bridge Western science and IKS concepts and practices. By this research, this interlocked gap is, thus, bridged because this research attends fully to connections between these research and policy goals (multiple epistemologies, and transformation).

Through this, this research directly engages with science education debates today because it can provide empirical evidence on ‘the ways that epistemological diversity is played out’ and ‘practices of pedagogical transformation or resistance’ through the reflections of lecturers on science education and, more generally, on ‘the relationship between science education and broader issues of pedagogy and transformation’ and finally, ‘the role of science pedagogy’ through its practical application of official policy guidelines on implementing integrated Knowledge Systems education into science education classrooms. Also, because this research demonstrates science education experiences through diverse settings, it illustrates ‘the ways that systemic issues’ meet ‘epistemological issues’ in effect, providing a more comprehensive comprehension of science education reformers’ goals and practices across South Africa. In conclusion, this study is a response to the imperative need for comprehension on how Indigenous Knowledge Systems can be meaningfully integrated into teaching Grade 9 Natural Sciences, by pursuing teachers’ experiences and approaches. By connecting these issues and concepts, this study is assured of providing a sufficient reason that this research is pertinent and imperative for educational transformation, as indicated and informed by post-Apartheid education reforms occurring within South Africa.

1.4. Motivation of the study

This phenomenological study records the perception and integration of Indigenous Knowledge in the scientific curriculum of the Metropole North District of Western Cape schools as experienced by selected Grade 9 Natural Sciences teachers. The main goal of phenomenology is to examine the phenomenon under study in detail to investigate the complex world of lived experiences from the actors' (those who experience it) point of view. Phenomenology, according to Koopman (2013), is interested in things that are fundamentally intangible, like human experience. By doing this, we can transform on a personal level while also understanding things or events at a higher level of consciousness and exploring our own nature. In this method, a researcher might engage in critical reflection and develop greater thoughtfulness and vigilance when it comes to comprehending social processes.

As a teacher of Natural Sciences, Life Sciences, and Physical sciences my own education experience brought forth the roots of this research. My own learning history shaped it, thinking about my Secondary school experience, where I attended Natural Sciences classes taught by a teacher who did not elucidate the content of this discipline. Lessons passed at breakneck speed, with no time for participation or explanation or depth of understanding. There were times where I was struggling to learn the concepts of science because the educator was just lecturing the curriculum rather than checking whether the learners were getting the content. It turned me off Natural Sciences to the point that I found the subject scary and disconnected from real-life applications. But yet, despite those issues, I had to push outside of the learning limited environment to evolve into the teacher, I am today. Having struggled with science content myself, I was determined that my learners would not have to suffer through this as well. Over time I realised that integrating Indigenous Knowledge Systems (IKS) with science learning might be a powerful way of connecting students with science. However, as I began into the process of looking for ways to implement IKS into the classroom, I encountered several obstacles, such as insufficient clear guidelines, limited time and the ambiguity surrounding the integration of IKS.

The reason I am undertaking this research is because I know that many other teachers face the same challenges. They lack guidance and education on how to incorporate IKS into their practices. I have always had the faith that if properly incorporated into the curriculum, it is possible to facilitate an interactive, inclusive learning space that allows learners to relate scientific principles to their cultural knowledge and lived experiences. I want to explore the lived experiences of Grade 9 Science teachers with similar challenges to integrate IKS through this study. By documenting their perspectives, it is hoped that the need for professional development courses, changes in the education system as a whole, and collaboration with Indigenous knowledge holders to aid teachers towards this goal is highlighted. My aim is to encourage an education system which recognises both as sciences (Western science and

Indigenous knowledge) so that learners in the system are educated in both a comprehensive and culturally inspired sense.

1.5. Research aim

This study investigates Grade 9 Natural Sciences teachers' lived experiences on the integration of Indigenous knowledge and Western Science in their lesson.

1.5.1. Objectives of the study

The main objectives of this study are:

i. To identify the specific challenges, successes, and concerns which teachers experience in enacting an integrated IK-Science curriculum.
ii. To elicit teacher suggestions / lessons-learnt to improve the enactment of such an integrated IK-Science curriculum in future.

1.5.2. Main research question

What are the lived experiences of selected Grade 9 teachers in integrating Indigenous Knowledge into their Natural Sciences lessons in the Western Cape province?

1.5.3. Subsidiary research questions

i. How do Grade 9 Natural Sciences teachers conceptualise Indigenous knowledge?
ii. How do Grade 9 teachers integrate Indigenous knowledge into their Natural Sciences lessons?

1.6. Literature review

This study performs a review of the literature on the integration of Indigenous knowledge and science as well as the significance of including Indigenous knowledge systems in science lessons. Therefore, a literature review is an examination of prior research on a subject. The literature review is the reading, analysing, and summarising of scholarly writings on a topic. Rowley and Slack (2004:31) describe a literature view as an extensive review of a field of study which enabled to identify specific field of research and requires searching different sources; academic and professional journals, articles, books and internet.

The incorporation of Indigenous Knowledge into science lessons can provide useful insights into the many methods of knowing and comprehending the natural world. Educators can obtain a better grasp of Indigenous cultures' cultural perspectives, traditional practices, and knowledge systems by reviewing existing research, scholarly articles, and publications on the subject. This literature evaluation can assist to shape science curricula that are inclusive, culturally responsive, and respectful of Indigenous methods of knowing. Integrating IK into the science lessons based on a thorough literature study allows educators to promote diversity, equity, and inclusion in science teaching while also cultivating a broader understanding for Indigenous peoples' rich legacy and contributions to scientific knowledge.

Indigenous Knowledge (IK) is localised, traditional, and distinct forms of knowledge constructed by Indigenous societies over time based on experiential living in relation to environments (Agrawal, 1995). The knowledge is rooted in traditional culture, customs, and systems of belief, which societies refer to in understanding and relating to environments (Nakashima et al., 2018). In contrast to Western scientific knowledge, which is documented and normalised, Indigenous Knowledge is primarily passed down verbally, through storytelling, rituals, apprenticeship, and experience (Hoppers, 2002). A distinguishing characteristic of Indigenous Knowledge is its inter-relatedness and holism (Battiste, 2002, p. 14). It is not disciplined in its structure, for example, in separating medicine, astronomy, and biology, but it inter-relates all these in a total understanding of the universe (Berkes, Colding, & Folke, 2000). For example, traditional modes of agriculture, such as intercropping and crop rotation, demonstrate a total understanding of sustainable ecosystems. In a similar way, traditional medicine, which makes use of vegetal treatments and rituals, demonstrates a rich understanding of medicinal plants and total well-being (Shizha, 2006).

Indigenous Knowledge is also dynamic because it is in a constant process of change. While it is based on centuries of experience, it is continuously altered in adaptation to changing environmental and social contexts (Nakata, 2007). Yet, despite its value, Indigenous Knowledge has been dismissed or rejected as unscientific under colonising influences and Western epistemology's dominance (Battiste, 2002). The exclusion of Indigenous Knowledge in systems of education has led to concerns for its loss and for loss of valuable cultural heritage (Dei, Hall, & Rosenberg, 2000).

Onwu and Mosimege (2004) provide a definition for Indigenous Knowledge (IK) which is all-encompassing knowledge embracing technologies and practices that Indigenous and people at a given location use for survival, adaptation, and existence in a number of different environments. Examples include, among others, agriculture, architecture, engineering, mathematics, indigenous and medicinal plant species, governing, and other social orders. Such areas are typically fields of knowledge. It is that which accumulates and develops over time through experience. It allows for an opportunity for the community to substantiate it over multiple generations by applying the knowledge (Ogunniyi, 2013), and elements of spirituality and philosophy (Rich, 2012). This broad definition of IK contains ontological and epistemological claims about its nature. Hence, IK encompasses what is testable and non-testable metaphysical phenomena for an effort to comprehend systems in terms of wholes, and an aspect of spirituality is deeply ingrained indigenous forms of knowing.

Responding to the Western point of view that supports African indigenous knowledge that has yet to clearly define and conceptualize what is meant by "knowledge," a number of scholars, such as Lander (2000) and Chavunduka (1995), are of the view that the Western conceptualisation of knowledge, since it arrived on and outside of Western society, fails to value the all-encompassing scope and approach embedded within non-Western epistemologies. Nkondo (2012) argues that the Western conceptualisation of traditional knowledge among Africans as mere doing without any theoretical foundation represents an expression of intellectual and cultural superiority. According to African researchers, if a traditional healer is able to heal a certain ailment using certain plants, he has knowledge and theoretical awareness about the features of those plant species. Mazrui (1978) also critiqued Western boundedness of scholarship and education, emphasising that genuine scholarship and scientific inquiry must be free from external influences, particularly those based on community engagement and governmental pressures.

As the Natural Science curriculum standards encourage the incorporation of Indigenous knowledge into schooling, it is important to inflect this knowledge in teaching (Department of Basic Education, 2011). This type of approach helps students to make sense of different processes biological, physical, environmental, technological, or sociological which impact on the environment, such as food production, distribution and consumption, health promotion, conservation and sustainability (Department of Basic Education, 2011). "Incorporating in the classroom, the use of indigenous knowledge can enhance student participation and is also a tool for community development." (World Bank, 2005).

It serves to be forgotten that nowadays much of this knowledge Indigenous Knowledge is pushed aside or taken for less than what it is worth and forgets that it is often the Indigenous Knowledge that has provided for the economic, social and spiritual wellbeing of thousands/millions of people, since the beginning of time and that this ancient epistemology can serve as an alternate paradigm for contemporary development and innovation around technologies in various fields. It generates wealth, both in economic and culture terms (Odora Hoppers, 2004). For a successful knowledge transfer, the entire school community (parent-teacher-student-government) must be involved. Respecting the cultures of students can greatly enhance the learning experiences of those who might find Westernised science learning difficult (Aikenhead & Michell, 2011).

The discussion surrounding Indigenous Knowledge encompasses its recognition, significance in educational development, and questions of ownership (Semali & Kincheloe, 1999). This study emphasises the significance of Indigenous Knowledge in enhancing teaching effectiveness and relevance, specifically within the context of science education as detailed in South Africa's updated CAPS document. The CAPS framework for Natural Sciences advocates for the incorporation of Indigenous Knowledge into educational environments, requiring educators to integrate this knowledge into their teaching methodologies. Incorporating Indigenous Knowledge into educational institutions fosters a stronger connection for learners with the material taught, potentially positioning them as key contributors to sustainable development within their communities (World Bank 2005; Brayboy & Castagno 2008).

The inclusion Indigenous Knowledge in the Science Curriculum has largely been ignored and negated as antithetical to typical scientific concepts based on linear scientific thinking. Some argue that disseminating Indigenous Knowledge could disadvantage non-Indigenous groups (Aikenhead & Ogawa, 2007). The prevailing science curriculum tends to reflect Western perspectives, frequently disregarding real-world social behaviors, which may alienate certain students (De Beer & Whitlock, 2009). This situation has an impact on social inequalities as traditional values and local knowledge are neglected (De Beer & Whitlock, 2009). Additionally, there exists a disconnect in the development of Indigenous Knowledge within the Science Curriculum for cultural contexts (Aikenhead & Ogawa, 2007; De Beer & Whitlock, 2009).

For an extended period, Indigenous Knowledge has been overlooked and dismissed within the realm of scientific education. It is often perceived as incompatible with conventional scientific understanding. Some individuals argue that sharing Indigenous Knowledge could be detrimental to non-Indigenous populations (Aikenhead and Ogawa, 2007). The existing science curriculum predominantly represents Western perspectives, frequently neglecting the real-world social behaviors and experiences that might be unfamiliar to certain students (De Beer and Whitlock, 2009). This situation contributes to societal disparities stemming from the disregard for traditional values and local knowledge. Additionally, there exists a feeling of disconnection from knowledge itself. This disconnection exacerbates moral, social, cultural, and environmental issues, which have led to a humanitarian crisis (Herusatoto, 2012; McInnes, 2017). According to Fedosejeva, BoËe, Romanova, Iliko, and Ivanova (2018), the disconnect between global development and unsustainable behaviour raises the question of whether pedagogy should be based on philosophy as a whole.

As pointed out by Naidoo (2007), there are a number of barriers that hinder the integration of Indigenous Knowledge into the classroom. The main issue is that the combination of Indigenous knowledge and school science places fundamentally varied knowledge structures deriving from various underlying assumptions in each individual element (Ogunniyi, 2004). Educational material such as national curriculum booklets and textbooks, and even products on the web, are often produced by subject specialists, contributing towards the school science as being seen as reliably good across different sectors of schooling within countries and across countries (Aikenhead, 2006). This allows for an easier way to teach (Ogawa, 1995). On the other hand, traditional indigenous knowledge is historically transferred through elders and indigenous subject matter specialists orally, mostly without the intention of publication (Battiste, 2002). Tensions also arise around the interface of Indigenous knowledge and science, due to biases against the former held by some educators, students, and researchers (McKinley, 2005). The long history of Western Science's domination over other modes of knowledge, which has left little opportunity for diversity in knowledge, is what fuels such prejudice. Furthermore, because so many educators have been exposed to a "Western" based system they are unfamiliar with Indigenous knowledge (Moyo, 2011; Ogunniyi, 2004).

Learning about science becomes more relevant and productive as learners draw connections between what they already know and the scientific method. According to Emeagwali (2003), effective integration of Indigenous knowledge into science necessitates a change from learner-centred and context-based education to teacher-centred and content-based teaching. Because of this, the learner-centred approach will further engage learners and include them in the learning process, empowering them to take ownership of their education. They will naturally be in a position to generate ideas for a deeper comprehension of phenomena as a result of this. While learners accept responsibility for their own context-specific learning, they may also challenge existing information. As a result, the creation and improvement of knowledge will advance. Social engagement with resources in their environment will increase their depth of knowledge. The concept, application, and current status of Indigenous knowledge as it relates to education must be thoroughly understood by the teachers. Teachers need to conduct studies on Indigenous knowledge, with emphasis given to what Indigenous knowledge applies within their teaching contexts and among learners. (Dei, 2000). Through these investigations, they may become familiar with the learners' knowledge and discover better ways to incorporate it into their lessons. Additionally, they must fully comprehend what the curriculum report says about Indigenous knowledge and how it is incorporated into formal education. In order for Indigenous knowledge to be integrated into science education, teachers need to work with students' cultural contexts. (Aikenhead & Michell, 2011). This will produce learning that is relevant and applicable to the learners, allowing them to comprehend the potential role science could play.

The incorporation of the diagram “A Simplified Network for IKS: Cosmology and Social Power” in this research is important, because it visual spans the complex web of the reality of the Indigenous worldviews. This is an important reference of how IK is situated within cultural, spiritual and social contexts in relation to the populations which feature in this work. In this chapter, the role of the figure one is to demonstrate to the reader the systemic and the interconnected nature of IKS in contrast to the often reductionist Western scientific approach to knowledge systems. Through the visual representation of the dynamic interplay between cosmological beliefs (e.g. the significance of ancestors, nature and the spiritual world), and social power arrangements (e.g. leadership roles, ends holders and gendered authority), this figure facilitates a better understanding of how IKS works as a lived and practiced system. This number is especially relevant for a phenomenological study because it serves to ground the experiences of the participants in an understanding of their lived experiences, and to interpret the narratives within a framework of Indigenous knowledge. It sets the tone for reflection on issues that will surface in the subsequent chapters, especially those on the infusion of IKS in schooling contexts.

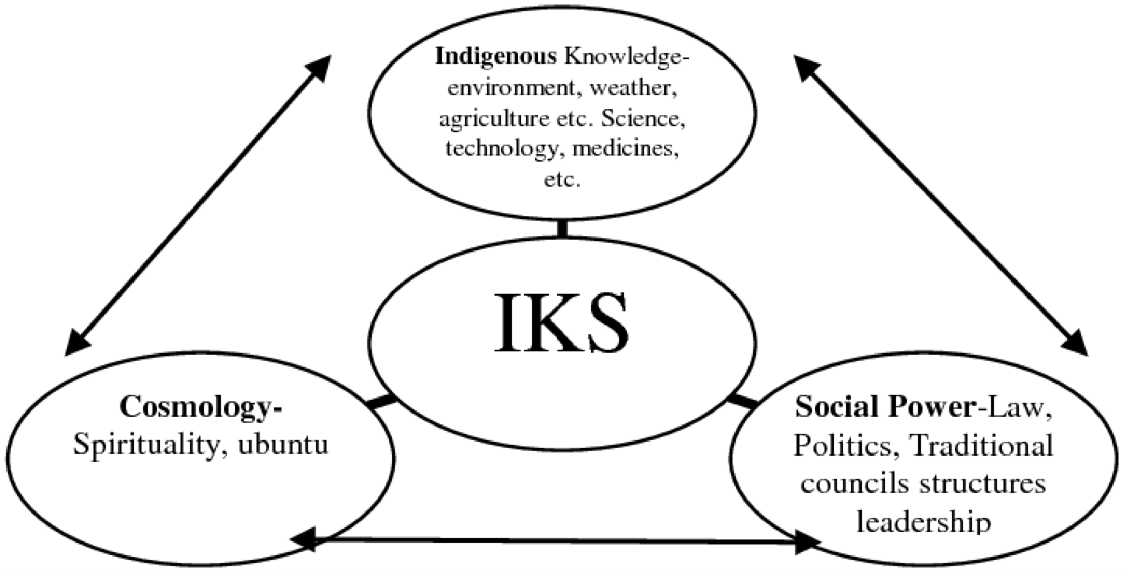

Figure 1.1: A simplified network for IKS
(Govender, 2012, p. 123)

1.7. Theoretical framework

The foundation of this study lies in is the phenomenological tradition, particularly as articulated by the writings of Edmund Husserl (1970; 1975), who is viewed as the father of phenomenology. The goal of Husserlian phenomenology is to present the lived experience exactly as it is and views experience as first-hand information (Finlay, 2011, p. 16). The Husserlian phenomenology treats the life world as a realm of natural attitudes found in daily existence; Husserl called these natural attitudes the first, pre-theoretical, and pre-reflective attitudes (van Manen 1984). Koopman (2013) asserts that Husserl believed that an individual's consciousness transcended factual knowledge that was aimed at discovering the truth about objects. Husserlian phenomenology is concerned with human consciousness, specifically focusing on whether the mind can actualise a person's mental state and being aware of a phenomenon (Giorgi, 2009, p. 69). This indicates that recall of a real event is more interesting to consciousness.

1.8. Methodology

Methodology in this study of research refers to the structure forms based on which design, procedure, and interpretation are developed. It includes the rationale for the type of research design, methods for collecting data and analysing data. A clear methodological approach ensures that there is both consistency and alignment between the processes, goals, and questions of the study (Creswell, 2013). The research is conducted using the qualitative approach with the phenomenological lens as its method. Phenomenology is informed by the philosophy of Edmund Husserl and Martin Heidegger. Phenomenology attempts to understand how individuals experience and create meaning surrounding their daily lives in certain contexts (Creswell, 2013; Moustakas, 1994). This is due to the fact that phenomenology allows researchers to understand and internalize the significant factors that influence human beings, as well as to articulate our identities in everyday life. Husserl rejected the idea that external objects possess an independent existence and that the information we have about them is reliable (Laverty, 2003, p. 22). According to Husserl (1998), phenomenology serves as a framework aimed at elucidating the essence of things and the authenticity of phenomena. The objective of employing phenomenology is to grasp the intricacies of lived experiences. As noted by Eagleton (1983) and Fouche (1993), individuals can have certainty regarding the appearance of objects as they manifest in their consciousness. To attain this certainty, one must disregard anything beyond immediate experience, effectively limiting the external world to the objects present in one's own awareness.

The study used the phenomenological approach in this investigation. The goal of the science of phenomenology is to characterise specific phenomena, or the way things seem, as lived experiences (Streubert & Carpenter 1999). This method requires suspending preconceived beliefs and biases to fully immerse oneself in the subjective experiences of participants. By using phenomenology, the study sought to learn about the lived experiences of selected Grade 9 teachers who integrate Indigenous knowledge into Natural Sciences lessons.

1.8.1. Data construction

In a phenomenological study data are created in-person through interviews, field notes, or detailed descriptive essays (Koopman, 2013). First-person account of lived experience as grasped by participant in his or her usual common-sense way of knowing is a naïve description (Van Manen, 1990, p. 9). The best and sole "record" of just that type of experience exists in the memory of the individual experiencing it from his or her subjective perspective because no-one else can co-live through the subjective psychological perspective of any lived experience with the participant (Van Manen, 1990, p. 11). The researcher audio tapes individual in-person interviews with each participant in order to capture an audio recording of experiences. Data about the feelings and thoughts of the participants were collected. When doing the research from the perspective of the researcher, Husserl called it bracketing. Miller and Crabtree (1992) mention a second form of bracketing in which the researcher "must 'bracket' her/his own presumptions and come into the individual's life world and employ the self as an experiencing interpreter". The age, ethnicity, location, and gender were taken into account when choosing participants for this study. Interviews and field notes were major data collection tools for conducting this study.

1.8.2. Study site

Geographically, the research takes place in the Metropole North District of the Western Cape, South Africa. Three secondary high schools in the Western Cape Metropole North District were the focus of this study. These schools were chosen since they serve in the similar school district. The researcher chose this location since it was convenient because she is familiar with the neighbourhood and the schools. It also saved time by making it easier to find schools to participate in the study because of the simple access to sites. Also, the researcher had easy access to the schools and teachers. Another rationale for the study's location in Cape Town is that the researcher lives in the city. Purposive sampling, also known as deliberate sampling, was used to select the teachers. The researcher considered a variety of characteristics while choosing the participants, including gender, racial group, age, area, and teaching experience.

1.8.3. The interview

The most effective methods for gathering comprehensive, detailed first-person narratives of daily experiences through phenomenology involve conducting deep, unstructured interviews (Koopman, 2018). the researcher conducted unstructured, in-depth phenomenological interviews with teachers. As pointed out by Koopman (2013), one of the benefits of this type of method is that participants feel more at ease and are also more open in responding to questions in a face-to- face conversation, and the researcher can observe direct reactions or ask to clarify certain perspectives that they may have misunderstood (topics). Images, body language, facial expressions, pauses between answers and the cues the interviewer gets from the participants in the interviews add to the narratives in such a way that makes the accounts lively and in-depth. The participants lived experience of their reality, perceptions, beliefs and values of the phenomenon studied informed these questions (Koopman,2017). Phenomenology enables teachers to share their stories, allowing the researcher to study their thoughts and gain insights into their lives and how these experiences influence their teaching practices. The researcher aimed to explore "what goes on within" the participants, encouraging them to "articulate the lived experience in a manner that minimizes the influence of intellectual and societal constructs." This process is referred to as bracketing, a term coined by Husserl to describe the approach taken by the investigator (Bentz & Shapiro, 1998). After each interview, audio recordings were reviewed, and notes were taken promptly. The researcher documented key words, statements, and phrases to ensure that the voices of the research participants were accurately represented.

1.8.3. Field notes

Field notes represent a type of secondary data gathering employed in qualitative research (Mulhall, 2003). These notes are crucial for qualitative studies, as human memory can easily overlook details (Lofland & Lofland, 1999). The researcher's field notes include information regarding the interactions with participants, detailing their actions, spoken words, tone, and any nonverbal cues that may have occurred (Emerson, Fretz, & Shaw, 2011). The transcript file, personal file, and analytical file are three separate types of field notes that are tracked throughout the study process, according to Minichiello, Aroni, Timewell, and Alexander (1995). Fieldnotes "assist the researchers in moulding and deepening their understanding of the participants' lived world," according to Koopman & Koopman (2020). As a result, fieldnotes helped the researcher remember key details from the interview and better captured the subject's demeanour, body language, and mood. The goal of field notes is to document participants' actual experiences as they occur in unaltered environments. The researcher used field notes to document the behaviours, expressions, gestures, verbalisations, and any other visible indications of the participants' experiences. The field notes contain observations regarding the degree of animation in the expressions as well as the energy of the non-verbal cues, such as their body language, facial expression, and level of relaxation or anxiety. It also covers how they reacted to inquiries and whether they had trouble expressing themselves verbally or finding the right words. Consequently, field notes include contextual data that facilitates placing participant experiences in the perspective of larger social, cultural, and historical developments.

1.8.4. Data storage

The researcher obtained permission from each participant to record their interviews on individual cassettes. Each interview was designated a unique code, such as "participant A, July 15, 2024," and the corresponding cassette was labeled accordingly. Groenewald (2004) recommends that researchers strike a balance between descriptive and reflective notes. Whenever the researcher documented field notes, they were dated and linked to the perspectives of other participants. Promptly after each interview, the researcher reviewed the audio recording and took notes. The researcher then transcribed the interviews and comments to ensure that the voices of the participants were captured.

1.9. Credibility, reliability, and trustworthiness

To determine the reliability, credibility and trustworthiness of a study, methods have to be rigorous, data collection systematic and results verifiable. Below is how all of them come into play in a study on the integration of Indigenous Knowledge Systems (IKS) into grade 9 Natural Sciences classes.

Credibility concerns the believability and truth of the study results. This can be assured by member checking, prolonged engagement, and triangulation (Lincoln & Guba, 1985). In this study, credibility was ensured by collecting data from multiple teachers (participants A–F) in different settings in order to have a diverse set of opinions on the incorporation of IKS. Also, by including direct quotes from participants, it ensured results were adequately represented and unbiased by the researcher (Shenton, 2004).

Reliability in qualitative research refers to consistency and dependability over time (Patton, 2002). Even though qualitative research does not seek numerical reproducibility, reliability can be enhanced by keeping accurate fieldnotes, utilizing a clear research process, and standardizing data collection instruments (e.g., interviews and focus groups) (Merriam & Tisdell, 2016). In this study, reliability was ensured by utilizing a clear interview guide to enable all participants to respond to the same fundamental questions on the integration of IKS.

Trustworthiness was achieved by making the study credible, transferable, dependable, and confirmable (Lincoln & Guba, 1985). To achieve this, the researcher subjected findings to peer debriefing through having colleagues and experts in education scrutinize them (Nowell et al., 2017).

1.10. Ethical consideration

Conducting research within an ethical framework increases the validity and trustworthiness of research. Ethical clearance for conducting research was received from the ethics Committee of the University of Western Cape (UWC) before commencing the study. Ethical permission for conducting the study was received from the Human and Social Sciences Research Ethics Committee (HSSREC) after due consideration and evaluation and agreed that the study was in alignment with the university's ethics standard in research on humans. The ethical permission number is HS24/6/42. Second, since the research involved human subjects in the schooling sector, permission was also applied for from the Western Cape Education Department (WCED). The submission included the research proposal, UWC ethics clearance certificate, participant information sheet, ethics informed consent forms. The WCED referred the application processed by it for consideration of determining if research proposed was in alignment with ethical and policy aspects in education and issued permission. After ensuring that ethical clearances were obtained, the researcher visited the selected schools to obtain authorisation from the school principals and to invite Grade 9 Natural Sciences teachers to participate in the study. All teachers were given an information sheet detailing the purpose, nature and expectations of the study, prior to them taking part. All participants were asked to provide written informed consent and were guaranteed confidentiality and anonymity, with the right to withdraw from the study without prejudice.

1.11. Significance of the Study

This study is significant as it contributes to the growing discussion on the integration of Indigenous Knowledge Systems (IKS) in science education, particularly in the Grade 9 Natural Sciences curriculum. By exploring teachers lived experiences, the study provides enlightening information on challenges, strategies, and attitudes towards IKS integration, indicating the gaps in pedagogical support, curriculum development, and assessment policy.

The findings of this study could inform education policymakers, curriculum planners, and teacher education institutions of the need to have structured guidelines, professional development workshops, and resource packages to be able to implement IKS in science classrooms effectively. It also emphasises the importance of culturally responsive teaching and advocates for the promotion of inclusive science education that values both Indigenous and Western knowledge systems.

1.12. Structure and organisation of the thesis

This study consists of six overlapping chapters focusing on pertinent issues.

Chapter one introduces the historical background of the study, the research question, the statement of the problem, the objectives of the study, the design and method. It outlines the importance and the scope of the study, provides a short literature review, discusses ethical considerations and presents the structure of the thesis.

Chapter Two this chapter summarises the existing literature on the phenomenon and phenomenological concepts. It addresses the theoretical basis of prominent phenomenologists such as Husserl and Heidegger, as well as past empirical research. The purpose is to discover gaps in the literature that the current study will fill.

Chapter Three, the methodology chapter describes the study's phenomenological approach and the procedures for gathering and evaluating data. In this chapter, the researcher's own lived experience of researching is considered. It explains how to choose participants, how to gather data (typically through in-depth interviews), and data explication are explained. Additionally, it covers ethical issues including confidentiality and informed permission.

Chapter Four this chapter presents the results of the study, here the researcher presents the explication of the essence of the phenomenon of the lived experiences of selected Grade 9 teachers' integration of Indigenous knowledge into their Natural Sciences lessons**.** Direct quotes from participants are used to illustrate their perspectives, and the essence of the phenomenon is described based on these lived experiences.

Chapter Five, in this chapter, the findings are discussed in relation to existing literature and theory. The researcher examines the implications of the findings, comparing them with previous studies, and explores their theoretical and practical significance. Limitations of the study are also acknowledged. Chapter six, this chapter summarises the key findings and their contributions to understanding the phenomenon. It reflects on the study's significance, offers suggestions for future research, and includes a personal reflection on the research process.

1.13. Summary

Chapter One is the starting point of the study and sets the scene for it by presenting the context and main elements of the study. The background to the study is introduced first, followed by an emphasis on why it is necessary to try to comprehend what is being studied. The problem statement is defined in this chapter, addressing what is at issue and what gaps in previous knowledge are to be looked at. This is followed by defining the research questions and guiding questions for investigation. The purpose of the study is also outlined in this chapter in terms of why it is important to this academic discipline. The design of this study and how it will be conducted is also outlined in this chapter. Ethical considerations are also outlined so that this study is conducted in compliance with ethical requirements. The scope of this study is also outlined so it is clear what limits are to be used. A short review of this literature is also provided so a context to this study is available early in this work. Chapter Two presents a detailed literature review and theoretical framework in much greater depth.

CHAPTER 2: LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1. Introduction

Chapter two is a literature review related to the phenomenon under consideration and the phenomenology theory. Building on chapter one, which introduced the context of the study, statement of problem, research questions and purpose of the study, this chapter presents a critical review of the literature on the identified lived experiences on selected Grade 9 teachers integration of IKS into Natural Sciences lessons. The chapter is directed toward exploring different theoretical and conceptual underpinnings of IKS integration in science teaching. The chapter reflects on how IKS is conceptualised by educators, its integration-related concerns, and pedagogy for mediating between IKS and Western scientific ways of knowing. Review of literature is critical since it provides an opportunity for anchoring of the study in existing literature, hence, determination of gaps in studies, and provides a platform for understanding IKS integration in science teaching in a nuanced way (Creswell, 2014). The literature review in this chapter is directed toward exploring major theories such as Constructivism, Sociocultural Theory, Multiculturalism Theory, Border Crossing, Collateral Learning Theory, and Argumentation Framework, which shed light on different ways learners experience IKS and Western scientific ways of knowing in a science class (Aikenhead, 1996; Jegede, 1995). Through an understanding of existing studies, this chapter attempts to identify IKS role in science teaching, its integration-related opportunities, and integration-related concerns educators may experience when attempting to integrate it in a school setting (Snively & Corsiglia, 2001).

2.1.1. Overview of the Current State of Science Education in South Africa

Science Education in South Africa is one of the most important aspects within national strategies for educational transformation, social equality, and the country's economic growth. Despite extensive curriculum transformation efforts since the advent of democratic order, there are still many inequalities in provision, quality, and outputs between traditionally well-funded schools compared to 'underfunded' schools for the less advantaged populace (Spaull & Ardington, 2022). The curriculum shaping tool, the 'Curriculum and Assessment Policy Statement' launched nationally in the country in 2011, aimed to promote standardisation of science teaching across the country, focusing on teaching 'inquiry, problem solving, and application of the curriculum' (Department of Basic Education [DBE], 2011). However, the available literature supports the view that there is inequality in the levels of application, with particular attention to socio-economic, language, and other inequalities existing across the country. Many educational facilities are still practising teaching strategies that focus on teachings in the class, with memory recall instead of cognitive mastery, pointing towards the gap between teaching strategies that are aimed for, and those practised inside the class or curriculum room (Ramnarain & Hlatswayo, 2021; Sibanda & Khoza, 2023). The legacies of inequality left by apartheid practices are still undermining the system in relation to many inadequately equipped science laboratories, overcrowding, lack of qualified teaching staff, all contributing minimally or otherwise to meaningful involvement in scientific investigation by learners across the country (Maringe & Prew, 2020).

The discourse from the last decade on science teaching in the nation has shifted toward decoloniality or the inclusion of epistemologies toward an appreciation of the need to embrace diverse practices of knowing the world. Scientists, such as Le Grange (2019) and Ndlovu-Gatsheni (2020) seem to agree on the fact that while Western science practices are prominent in the educational system, due to the diverse cultures existing in South Africa, there is a need for teaching practices that converge the experiences of the learners with science formally taught in the curriculum. This recognition has ignited an incessant debate about the inclusion of IKS in the curriculum to improve the relevance, context, and social justice in teaching science in the nation. Despite the clear support from the South African government, as formally indicated in the National Policy on Indigenous Knowledge Systems (2019), there appear to be uncertainties among teachers regarding the inclusion of Indigenous perspectives in their teaching. This is largely due to a lack of pedagogical guidance, support, and clarity within the curriculum (Mutanga et al., 2022; Makgoba and Waghid, 2021).

Also, the current literature has evidenced that scientific teaching is mostly assessment-based, with the focus on academic educational outcomes, sometimes even to the detriment of exploration, creativity, or context-based educational practices

(Ngubane & Southwood, 2022). Added to the challenges of application-driven teaching is the current condition of the educators' professional development, with insufficient long-term development available for educators on how to effectively integrate the viewpoints of Western and Indigenous sciences (Makgoba & Waghid, 2021; Sibanda & Khoza, 2023). However, some encouraging shifts have also emerged, notably in educational institutions or districts where teachers have relied on the community's body of knowledge or resources available in the environment to apply scientific teaching in a more applicable, useful, or even motivational way to learners. Such developments are representative of the current realisation, particularly among South African teachers, that scientific education must also move beyond the Eurocentric paradigm, taking on both the cognitive and the more culturally based aspects of the learning process effectively (Ramnarain & Hlatswayo, 2021). The state of science education in South Africa is characterised by ambitious policies pitting the reality of challenges. The curriculum supports inclusivity; however, inequalities, injustices, and hierarchies shape the dynamics. The way the process of dealing with these challenges, particularly with the integration of IK with Natural Sciences, is crucial in obtaining an insight into the pursuit of educational reform in the nation. The study focuses on the challenges faced by teachers of Grade 9 Natural Sciences with the incorporation of IK, Western, differently, involving the challenges/opportunities encountered.

2.1.2. Science Teaching Pedagogies and Their Development in the South African Context

The teaching of science in South Africa has also undergone much change over the last thirty years, with the educational system trying to rectify the inequalities caused by apartheid, while also attempting to bequeath the world with the demands of globally interested educators, who promote learner-focused, inquiries-based, and culturally relevant science education. The CAPS curriculum, articulated by the Department of Basic Education in 2011, focuses on the growth of learners' critical thinking, problem-solving capacities, and relevance of science in their daily experiences. However, the chasm between educational ideals and practical teaching still exists, with educators' teaching practices, to date, entailing traditional approaches to teaching that focus on the content, instead of emphasising concepts over factual recall (Ramnarain & Hlatswayo, 2021; Sibanda and Khoza, 2023).

The last decade has seen the integration of inquiry-based teaching, constructivism, the recognition of the importance of context-driven, culturally sustaining teaching practices, or all of the above gaining popularity. The South African context, Makgoba and Waghid (2021) is one in which science teaching is challenged by the simultaneous demands of the international STEM teaching standard, coupled with the national project of the decolonisation of knowledge. Research undertaken by Mpofu (2022) Mutanga et al (2022) indicates that science teachers are struggling with the incorporation of IK into their practices not because of the push-back, but because the teacher preparation was largely grounded in Western scientific practices, with scant attention paid to IK teaching practices. The movement towards decolonial pedagogy has had major impacts on science education discourse. Decolonial pedagogists conventions within the curriculum, encouraging the incorporation of learners' experiences in creating meaning for science itself (Chahine, 2021; Le Grange, 2019). This paradigmatic change neither supports the replacement of Western science with decolonial practices but the co-existence of the two to represent epistemic justice instead (Mabaso, 2020). For instance, in sustainability teaching, one can connect scientific ideas with existing agricultural practices, allowing learners to create meaning from their own experiences while also satisfying the curriculum requirement in science (Ramnarain & Hlatswayo, 2021).

Despite these advances in pedagogical practices, there are some overarching challenges that work against the application of innovative science teaching strategies in South African schools. The deeply rooted exam-focused ethos prevailing in South African school's forces educators to focus on the completion of the curriculum rather than on lived experiences or dialogical learning practices in the classroom (Ngubane and Southwood, 2022). Furthermore, the lack of resources, over enrolment, or lack of support in staff development is also hampered in the process of implementing transformative teaching methodologies in the classroom (Sibanda & Khoza, 2023). More often, staff development is solely curriculum-based but cannot help teachers gain access to culturally inclusive or IKS-driven teaching methodologies in the curriculum itself (Makgoba & Waghid, 2021).

The manner in which science is taught is also influenced by the professional identity of the teacher. Research indicates that teachers who view themselves as co-producers of knowledge, instead of disseminators, are able to more effectively implement IKS within the teaching process (Maponya, 2021; Ramnarain and Hlatswayo, 2021). Yet, these processes must also be guided by reflection, an element often neglected within the context of educator preparation programmes (Mabaso, 2020). This is mostly because the teachers end up being unsure about their own ability to deliver the indigenous worldview without undermining the scientific integrity of the information delivered (Mutanga et al., 2022). Collaborative teaching approaches also appear amongst the best practices in the integration of IKS into science teaching. Collaborative teaching promotes the involvement of teachers, elderly people from the communities, traditional healers, and community experts in the development of teaching material that combines Western scientific schools of thought with the IKS schools of thought (Odora Hoppers, 2018; Sibanda & Khoza, 2023). For example, in the teaching of plant classifications or their uses in medicines, involving community herbalists or botanists' aids in putting teaching in the context of usable knowledge in real-life settings, hence promoting greater learner involvement, which is the teachings of Ubuntu, respect for all other forms of knowledge (Le Grange, 2019).

Furthermore, the development of technology, coupled with Open Educational Resources, provides other possibilities for cooperation over the sharing of indigenous knowledge, for example, in the form of electronic databases of indigenous plants, indigenous weather forecasting, or the environment (Mpofu, 2022). Yet, without the support of the system, all these aspects are generally unofficial, relying largely on the teachers themselves (Ramnarain and Hlatswayo, 2021). In the end, the development of science teaching methodologies in South Africa is the result of the complex process of interactions between global educational ideals, on the one hand, and the South African need for an epistemological shift on the other hand. The incorporation of the study of the Indigenous Knowledge Systems (IKS) into the Natural Sciences curriculum is, from the educational ethics viewpoint, the dedication to the ideal of inclusiveness, representativity, and social justice, in the context of the South African educational system, described by (Le Grange ,2019; Ndlovu-Gatsheni, 2020). The ideal of twenty-first-century education is one that needs to provide learners with scientific literacy but also recognises South Africa's diverse intellectual and cultural heritage.

2.2. Understanding of phenomenology

Phenomenology is a qualitative philosophy-based methodology that tries to study and understand human experiences based on those who experience them. It deals with how people understand their lived experiences and interpret them. The origins of phenomenology go back to work of philosopher Edmund Husserl and were later followed by philosophers such as Martin Heidegger and Maurice Merleau-Ponty. Phenomenology holds that at least reality is our own work, and while human experiences can be sensed and so on (as in science), their ultimate nature only appears when we make a detailed study of types of intention or how people relate parts together, etc. (Creswell, 2013). Bracketing is part of phenomenological studies where researchers strive consciously to bracket away any preconceptions and assumptions, they have to encounter the participants' experiences with openness and reflectiveness (Tufford & Newman, 2012). This process allows the researcher to notice the minute details of how participants live through a particular phenomenon and capture its very essence. In phenomenological studies, data collection typically entails in-depth interviewing, observation, and in some cases, written descriptions, with the aim of gathering common patterns of meaning that reveal the very essence of the study phenomenon. For instance, in education research, phenomenology serves as a valuable approach to exploring teachers' lived experiences with implementing Indigenous Knowledge Systems (IKS) in the classroom, aiming to uncover the core of these experiences and the meanings teachers attribute to them.

By focusing on people's everyday lives, phenomenology offers an understanding of how people perceive and interpret the world around them and how they relate to it, providing rich and in-depth data beyond surface description (Creswell, 2013; Moustakas, 1994).

2.2.1 Philosophical phenomenology of Husserl

Philosophical phenomenology as formulated by Edmund Husserl is a fundamental methodology towards understanding human consciousness and experience. Husserl's phenomenology, otherwise referred to as the descriptive tradition, investigates how we experience the world around us and how such experiences are structurally constituted into consciousness. At the core of this philosophy is the concept of intentionality, where consciousness points towards something it is always pointing towards or points towards an object, material or abstract (Husserl, 1913). Husserl's phenomenology endeavours to uncover the underlying structures of experiences by describing them in their purest form unencumbered by assumptions, prejudice, and preconceptions.

Under the descriptive approach, Husserl emphasises bracketing or epoché in which judgment concerning existence and reality of the external world is suspended to solely pay attention to how it appears to us through consciousness (Husserl, 1931). This allows the philosopher or the researcher to investigate the phenomenon itself by observing how it is experienced subjectively. Through suspending the prior assumptions, phenomenologists aim to return to the "things themselves" the immediate lived experiences as they present themselves to consciousness.

Phenomenology describes the experiences as closely as possible and to distinguish the essences or universal structures of experience free from any external influence and interpretation (Giorgi, 2009). With a focus on descriptions of lived experiences, Husserl's phenomenology seeks to reveal the invariant core features of such experiences as they remain constant despite variations in perception by individuals.

2.2.2 Heidegger phenomenological philosophy

Heidegger's phenomenological philosophy develops and deepens the work of Edmund Husserl but with an evident shift in methodology and focus. Husserl's phenomenology is concerned with the descriptive dimension of experience, i.e., an analysis that is conducted in a neutral manner and without any interjection of one's own preconceptions (Creswell, 2013). Heidegger adds an interpretive aspect (or hermeneutics, as it is formally called) to this approach. As he sees it, rather than merely describing structures of experience, we are always involved in interpreting and understanding those structures because human beings always exist in touch with their world.

Heidegger's work particularly his most famous Being and Time (1927), has been as its major theme and takes as the phenomenon of our being-in-the-world. Human beings (the way Heidegger discusses elements of human existence) are not beings apart from their world. Instead, we are always already in relation to it, and understanding our own experience in this relation is informed by what is around us (Heidegger, 1927). This is a big departure from Husserl's more abstract method, in that instead of being described, meaning is situated and interpreted (Heidegger).

This shift in phenomenological methodology, from Husserl's approach to description and Heidegger's move toward interpretation, signals something important about the nature of phenomenological method. While Husserl's phenomenology strived to describe structures of consciousness and experience, interpretive phenomenology by Heidegger acknowledges understanding as a non-neutral and non-detached process based on our existence. Interpretation becomes an engaged sense-making process in the world and sense in the context of lived experience rather than abstract theoretical description. Under this phenomenological tradition, study involves an interpretation of how individuals build their existence in relation to their world. These scholars do not seek to describe the experiences but to interpret individuals' means of experiencing and making sense of their lived realities.

2.2.3 Gadamer's contribution to interpretive phenomenology

Gadamer's phenomenology and hermeneutics emphasize that understanding is an ontological event and not just a process of cognition. Understanding in Gadamer is always an interpreter-interpreted event where reason and history are engaged, and interpretation happens in the context of dialogue and prejudices. This interest in the interpretation process sets Gadamer's phenomenology apart from others as it emphasises the dialogic and historic nature of interpretation.

By emphasising the horizon of fusion and the dialogic nature of understanding, Gadamer's philosophy unlocks a more relational interpretation approach. This deviates from the scientific approach of objectivism and instead embraces the viewpoint that interpretation depends on the horizon of the interpreter and the dialogue between the subject and the interpreted entity.

Gadamer's interpretive phenomenology adopts the concern of Heidegger with human understanding and adds the dynamic and relational nature of interpretation to it. With such features as fusion of horizons, historicity, and prejudices, Gadamer offers an understanding neither static nor detached but fluid, tied by context and inescapably dialogical in nature. His philosophy transcends traditional modes of understanding and leads us to the primacy of historical context, language, and preconceptions in understanding human life. For Gadamer, meaning does not arise out of detached scrutiny but out of an engaged, interpretive dialogue between the individual and the world.

2.2.4 Phenomenology of Amadeo Giorgi

Amadeo Giorgi's phenomenological approach follows Husserlian phenomenology and rigorous methodology for analysing lived experiences (Giorgi, 2009). Giorgi developed the descriptive phenomenological psychological approach, which provides a systematic methodology for analysing human experiences by bracketing presuppositions and fidelity to participants' descriptions. His approach is of unique use in education, psychology, and social sciences because of its purpose of finding out how people live through phenomena in natural settings (Giorgi, 1997).

Giorgi bases his approach on four key philosophical and methodological pillars: epoché (bracketing), description, horizontalization, and intentionality (Giorgi, 2009). Epoché entails suspension of assumptions and biases in order to avoid projecting subjective opinions on data (Giorgi, 1997). In this process, the researcher allows the participants' original meaning of their experiences to emerge. Description is at the center of Giorgi’s approach because he holds the view that he should describe and not interpret experiences as in the case of hermeneutic phenomenology where interpretation plays an incredibly significant role (Giorgi, 2009). Horizontalization ensures all items in the participants' descriptions are treated as of equal importance before the identification of basic structures. Finally, intentionality concerns itself with the relationship between consciousness and objects such that people’s experiences are always directed towards something in the world (Giorgi, 2006). Giorgi's phenomenological five-step approach consists of (1) reading the description as a whole in order to obtain an idea of the entirety, (2) isolating the meaning units, (3) transcribing the meaning units into psychological descriptions, (4) synthesizing the meaning units into an overarching structure, and (5) checking the results (Giorgi, 2009). This step-by-step approach maintains fidelity to participants' lived realities and systematic extraction of essential meanings. His descriptive approach best applies in researching subjective realities in education, such as how teachers conceptualise and apply Indigenous Knowledge Systems (IKS) in science education.

One of the advantages of Giorgi’s phenomenology is its capacity to balance scientific rigor and human experience’s richness and depth (Giorgi, 1997). Unlike other qualitative methods, which may prioritize interpretation and subjectivity at the expense of others, Giorgi’s methodology provides a systematic yet adaptable format for investigating human consciousness in-depth (Giorgi, 2009). His methodology is most suitable in studies where participants’ words and personal meanings are at the study’s focal point as in the study of challenges experienced by Grade 9 Natural Sciences teachers in integrating IKS into their instruction.

Giorgi’s phenomenological approach in the science education and integration of IKS context allows for the collection of teachers’ lived experiences free from assumptions on Indigenous knowledge beforehand. It allows for an in-depth and authentic exploration of teachers’ successes and difficulties and how they view them and thus qualifies as a powerful tool in understanding the effect of education policy and practice on real teaching (Giorgi, 2006). Overall, Amadeo Giorgi’s phenomenological approach offers an organized yet human-oriented methodology for qualitative research and consequently a suitable methodology for exploring how people perceive and interpret complex education phenomena such as the incorporation of Indigenous knowledge in science classes (Giorgi, 2009).

2.3. Theoretical Approaches for Integrating IKS in Education

A theoretical framework is a guided window in which Grade 9 Natural Sciences can be examined in relation to IKS integration. Various theories of education give a window of understanding for IKS integration when compared to Western science. The current framework is constructed on Constructivism, Sociocultural Theory, Border Crossing, Collateral Learning Theory, Multiculturalism Theory, Collateral, and the Argumentation Framework for informing IKS integration in science education.

2.3.1 Constructivist Learning Theory

Building on Piaget (1973), and Vygotsky (1978), constructivism is premised on learners constructing an active understanding of the world based on past experiences and engagements in the environment. Students can extend current systems of knowing by adding IKS in science class, making learning more personal and meaningful. The constructivist principles, which take it for granted that learning is an active process of constructing knowledge via experience and negotiation, resonate well in IKS emphasis on observation of, and engagement in, the environment (Vygotsky, 1978). In an effort to promote a more nuanced understanding of ecosystems, learners can study about Indigenous ecological practices, such as traditional understanding of cycles of growth in plants, alongside scientific understanding of such phenomena as interactions of species in a Natural science biodiversity lesson. For Grade 9 Natural Sciences, teachers using a constructivist pedagogy must create learning environments in which students find connections between scientific concepts and traditional knowledge through discussions, hands-on experiments, and learning by inquiry (Tobin, Tippins, & Gallard, 1994).

2.3.2 Socio-constructivism

According to Vygotsky's (1978) work, socio-constructivism is a learning theory which assumes that knowledge is constructed socially in relation to others. This is a critical issue in teaching Indigenous Knowledge Systems (IKS) in Grade 9 Natural Sciences, as it is rooted in culture, social context, and co-operation in learning. In a socio-constructivist learning situation, learners play an active role in discussion, group work, and learning by discovery, co-constructing understanding based on Western scientific concepts and IKS (Driver, Asoko, Leach, Mortimer, & Scott, 1994).

Integrating IKS in a socio-constructivist learning process allows learners to make scientific understanding relate to everyday experiences and culture. Western science and IKS, however, have different perspectives of the world, as postulated by Aikenhead and Michell in 2011. Western science can, however, be integrated with IKS when it is presented in a way inclusive of learners' cultures. In this process, learners have room for rich discussions, trading traditional practices, and critical analysis of how IKS is aligned, or diverges, from scientific concepts. Through this process, learners come to enjoy different forms of knowledge, hence reducing science being approached in Western perspectives in exclusivity (Ogunniyi, 2007).

However, this integration is difficult for various educators due to a lack of pedagogy training and teaching materials (Jegede, 1995). Educators in a socio-constructivist learning environment have a role of being a facilitator, orchestrating discussions on integration of IKS and scientific principles, and challenging learners to think about learning. For example, educators can incorporate learners in project learning in which learners learn traditional practices in agriculture, traditional medicine, or purification of water, comparing these practices with scientific practices in modern time (Shizha, 2013). Through this, learners come to have an improved understanding of IKS applicability in modern science as well as constructing learning in an active process of collaboration and questioning.

2.3.3 Border Crossing Theory

The Border Crossing in science learning by Aikenhead (1996), is a cognitive and a process of culture transition when learners make a transition between everyday world understanding and scientific concepts in class. In instances of Western science and Indigenous Knowledge Systems, border crossing is about learners struggling in balancing different worldviews (Aikenhead, 1996). For many learners who belong to culturally different, in this case, especially Indigenous, backgrounds, science is a foreign culture, which calls for learners switching between traditional understanding and Western, school-formalised science. If border crossing is poorly managed, learners can end up being alienated or misinterpreting scientific concepts, which leads to disengagement or misconceptions of scientific concepts (Aikenhead & Jegede, 1999). When IKS is embedded in Grade 9 Natural Sciences in class, it provides opportunities and challenges for border crossing. Students have prior Indigenous knowledge of phenomena in nature, such as traditional medicine, farm practices, and care for the environment, which can diverge from scientific explanations in textbooks. If this prior knowledge is not legitimised and recognised, students can experience challenging border crossings, in which science is foreign, rigid, and unapproachable material for them (Jegede & Aikenhead, 1999). This can result in so-called cultural discontinuity, in which students struggle to identify with material due to an extreme difference between science being introduced in class and their culture (Ogunniyi, 2007).

To facilitate border crossings, educators must apply pedagogies of a culturally responsive type, which locate and incorporate IKS in a major way in science education. This can be made achievable by teaching scientific concepts alongside Indigenous explanations, discussing in a way in which students can make comparisons and differences between the two systems, and involving community elders or traditional holders in learning (Msimanga & Shumba, 2021). For example, when learning about medicine plants, educators can teach traditional uses of plants and biochemical mechanisms underlying medicinal properties, so students can make connections between the two systems of knowledge.

Still, among the primary barriers for integration of IKS in science education is a lack of clearly developed curriculum guidance and educator capacity. Educators themselves may not have been well-trained in border crossing between IKS and Western science, which leads to patchy, superficial integration attempts (Mosimege, 2020). In the absence of support, educators may perpetuate Western science dominance, inadvertently stigmatising IKS as unscientific, lower, and therefore, undeserving. This necessitates professional capacity-building programs for preparing educators for border crossing so learners can learn about, respect, and integrate both systems of knowing in a proper, balanced, and non-hierarchical way (Aikenhead, 2001). Broadly, border crossing is a critical conceptual tool for understanding teaching strategies and barriers for teaching IKS in Grade 9 Natural Sciences. With an understanding of learners' cultural conflicts and an embracement of inclusive pedagogy, educators can create learning environments in which learners can transition between Western and Indigenous ways of knowing in a comfortable manner. This not just enhances scientific literacy, it results in a greater understanding of ways of knowing, which makes science education a more holistic and culturally appropriate experience (Ogunniyi, 2007).

2.3.4 Collateral Theory

Jegede (1995) developed the Collateral Theory of Learning, which depicts how IKS, and Western scientific thinking coexist in the experience of non-Western learners. According to the hypothesis, students from non-Western cultures coexist in two modes rather than abandoning the IKS worldview in favour of Western scientific thinking. Depending on their experiences, students can integrate, separate, or blend these two systems of knowledge in many ways. This is especially true in Grade 9 Natural Sciences, where students are required to grasp scientific ideas that may be culturally incongruous.

Parallel collateral learning is when students have separate cognitive systems for IKS and Western science and never attempt to integrate these. Dependent collateral learning is when students first depend on an Indigenous worldview, and Western scientific explanations eventually shape a modified worldview. Secured collateral learning is when students discover a mechanism for balancing both systems of knowing, reaching cognitive balance. Lastly, simultaneous collateral learning is when students integrate an understanding of an Indigenous and scientific worldview contemporaneously. The process of learning reflects sophistication in using IKS in science education in schools and emphasises the need for teaching practices which respect and support diverse ways of knowing (Jegede & Aikenhead, 1999). Collateral learning theory can help Grade 9 Natural Sciences teachers plan teaching strategies for identifying and honouring Indigenous ways of knowing and weaving these in a complementary relationship with scientific ways of knowing. For instance, teachers can make use of storytelling, community sharing of knowledge, and hands-on demonstrations in teaching scientific concepts in an Indigenous context (Ogunniyi, 2007). This makes science more interesting for learners, in addition to developing critical thinking and cognitive adaptability. With a lack of guidance and workshop support, however, most educators struggle to make these connections, resulting in superficial, patchy integration of IKS in science learning (Msimanga & Shumba, 2021). Application of collateral learning theory in teaching science in Grade 9 requires educators to create a culturally responsive learning situation in which IKS is recognised as scientifically valuable. Teachers have an obligation of discussing, which allows for opportunities for learners to make connections between new scientific concepts and prior learning and doing so in a critical way. This enables learners to mediate between Western science and IKS in a productive way, ultimately enhancing scientific literacy and culture identity (Aikenhead & Jegede, 1999).

2.3.5 Multicultural Theory

Multicultural theory is based on recognition and respect for various cultures in learning environments (Banks & Banks, 2019). This is particularly so when teaching Grade 9 Natural Sciences based on Indigenous Knowledge Systems (IKS), as it provides a school program which includes contributions and experiences of various cultures (Banks, 2008). Multicultural education aims for a learning community in which all learners can see and identify themselves and cultures in the school program, and hence a sense of belongingness and interest (Ladson-Billings, 1994).

Integrating IKS in a multicultural system allows educators to counter Western scientific paradigms of dominance by taking on Indigenous perspectives of nature, environmental responsibility, and sustainability. By teaching scientific concepts alongside traditional knowledge, educators can make students notice the applicability of IKS in addressing current environmental issues and expand on scientific inquiry (Aikenhead, 2001). For instance, when teaching concepts of ecosystems or resource management, educators can guide students in examining ways in which traditional societies have been in relationship with environments, highlighting practices for biodiversity and sustainability (Battiste, 2013).

Still, successful integration of IKS in a multicultural science program requires educators to acquire culture competence and awareness of learners' diversities (Gay, 2010). Educators have a responsibility to ensure there is a learning culture of inclusion in which all learners have a chance to contribute based on experiences and understanding. This can be achieved in group discussions, collaborative project work, and culturally related materials, which assist learners in making connections between IKS and scientific principles. For example, learners can collaborate on projects comparing traditional environmental knowledge and current scientific practices in environmental management and conservation (Berkes, 2012). To summarise, employing multicultural theory in teaching IKS in Grade 9 Natural Sciences not just makes learning richer, it also improves critical thinking, respect for other systems of knowledge, and an enhanced understanding of scientific principles among learners (Dei, 2000).

2.3.6 Argumentation Framework

Argumentation is a critical science learning skill, emphasising reasoning, critical thinking, and being able to engage in discussions for assessing different views (Erduran, Simon, & Osborne, 2004). For the integration of Indigenous Knowledge Systems (IKS) in Grade 9 Natural Sciences, argumentation provides a platform for learners to inquire and compare scientific concepts and traditional knowledge. This integration allows learners to represent an understanding of each of these systems of knowledge and asks learners to debate and critique the applicability and validity of IKS in scientific argumentation (Dawson, 2014).

Challenging students to debate IKS is about creating a class culture in which various perspectives are valued and respected. Students can be invited by educators to think about questions such as ways in which customary environmental practices enhance sustainable utilisation of resources or ways in which concepts of the environment in Indigenous worldview intersect, agree, or disagree with Western scientific hypotheses (Aikenhead & Michell, 2011). Through debate in which students have to argue for a stance, give evidence, and counter argue, educators help students achieve a greater understanding of IKS-Western science interconnections and nuances (Kuhn, 1991). For example, in an IKS unit on biodiversity, students can be requested to debate new vs. traditional forms of agriculture. The debate, aside from refining students' argumentation, inculcates a greater respect for the value of IKS in addressing current environmental issues (Hodson, 2008). Secondly, teaching argumentation in an IKS class can help students learn critical thinking on information, making well-informed decisions, and productive discussion of different perspectives (Driver et al., 2000).

To conclude, integration of argumentation in Grade 9 Natural Sciences studies involving IKS not only improves learners' understanding of scientific concepts, but it also develops critical thinking along with respect for other systems of knowledge, preparing them for today's globalised world challenges (Sadler, 2006).

2.4. The conceptual framework for IKS integration in Grade 9 Natural Sciences

The conceptual framework is based on interdependence among pedagogy, knowledge systems, and enactment of curriculum. The structure helps in grasping IKS integration in class in a productive balance between Western scientific and Indigenous perspectives. The conceptual structure is required for informing educators about IKS integration in a well-organised, productive, and culturally appropriate manner (Mosimege, 2020).

Central to this conceptual framework is an understanding of IKS and Western science as sources of scientific knowledge, each of which can contribute valuable insights on understanding phenomena of nature. IKS is traditional, community, and holistic knowledge constructed by Indigenous societies over time, based on experience, observation, and spiritual understanding of nature (Ogunniyi, 2007). Western science, on the other hand, is experimental evidence, observation, and systematised experience, traditionally expressed as objective and universally valid (Aikenhead, 2001). While these systems of knowing have traditionally been conceptualised as separate, and in some instances, in competition, each can be integrated in ways which can enhance learning and enhance understanding of scientific concepts for students (Aikenhead & Jegede, 1999).

The key concept in this paradigm is border crossing, which is cognitive and cultural transitions between scientific school science and students' home-based IKS (Aikenhead, 1996). If students experience a smooth border crossing, learning science is possible in a prior experience and culture-based way, making learning personal and accessible. If, on the other hand, teachers fail to consider students' IKS, students experience difficult border crossings, which lead to confusion, withdrawal, or outright rejection of science as a science of pertinence (Jegede & Aikenhead, 1999). This necessitates taking pedagogy in schools in a direction of making connections between IKS and scientific concepts in school science.

Another key element of the conceptual framework is collateral learning, which outlines how learners co-exist in mind in different, usually conflicting, systems of knowing, though not necessarily in a cohesive whole reconciled (Jegede, 1995). For example, a learner can have a scientific understanding of the rainmaking process and a spiritual understanding of rainmaking rituals. Collateral learning suggests that in place of asking learners to make a dichotomous choice between Western science and Indigenous knowledge, educators can create learning environments in which each is valued and interrogated in a critical way (Jegede & Okebukola, 1991). This is not a question of respecting difference; it is a question of encouraging learners to think more abstractly by comparing and analysing different forms of knowing.

The integration of IKS in Grade 9 Natural Sciences learning must incorporate a multicultural education pedagogy, which is inclusive and accepts students' diverse cultures (Banks, 2008). This necessitates employing culturally responsive pedagogy, such as experiential learning, storytelling, and integration of community, in science teaching using IKS (Msimanga & Shumba, 2021). For example, when teaching medicinal plants, traditional healers can be invited in class to explain traditional medicine alongside scientific explanations of biochemistry in plants. This is a respect for IKS, but it ensures learners have a well-rounded understanding of scientific concepts.

Furthermore, it is a conceptual framework that gives priority to adaptation of the curriculum and educator professional growth. The largest barrier in adopting IKS in science education is a lack of guidance and organised materials for educators (Mosimege, 2020). Educators themselves say they have been inadequately trained and pedagogically unprepared for teaching IKS. In a bid to address this, it is recommended in this framework that workshop sessions, curriculum redesign, and peer learning sessions in which educators can acquire best practices on utilising Indigenous knowledge in science class be introduced (Ogunniyi, 2007).

Integrating Indigenous Knowledge in science and education curricula is imperative in addressing multiculturalism, sustainability, and respect for diverse ways of knowing (Aikenhead & Ogawa, 2007). Educators, however, struggle to integrate it due to a lack of guidance and pedagogy (Msimanga & Shumba, 2021). Integration of Western and Indigenous systems of knowledge must be a joint effort of educators, Indigenous experts, and policy planners so that Indigenous Knowledge is recognised, conserved, and embedded in learning contexts appropriately (Moore, 2012).

2.5. Historical and Cultural Relevance of IKS

From millennia of experience, observation, and living in relation to their natural environments, complex systems of knowledge developed in Indigenous societies. Indigenous knowledge is holistic in its place, positioning human beings in a system of ecosystems, which is different compared to Western scientific practices, which concentrate on abstract, disjointed data (Berkes, 2018). Crop planting companions, for instance, and crop rotation, which is an example of indigenous ways of managing crops, illustrate rich understanding of well-being in soil and biodiversity, concepts which underpin modern ecology (Turner et al., 2000). Transmission of data on phenomena in nature is in rituals, storytelling, and experiential experience in relation to the environment. This data is embedded in spiritual values in a number of Indigenous cultures, so data is conserved for its utility and for its cultural and moral worth (McGregor, 2004). For instance, inhabitants of the Amazon have developed a great understanding of forest ecosystems, which underpin forest harvesting and forest conservation in a sustainable manner in this community (Maffi, 2001).

Natural Sciences IKS is closely aligned with a variety of Indigenous cultures whose worldview is based on seeing humans as part of a wider, inter-related web of existence. The more human-centric perspectives of Western science, which too readily see humans and nature as distinct entities, stand in great contrast to this (Nabhan & St. Antoine, 2008). For example, fire management is a process followed by a variety of Indigenous tribes of North America in keeping ecosystems healthy. In addition to preventing fires, judicious use of fire is a critical environmental practice maintaining biodiversity and animal and plant well-being (Pyne, 2007). TEK is characterised by a great stress on respect for, and a focus on, living sustainably in relation to, the natural world, concepts which modern science is struggling increasingly to incorporate. In aiding societies in preparing for, and coping with, change in the natural world, indigenous systems of knowledge may involve observations of weather patterns, animal patterns of behaviour, and environmental cycles on a time scale of years, decades, and in a few instances, millennia (Berkes, 2018).

The growth and spread of indigenous systems of knowing were severely undermined by the entry of colonising forces. Western colonisation constantly downgraded IKS, which imposed systems of formal education, which branded it as unscientific or outdated. Many of these traditional ways of knowing have been lost due to this marginalisation, especially in sciences such as in agriculture, medicine, and environmental care (Battiste, 2000). Different Indigenous societies have made efforts in preserving their systems of knowledge despite these barriers, usually helped by elders, traditional keepers of traditional knowledge, and community-led efforts. IKS is on a rising trend in popularity, especially since modern studies find solutions for environmental concerns such as biodiversity loss, climate change, and sustainable utilisation of resources (Berkes, 2018).

Indigenous Knowledge Systems is of great cultural importance in Natural Sciences for its usefulness and its role in shaping Indigenous people's worldview and identity. IKS is a source of Indigenous people's relationship with ecosystems and territories and is usually inextricable from practices, language, and religion (Maffi, 2001). In a vibrant culture, humans acquire an understanding of ecosystems, animals, and crops in ceremonies, storytelling, and collective rituals. For the Indigenous, integration of IKS in science is a vehicle of rejuvenation of culture. For McGregor (2004), it is a tool for empowering certain Indigenous students by exposing them to pedagogy systems which honour their heritage and scientifically educate them. Such a process is boosted by enhanced recognition of Indigenous people as keepers of knowledge and active contributors in scientific studies.

The contribution of IKS toward addressing environmental concerns of today is now clearer in recent years. The environmental tradition of Indigenous people is shown to have been effective in managing and conserving resources. For instance, in a quest to mitigate fires and preserve biodiversity, traditional fire management of Indigenous people is now a part of modern Australian conservation practices (Gammage, 2011). Wildlife conservation in Canada draws its guidance on traditional land management of Indigenous people, which includes sustainable fishing and hunting practices (Turner et al., 2000). IKS 'increased visibility in the natural sciences testifies to its great integration in Western scientific practices. With its more abstract or universal orientation, modern science may overlook or downplay precious observations IKS makes about local ecosystems. The integration of IKS introduces new insights for sustainable environmental management since climate change, resource depletion, and biodiversity loss continue to pose threats in ecosystems throughout the globe (Berkes, 2018).

2.6. The Benefits of Integrating IKS in Natural Sciences education

Among the greatest advantages of adopting IKS in Natural science is inculcation of environmental responsibility. Years of experience in managing ecosystems and a thorough understanding of ecosystems have made Indigenous societies develop sustainable practices in managing resources and preserving biodiversity. The traditional Ecological Knowledge, for instance, provides valuable insights on sustainable utilisation of land and resources, such as rotations of crops, controlled burning, and practices of conserving water (Berkes, 2009). Students acquire a greater understanding of sustainability beyond Western scientific thinking by adopting these practices in science. The management system, which uses controlled burns to prevent bushfires (Simpson, 2004). Because of this integration, students may be encouraged to take modern environmental challenges more seriously and to adopt a more sustainable resource use. The comprehensive framework for ecosystem management is illustrated in the Australian firestick alliance, where ecosystems are regulated, and bushfires mitigated using controlled burns (Simpson, 2004).

Integrating Indigenous systems of knowledge in Natural science studies can assist in empowering Learners in realising the value of each of these systems of understanding and in filling in the gap between Indigenous understanding and Western scientific understanding. Integrating science education using Indigenous knowledge, as envisaged by Aikenhead (2001), enables learners to comprehend science as an interpretation process of culture and learning in contexts, in parallel with a body of objective facts. Learners can come to a mature understanding of scientific phenomena by honouring scientific and Indigenous perspectives. For instance, Western environmental concepts and ways of doing things can be used in teaching biodiversity conservation in environmental science. Western science can concentrate on learning about species populations and habitat conservation, and Indigenous ways of doing can stress a relationship of interdependence of human and land and a mutually interdependent relationship between human and environmental relations (Puhl & Aikenhead, 2007). Many ways of seeing exist and coexist in an inclusive learning community constructed by this dual understanding.

Integrating IKS in the study process shall enhance inclusion of cultures since respect for Indigenous cultures is instilled. Since in traditional Western science studies, their culture practices and systems of knowledge are downplayed or overlooked, various Indigenous students may end up being alienated. With integration of IKS, educators provide an inclusive classroom which affirms Indigenous students' culture and ways of knowing, hence making them active and motivated in class (Simpson, 2004). Introducing IKS among non-Indigenous students results in a greater understanding of human variety of knowledge and views. Students who study about Indigenous ways of knowing can clearly identify about variety in cultures and dispel myths, which results in a greater inclusive and considerate learning community in class, argues Sillitoe (1998). In Booi (2015), the integration of IKS within the study of Natural Sciences is offered as a powerful way to improve the science knowledge of the student. With the blending of Indigenous knowledge and formal scientific principles, the student is exposed to the world from a more holistic point of view and is able to understand science as a dynamic and multifaceted field of study. Despite the challenges of teacher preparedness and the blending of two knowledge systems, the reward of a more comprehensive and contextual science curriculum is high. IKS in the Natural Sciences has the capacity to bridge the gap between Western science and Indigenous ecological knowledge. The Indigenous people possess comprehensive knowledge of the natural environment, plants and animals, weather and weather patterns, and ecosystems. This is passed orally based on long-term observation of the natural world. Including it in the curriculum of the Natural Sciences equips the learners with deeper knowledge of the principles of science and informs them that science is not limited to Western approaches (Booi, 2015).

When IKS is embedded in Natural science, learners can think creatively and critically about complex environmental questions. IKS is usually experiential, place-specific, and holistic, so in solving a problem, learners must take account of a variety of different ecological, social, cultural, and ethically based factors. This contrasts with Western science, which is usually reductionist in its orientation, separating factors in controlled environments. Learners can acquire great problem-solving capacity by studying case studies in which IKS has been used in addressing environmental concerns in each location, such as fishery rejuvenation or forest regeneration. One example of an IKS solution being directly used in addressing a current environmental question is in utilising Indigenous fire practices in controlling fires in North America, which have been shown to suppress wildfires and preserve biodiversity (Berkes, 2009). Learners who learn about these solutions in operation have a greater understanding of science by relating abstract concepts and actual usage.

By presenting different views of naturally occurring phenomena, IKS makes science teaching richer when it is integrated. Through experience and observation over millennia, traditional societies have developed rich, complex systems of knowing which can give valuable insights on such topics as astronomy, ecology, medicine, and agriculture. For example, in relation to Western hypotheses about astronomy, Indigenous astronomical knowledge of stars and celestial navigation provides a different, valid understanding of the universe (Aikenhead, 2001). Educators can expand learners' views and help learners learn more about all forms of knowing being interrelated by embracing these different views.

2.6.1 Challenges and Hindrances in Integrating IKS

There are various advantages of utilising IKS in Grade 9 Natural science, though there is a drawback. Such drawbacks may hamper successful integration of IKS in schools and may call for careful discussion, planning, and collaboration between educators, Indigenous societies, and lawmakers. One of the major barriers in utilising IKS in Grade 9 Natural Science is a dearth of appropriate teaching training and professional development. IKS can be misconceived, oversimplified, or misrepresented in class due to unfamiliarity of IKS among many educators (Simpson, 2004). Educators may be ill-trained in utilising IKS in an effective way in science teaching unless trained appropriately. Lost learning opportunities for students can be caused by educators' unfamiliarity about ways of relating IKS and Western science in a meaningful way.

Education systems may resist inclusion of Indigenous perspectives, especially in states emphasising standardised curricula. Teachers may be restricted by national or regional expectations emphasising Western scientific knowledge, and there is a rigidity in many curricula. The historical marginalisation of Indigenous cultures, unfamiliarity with IKS as a valuable contribution, and a preference for more traditional pedagogy can all contribute to this reluctance (Battiste, 2002). Teachers may find it difficult to integrate oral tradition, storytelling, or worldview holism in a science curriculum dominated by experimental procedure and empirical facts.

Oftentimes, there is a dearth of accessible, credible materials and sources for inclusion of IKS in studies of natural science. The science textbooks and teaching materials, which have a Western scientific orientation, seldom, if ever, mention Indigenous knowledge. For McGregor (2004), it is hard to incorporate Indigenous knowledge in government-approved learning materials since it is usually verbally shared or in culturally specific ways. Educators find it hard to incorporate IKS in studies when there is a scarcity of culturally appropriate learning materials. It is hard to find textbooks, let alone course outlines, which portray Indigenous knowledge in a credible and respectful way, especially in environmental science, which may incorporate traditional ecological knowledge.

Students' attitudes and motivation in IKS in Grade 9 science learning is shown to enhance interest in learning and foster positive attitudes toward science and toward Indigenous cultures. With IKS integration, science is made accessible and meaningful for learners, and especially for Indigenous learners who can make connections between school learning and their traditional ways of knowing. Such relatedness is a powerful driver of interest and enthusiasm in learning (Pihama, 2017). Integration of Indigenous environmental ways of knowing and traditional ways of doing, in addition, allows learners to think more analytically, challenging them to make comparisons and analyse different ways of knowing (Barnhardt & Kawagley, 2005). Educators who integrate IKS assist in making a culturally inclusive learning community, which is a determinant of enhanced relations between educators and learners, and of enhanced motivation among learners (Canadian Teachers' Federation, 2015).

Natural sciences for Grade 9 are an education paradigm-shifting approach to make scientific education more inclusive and relevant. In appreciation of the strength of Indigenous perspectives, teachers have a platform to enrich their curricula, hence enabling students to have better understanding of ecological and biological fundamentals. Such incorporation, apart from respecting diverse heritage and practices of Indigenous societies, enhances thinking and problem-solving ability by exposing students to diverse modes of understanding. Such incorporation also enhances appreciation and empathy for culture, hence enabling diverse celebratory classrooms. As students encounter both standard scientific understanding and Indigenous understanding, students have better understanding of the world, and hence, better tools to address contemporary world problems. Lastly, such incorporation of IKS in official education is an innovative approach to inclusive and holistic learning environments.

2.6.2 Teachers' Perspectives on IKS in Science education

Science educators' beliefs regarding IKS play a critical role in determining whether and in which manner it is included in curriculum. Such beliefs are highly variable, with some science educators regarding IKS as a complementary addition to Western science, while some think that IKS is independent, second-rate, or in contradiction with science (Aikenhead & Michell, 2011). Teachers who conceptualise IKS as crucial in science learning attempt incorporating it into the curriculum, as they are assured that IKS presents students with a more holistic picture about science. Teachers who conceptualise IKS as having a role in environmental sustainability, healthcare methods, as well as in agricultural growth (Onwu & Mosimege, 2004), are more likely to integrate local IKS into curriculum. Such educators are likely to make science more locally relevant as well as engaging. Despite a supportive attitude from some science educators, a lack in pedagogic competence as well as in resources tends to hinder effective incorporation.

2.6.3 The Role of Language and Diversity in IKS Integration

Language is crucial in implementing Indigenous Knowledge Systems (IKS) in Grade 9 Natural Sciences because it is a channel through which understanding is communicated. But in pedagogy in IKS, linguistic difference is a source of common challenges. Many concepts in Indigenous knowledge are embedded in local languages, which makes it difficult to translate these into a language of study that is predominantly English or Afrikaans in schools in South Africa (Brock-Utne, 2017). The linguistic divide can lead to misunderstanding or simplification of Indigenous knowledge, which makes it lack depth as well as its meaning in culture (Msimanga & Lelliott, 2014). For instance, some terms in Indigenous describing environmental systems or medicinal plants lack equivalents in Western science jargon, which makes meaning shift once adopted into a curriculum (Ocholla, 2007).

Also, students from varying cultural contexts understand IKS in a different perspective in relation to experiences as well as beliefs. Some students are easily able to relate with IKS because they have a background in a culture that is supportive towards it. Other students, mainly from urban areas, can be in a dilemma as far as its application in science is involved (Aikenhead & Ogawa, 2007). The variation in understanding can lead students who believe that IKS is outdated or not relatable with advancements in contemporary science (Keane, 2016). The existence in a classroom of more than a single culture also means that educators have to be in a position to present IKS in a way that does not alienate a single culture (Mavuru & Ramnarain, 2021). Teachers navigate linguistic as well as cultural heterogeneity in a classroom with a range of strategies that allow a transition between Western as well as Indigenous forms of understanding. Code-switching is a common strategy in which a teacher switches between a local language as well as a language of instruction in order to allow learners' understanding of problematic concepts (Setati & Adler, 2000). Teachers can also resort to narration, proverbs, as well as demonstration as a means to make IKS more accessible as well as more engaging (Onwu & Mosimege, 2004). Students' common experiences with IKS from native culture can also allow a more participative as well as more inclusive classroom (Shizha, 2013). The success with these strategies is predicated on a teacher's comprehension of IKS as well as a teacher's competence in meaningfully incorporating IKS into a curriculum despite common language as well as culture barriers (Ogunniyi, 2007). Overall, linguistic as well as cultural diversity are key in making IKS a component in Grade 9 Natural Sciences. The failure in effective transfer from Indigenous forms into the official language of instruction, as well as learners' varying experiences in culture, presents challenges that must be addressed with care by teachers. To integrate IKS meaningfully, educators must adopt inclusive pedagogies, i.e., code-switching as well as culture-based pedagogies, in order to enable all learners to meaningfully engage with Indigenous knowledge. Teacher training in linguistic as well as culture-based approaches in science pedagogy is essential in order to produce a more holistic as well as more inclusive learning environment.

2.7. Guiding principles in integrating IKS in Natural sciences

Integrating Indigenous Knowledge Systems (IKS) into Grade 9 Natural Sciences requires systematic strategies, innovative pedagogical approaches, as well as local as well as educational system assistance. A couple of case studies have established that IKS can be implemented successfully by incorporating local knowledge into science curriculum, contextualising learning material, as well as engaging with custodian elders from local communities. For example, a study conducted in South Africa by Keane (2016) established that in rural schools, traditional environmental knowledge was used by teachers in order to explain environmental science principles such as biodiversity, conservation, as well as ecologically appropriate farming. In making traditional farming methods compatible with contemporary agricultural science, learners experienced a sense of relevance between IKS in application in contemporary science, which made learners more engaged with the curriculum. Similarly, in a study conducted by Mavuru as well as Ramnarain (2021), students experienced more interest as well as understanding in science principles whenever traditional lore, myths, as well as culture artifacts are made use of in order to explain science principles.

Some strategies can be adopted in order to integrate IKS into the curriculum in the field of Natural Sciences. A strategy is curriculum adaptation, wherein formal science is blended with Indigenous knowledge in a systematic way. Teachers can, for example, compare Indigenous ways of forecasting the weather, i.e., reading clouds and animal behaviour, with meteorology (Onwu & Mosimege, 2004). Experiential learning is another effective approach wherein students are involved in direct experiences in Indigenous activities, i.e., preparation of medicinal plants or water-purification methods, followed by analysing these methods with science principles (Shizha, 2013). Not only does it legitimise Indigenous knowledge, but critical thinking is also enhanced as learners are encouraged to compare as well as analyse contrasting bodies of knowledge. Partnership with Indigenous holders is another essential approach wherein local practitioners, such as healers and farmers, can be invited into classrooms in order to speak about experiences as well as provide live demonstrations (Ogunniyi, 2007). Some schools in Canada as well as in New Zealand have successfully implemented this strategy wherein science educators co-teach with Indigenous elders in order to integrate culture perspectives into curriculum (Aikenhead & Ogawa, 2007).

Despite its promise of effective integration, challenges persist, including a lack of pedagogic competence in teachers as well as a lack of suitable instructional material. To address these challenges, training in IKS pedagogy is essential in a way that ensures that the teacher is both knowledgeable as well as having confidence in incorporating Indigenous principles in curriculum (Msimanga & Lelliott, 2014). In addition, IKS-compliant textbooks as well as digital resources will create a convergence between Western as well as Indigenous forms of knowledge, making it more likely that teachers will adopt IKS in a systematic approach (Ocholla, 2007). Policymakers are also involved in reforming methods of examination in a way that IKS is made compatible with traditional methods of examination, from Western-based forms towards incorporating forms that are more appropriate in Indigenous contexts, i.e., narration, demonstration as well as oral presentation (Setati & Adler, 2000).

In sum, incorporating IKS into Grade 9 Natural Sciences calls for a multidimensional strategy that encompasses curriculum reform, experiential learning, partnership with Indigenous knowledge keepers, as well as teacher development. Successful experiences from South Africa, Canada, and New Zealand affirm that learners achieve a more complete understanding of science, with a deeper appreciation for multiple ways of knowing. But for effective and enduring incorporation, teachers have to be sufficiently trained, equipped with suitable resources, as well as supported at the level of institutions. In the future, stakeholders in education have a shared obligation to produce a science curriculum that is inclusive as well as contextually appropriate, which respects and incorporates Indigenous knowledge in a genuine manner.

2.8. Summary

Chapter two was a critical review of literature and theory relating to this study. It considered in depth the essential principles of phenomenology, specifically Husserl and Heidegger's work, and how these philosophical insights influence the type of inquiry in this study. The chapter also reviewed previous empirical studies examining similar phenomena to establish gaps and where this investigation will be able to contribute meaningfully. By looking at these empirical findings and theoretical foundations, Chapter two established a foundation for what is to be understood in this phenomenon and established a need for this investigation. Expanding on this theory foundation provided in chapter two, chapter three will outline the methodology to be used to study the phenomenon. While Chapter two gave a detailed insight into literature and theory considerations, chapter will outline how this insight will be translated in the study design. This chapter explains in detail what type of study design will be used, data collection methodology, data analysis and data interpretation based on the phenomenology discussed in this work. The chapter outlines how the participants were selected and what instruments were used to collect data, and how Giorgi’s phenomenological approach will be used to analyse.

CHAPTER 3: METHODOLOGY

3.1. Introduction

This chapter builds upon the theoretical foundation laid out in Chapter Two which presented about basic concepts of phenomenology as well as the existing literature on the phenomenon. It further to introduces the philosophical perspectives as well as outlining the research framework that guides the study. The phenomenological investigation was made up of a systematic series of stages (phases) for investigating Grade 9 Natural Science teachers integrating IKS into lessons. This process began with the framing of what was to be inquired into the experiences of teachers, living those experiences of integrating Indigenous Knowledge Systems and being bounded by the official science curriculum. Second, bracketing (epoché) was employed as the researcher put aside personal assumptions and preconceptions and attempted to engage directly with participants' experiences. Next was data gathering through in depth interviews that provided participants an open space to narrate stories with full details. The next step, horizonalization, involved tabulating key statements attached to the data and treating them equally for patterns to be identified. These patterns were then grouped into thematic families during thematizing and clustering and like thoughts placed together into broader groups such as time-barrier, support barrier, and cultural barrier. When themes were identified, textural descriptions (what they lived) were developed and structural definitions (how and what) generated which linked to an integration to the process of the synthesis of what constituted the experience. This synthesis of experience is what everyone was on about, and in return, it provided a snapshot of what the incorporation of Indigenous knowledge into e education might look like – its difficulties and complications. To explain the methodological approach used in this study, the process of carrying out phenomenological research described in detailed. Figure 3.1. illustrates major phases of phenomenological investigation from defining the phenomenon to interpreting the participants' experiences of living.

Figure 3.1: A process for doing phenomenological research

(Creely, 2016, p. 9)

3.2. Ontological and Epistemological Position

Ontology refers to the nature of reality and epistemology refers to the nature of knowledge and how knowledge is acquired (Crotty, 1998). The ontology adopted by this study is interpretivist in nature which assumes that reality is socially constructed and is subjective because it is influenced by individual experience and interactions (Bryman, 2016). This shaped the study's application of phenomenology to allow for the consideration of teachers' own experience within their own contexts.

The researcher's epistemological stance is constructivist in orientation, believing that knowledge is co-constructed in experience and social interaction (Lincoln & Guba, 1985), which guided the selection of unstructured interviews and field notes as primary data-gathering strategies. By having teachers narrate in their own words, the researcher aimed to gain a rich and contextualised understanding of IKS integration in classrooms.

To understand the ontology and epistemology of lived experiences of Grade 9 teachers who implement Indigenous Knowledge Systems (IKS) in Natural Sciences education, it is essential to explore philosophical foundations informing the interpretation of their experiences and how knowledge on their integration of IKS is generated. Mabodoko's (2017) ontological and epistemological foundations of phenomenology are consistent with the basis of instruction which focus on integrated development of a learner. Ontology is questioning of 'being' and with 'what is', namely, existing and form of such reality (Crotty, 1998) or what is known about the world (Snape & Spencer, 2003). For Richards (2003), ontology is about making assumptions about kind and character of reality and about what there is. Snape and Spencer (2003) have also described ontology as the character of world and about what is known about it. In addition, Bryman (2008) proposes an account of 'social ontology', and explains it as a consideration within research, a consideration about character of social entities, namely, whether such social entities are or are able to be objective entities which exist separately from social actors or else, they are social constructions in and of themselves fashioned out of individual's perceptions, actions and interpretation within society. In brief, ontology is concerned with our ideas about sort and character of reality and of social world (what is).

Ontology concerns reality, that is, what exists and is real. In terms of Grade 9 teachers' integration of Indigenous Knowledge Systems (IKS) in Natural Sciences, ontology would try to comprehend: Teachers' lived realities involve several realities in which Western science and Indigenous knowledge coexist and inform each other. Teachers' ontology in such integration would view IKS as a real and authentic system of knowing providing an alternative perception of knowing about the world, in contrast with Western scientific approaches' dominant, empirical epistemology. In ontological terms, IKS is not a theoretical entity but an actively lived and experienced reality for teachers and students, shaping them in terms of living in and with the environment and surrounding world. IKS is a relational, a whole view of the world in which humans, nature, and the spiritual sphere interrelate and interpenetrate each other. Teachers can have a reality in flux in which both scientific and Indigenous knowledge must be negotiated and sometimes synthesised with each other (Aikenhead & Jegede, 1999). That makes IKS integration reality in flux, not in a state of being, and between and amongst several forms of knowing, the borders and definitions may not necessarily be sharp and defined. Teachers become critical to such ontology, in that they interpret, negotiate, and reify IKS integration lived reality in and through practice in the classroom. Teachers' ontological assumption in such a scenario is that realities for them emanate out of social, cultural, and educational environments, and shape them in terms of seeing and acting out IKS.

Epistemology concerns one's manner of knowing, understanding, and confirming knowledge. In researching epistemology of teachers' lived experiences in incorporating IKS in Natural Sciences, one would observe: Indigenous epistemologies depend on experiential knowing, passed down through generations through narrative, oral lore, ceremonies, and observation. Teachers can draw on such epistemologies in a manner that enables learners to comprehend about processes in nature through lived, community-based experiences. Epistemologically, such knowledge is seen to be experiential, contextual, and holistic, in contrast with Western science's experimental, reductionist, and empirical ones. Teachers' epistemologies must necessarily adapt when combining IKS with scientific information in Natural Sciences. Teachers can build a pluralistic epistemology, in which a variety of forms of knowing become complementary, not contradictory. Involving IKS problematizes Western science's objectivist position and suggests that knowing that is subjective (embodied in lived, situated experiences) is of equivalent value to objective scientific knowledge.

The teachers' social and cultural background and individual conceptions regarding IKS value inform them in terms of how they interpret and apply knowledge in the classroom (Semali & Kincheloe, 1999). Teachers with a deeper acquaintance with Indigenous cultures, for example, will have a different model for injecting IKS in the curriculum in relation to less acquainted teachers (Ogunniyi, 2007). Social epistemology, therefore, comes into play, with social settings and social selves defining teachers' engagements with and constructions of knowledge (Goldman, 1999). In IKS integration, in the case of teachers, epistemology takes a relational view of knowledge, such that teachers can enhance students' learning through connecting students' learning with immediate environments and with cultural practice (Bang & Medin, 2010). Relational epistemology perceives knowledge as interdependent, not trapped in individual minds and individual disciplines (Battiste, 2002). Teachers' experiences with IKS integration in practice vary with individual, cultural, and work-related factors and therefore become individual experiences (Shizha, 2010). In such epistemology, it is a taken-for-granted fact that knowledge arises through a social relation, for example, between teachers and students, between surrounding environment and epistemologies, and between epistemological traditions that teachers bring with them in school (Semali & Kincheloe, 1999; Chilisa, 2012). Figure 3.2 shows the relationship between ontology, epistemology, and methodology

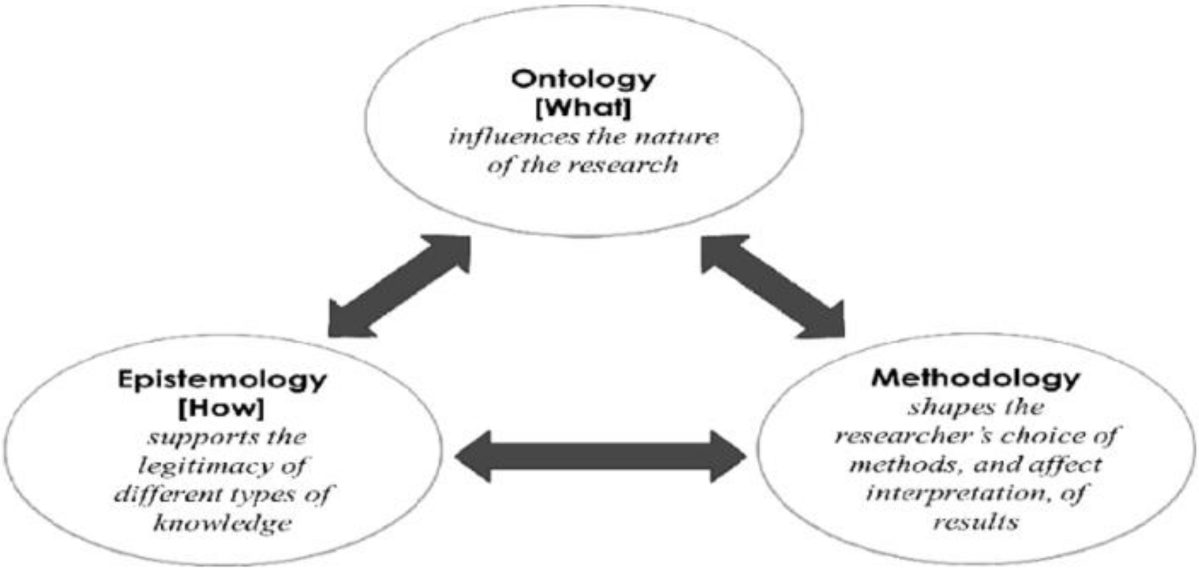

Figure 3.2: Relationship between ontology, epistemology, and methodology

(Amiri, 2024, p. 73)

3.3. Research Approach: Phenomena

Phenomenology is a qualitative research design that aims to explore and describe how people experience certain phenomena in their daily life (Creswell, 2013). This research applies Giorgi's descriptive phenomenological approach, which is most often used in educational research to capture participants' experience. There are four main steps in Giorgi's approach:

- Reading the description in its entirety to have a full understanding of the experience.
- Breaking down the text into meaning units in line with participants' expressions
- Converting meaning units to psychologically informed expressions.
- Synthesising the transformed meaning units into a description of the phenomenon as a whole (Giorgi, 2009).

The following table describes the four major steps in the Giorgi's descriptive phenomenological explication. This means that the researcher remains rooted in the voices of the participants but also develops a thematic understanding of the way IKS is experienced and comprehended in the context of the classroom. Through this method, the researcher was able to identify themes that reflect how teachers integrate IKS into Natural Science lessons, what difficulties they experience, and what they believe about the role of Indigenous knowledge in the curriculum. Figure 3.3 shows Giorgi's four-stage model for interpreting interviews

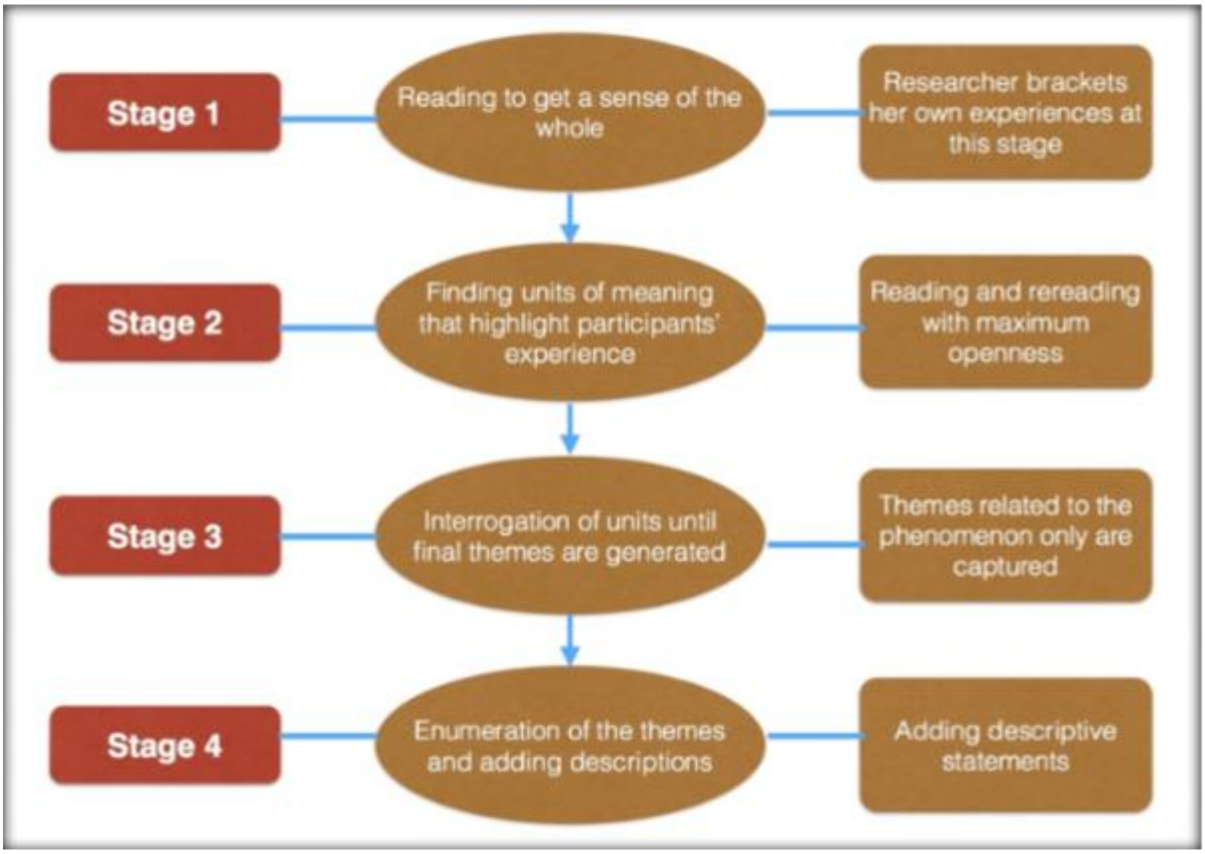

Figure 3.3: Giorgi's Four-Stage Model for Interpreting Interviews

(Alokaily, 2016, p. 10)

3.4. Research Design

The research applies a qualitative research design informed by the interpretive paradigm and seeks to capture teachers' subjective meanings that they attribute to their experience (Creswell, 2013). The phenomenological tradition was adopted to establish a rich understanding of teachers' experience in incorporating IKS in the Natural Sciences lessons. This research design is most appropriate to explore how teachers interpret, experience, and manage IKS integration in classroom settings.

3.5. Study Site

The study was conducted in three high schools located in the same geographical area of the Metro North District in the Western Cape Province, South Africa. These schools were selected because they represented a variety of student bodies and shared a common membership of the district, giving the researcher the opportunity to explore common practices and challenges surrounding the incorporation of Indigenous Knowledge Systems (IKS) into Natural Sciences teaching and learning. The three schools are English-medium schools and the home language is mainly isiXhosa and Afrikaans. The researchers conducted the investigation at the participants' workplace. "It is necessary to conduct research in the field where the participants live and work since these are important contexts for comprehending what the participants are saying," according to Creswell (1994).

3.6. Sampling and Participant Recruitment

In a phenomenological study of the lived experiences of Natural sciences teachers in the integration of Indigenous Knowledge Systems (IKS) in instruction in Natural sciences, selection is significant in ensuring that participant experiences will be rich, rich in diversity, and indicative of the researched phenomenon. Sampling and a consideration of race can yield even deeper insights about the intersection of instruction, IKS conceptions, and educational structures with race.

Teachers from various racial or cultural origins may provide unique views to IKS, particularly in contexts where historical and colonial legacies have affected attitudes towards Indigenous knowledge. The research explores how teachers racially identify and what systems of knowing surround their perceptions and interpretations. Indigenous Knowledge Systems (IKS) may mean different things to teachers of certain racial or cultural ethnicities depending on their lived experiences and their cultural context. In this sense, teachers from Indigenous communities see value in IKS inclusion as a means of revalidation of their own cultural history, whereas other racial/ethnic groups of teachers look for IKS inclusion as a means of enrichment of their pedagogical practices. By exploring race and identity as part of the integration of Indigenous Knowledge Systems offered an important awareness of how individual thought, the cultural pedagogies we bring, and educational principles inform practice. Exploring how race and identity influence IKS integration can reveal important insights into how personal ideas, cultural norms, and educational philosophy shape teaching practices. This study used purposive sampling which means that the selection of the sample was based on familiarity with the population. Punch (2005) elucidates that the term purposive sampling is used to refer to sampling in a deliberate manner with a purpose or focus on mind. This means that the researcher is unable to make a random selection but needs to make a judgement in selecting a sample to supply the necessary data.

The study consisted of six Grade 9 Natural Science teachers in three multiracial schools within Metro North Education District. Participants were selected purposefully in line with the following criteria:

- Teaching experience in Natural Sciences for 9th grade
- Familiarity with Natural Sciences curriculum, in particular IKS integration.
- Willingness to be a participant in research and to share their experience.

- Purposeful sampling allowed the researcher to select participants with direct experience and knowledge about the phenomenon under research (Patton, 2015).

3.7. Location of the study

This study was conducted in Western Cape schools where the researcher was given permission to collect data from teachers and learners who were experiencing the identified problem. The Map in Figure 3.7 shows the geographical location of schools where the research was conducted.

Figure 3.4: Western Cape education districts map

(Western Cape Education Department, n.d.)

In a phenomenological study into the experiences of grade 9 teachers of Natural Sciences who had integrated Indigenous Knowledge Systems (IKS), participant selection is very important if rich and diverse narratives are to be obtained. The demographically diverse population of the Western Cape, including Indigenous, African, Coloured and White people, provides a useful setting in which to explore the ways in which sociocultural contexts influence the way in which IKS is taught. It is this racial and cultural diversity that enables in third place, nuanced perception regarding challenges and enablers of the IKS integration within science education. Because South African policy supports the inclusion of Indigenous ways in curricula (Department of Basic Education, 2011), and because lived experiences of this in multicultural contexts offer insight into how policy dissemination is enacted in practice. Furthermore, analysing teachers' narratives in this context advances a broader conception of science that is inclusive in response to calls for epistemological pluralism and decolonisation of education (Kraak & Paterson, 2021; Odora Hoppers, 2002).

So, given that the region is multiracial, it is an ideal context to explore how teachers of varied races, cultures, and socio-economic backgrounds experience the integration of Indigenous knowledge into scientific investigations. Since IKS is situated in specific geographical and cultural environments, it is critical to explore how teachers with different communities encounter such a form of knowledge.

Western Cape possesses a unique background of Indigenous cultures, particularly the Khoisan and other native groups in and around the region. By focusing in Western Cape, the study can investigate how teachers interpret and present IKS, and such an interpretation and presentation could vary according to its cultural affiliation and individual encounter with such a form of knowledge. This study is located in Western Cape in a multiracial community in Western Cape, an area famous for its diversity in terms of ethnicity, culture, and socio-economic profiles. There are people with a variety of racial groups, including Black, Coloured, and White South African, and communities with a variety of historical and cultural ties to Indigenous Knowledge Systems (IKS). Because Western Cape is a multiracial region, the study location affords a diversity of experiences and perceptions that matter when investigating integration of IKS in the Natural sciences lesson.

By selecting two teachers from each sampled school, the study captured a broader range of experiences within the same institutional setting. This is because teachers in the same school can have differences in approaches towards integrating IKS in their classroom teaching because of their individual background, teaching philosophies or approaches, and level of exposure to IKS (Ogunniyi, 2007). Two teachers in a school allow comparative analysis, offering an analysis of diversity in approaches, challenges, and success in one school setting. (Naidoo & Vithal, 2014). Comparison can expose whether integration of IKS is vastly different in one school setting, or whether similar trends in one teacher occur in several teachers (Mabasa-Manganyi & Ntshangase, 2023). In a multiracial region such as Delft, a teacher sample could involve teachers with racial, cultural, and language diversity. For example, one teacher could have a background in an Indigenous community with a direct, individual affiliation with IKS, and a teacher with a Westernised, privileged racial background. With such diversity, rich analysis can be extracted of a teacher's cultural identity guiding them in including IKS in instruction and challenges experienced in its integration in the natural sciences curriculum (Naidoo & Vithal, 2014). Teachers could have a variation in training, years of practice, and acquaintance with including IKS in the Natural sciences curriculum (Mabasa-Manganyi & Ntshangase, 2023).

Grade 9 is a key grade in South African school life, in which learners begin studying increasingly complex subjects in the Natural sciences, namely in subjects such as ecosystem-related subjects, environment and development, and practice for a sustainable future subject in which IKS can effectively be included. It is a key stage for researching in detail how IKS can effectively become part of instruction in science and is received positively by learners. Teachers in grade 9 have a role in offering both traditional scientific information and, in a South African educational sphere, increased prominence in curriculums including IKS. Including IKS in curriculums tends to become challenging for teachers, specifically when not having been professionally trained and developed in terms of instruction in IKS.

This study is phenomenological because it seeks to understand teachers' lived experiences when practicing IKS integration. It seeks to obtain teachers' individual understandings, reflection, and challenge in practice in a first-person format Koopman, 2016). Phenomenology helps the researcher access teachers' affective and cognitive experiences with IKS integration, studying feelings of success, frustration, and disease in accomplishing such an activity (Pishghadam et al., 2023). In in-depth interviewing or a group discussion, teachers can recount in detail about experiences, and a rich picture of the phenomenon can be constructed through such an inquiry (Arcuino et al., 2023). It will produce information that can inform educational practice, educational policies, and teacher training programs, particularly in racially mixed schools in which IKS integration is a developing practice.

3.8. Obtaining Institutional Permissions

Before any information collection can start, approval must first be received from respective governing bodies or institutions. This research involved teachers working in specific schools, and permission from a school principal was requested. This involved sending a formal letter and a research proposal stating aims, methodology, and ethical concerns of the research. The study was approved ethically by an IRB (Institutional Review Board) / Ethics committee since this research was conducted using human subjects. That was so that they could verify that the research complied with ethical standards such as informed consent, confidentiality, and protections for participants' rights.

3.9. Data collection methods

Data was obtained through unstructured interviews and field notes. All these methods collectively provided a rich insight into how teachers integrate IKS into their lessons.

Unstructured interviews were used to give participants freedom to express themselves and their experience in an open-ended way without being bound to a predetermined set of questions. This enabled unforeseen themes to be investigated and a greater understanding to be gained from the teachers' lived experience (Denzin & Lincoln, 2011). Interviews were carried out in an open-ended style, encouraging teachers to discuss their challenges, achievements, and views regarding IKS integration (Kvale, 2007). Follow-up questions were asked to participants following their responses to elicit clarification and additional detail to salient points.

Field observations and interviews were recorded to capture contextual information, emotions, and body language that enriched understanding teachers' experience (Emerson, Fretz & Shaw, 2011). Other contextual information for interpreting data was gathered from field notes, which revealed underlying themes and participant emotions that may have remained unarticulated in verbal responses.

3.9.1 Interview

The integration of Indigenous Knowledge Systems (IKS) in Natural Sciences education has been mooted as a tool for creating an inclusive and relevant curriculum.

Teachers attempting to integrate IKS in teaching, however, encounter pedagogical, institution, and epistemological barriers (Onwu & Mosimege, 2004). To explore these barriers and success, in this study, a phenomenological practice of inquiry was adopted, one that seeks to know about lived experiences through a reflection about individual experiences and interpretations (Van Manen, 2016). In a sequence of in-depth interviews, the study assesses teachers' experiences with IKS integration, including motivation, approaches to instruction, barriers, and institution support. In a phenomenological research study that explores Grade 9 Natural Sciences teachers' lived experiences of implementing Indigenous Knowledge Systems (IKS) in their teaching, the interview process plays a critical role in accessing the depth and richness of participants' first-hand experiences. What follows is a description of how the interview process is structured and carried out in this study:

The objective of the interview for this phenomenological study is to come to terms with how Grade 9 Natural Sciences teachers experience the integration of Indigenous Knowledge Systems (IKS) in their teaching. Phenomenology focuses on exploring lived experiences from the viewpoint of participants and having participants tell their own stories with rich, detailed descriptions that are typical of their individual experiences.

The researcher recognised from the onset of the interview process the importance of ensuring that the participants were aware of the purpose and scope of the study . A written explanation about the study emphasising on the confidentiality of their responses and right to withdraw from the study at any time, was given before partaking in the study (Creswell & Poth, 2018). Furthermore, the research clarified that the goal was to capture their subjective experience of integrating Indigenous Knowledge into their Grade 9 Natural Sciences teaching. In keeping with phenomenological methodology requirements, the researcher engaged in a process of bracketing, setting aside her own biases and assumptions about the topic so that she would be able to approach each participant’s story with an open mind. This is critical to phenomenological research in that it enables the researcher to avoid imposing her/his own opinion on their lived experiences.

The interviews were unstructured, in the sense that the researcher had a list of open questions to go through with the participants but also allowed space for the participants to speak more freely about their thoughts and experiences. The researcher began the interview by setting a comfortable and relaxed atmosphere. The researcher introduced herself and thanked the teacher for participating. Also made the participant aware that there are no right and wrong answers and encouraged them to speak freely about their experiences. After the teacher was comfortable, the researcher began to ask more specific questions about their experience using Indigenous Knowledge Systems in their teaching. Throughout the interview, the researcher's focus was on active listening and making the participant feel respected and listened to. The researcher was not only concerned with what was said in answer but also the speaker's intonation and feelings.

After the interview, the researcher took some time to reflect on the conversation. The researcher made sure that she jotted down any immediate impressions or observations that she taught that would help her better understand the participant’s lived experience in a more holistic way. Also listened to the recordings to ensure that she had captured all the facts accurately. One of the most important aspects of the phenomenological interview process is member checking. The researcher practiced active listening during interviews to ensure the participant felt heard and respected. The answer from the researcher was not only concerning the content of their replies, but also the tone and emotions.

After the teacher expressed comfort, the researcher commenced posing more specific enquiries regarding their experience incorporating Indigenous Knowledge Systems into their classroom. During the interview, the researcher's attention was on actively listening and making the part.

The researcher was listening to the emotions and tone of the answers, not just the words. After the interview, the interviewer mulled over the conversation. The researcher ensured that she noted any immediate observations or impressions that she taught that could assist her in understanding the participant’s lived experience to a greater extent. Also listened to the recordings to ensure that she had gotten all the facts correctly. A significant part of the phenomenological interview process is member checking. This is where the researcher gave participants a chance to see their transcript or a summary of the interview after it was conducted, and to check that what written down truly reflects what they said or how they felt. It allowed them to validate their lived experience, and it also afforded them the opportunity to clarify points they feel could use amplification.

Having completed all interviews, the researcher set about transcribing the recordings verbatim. The transcripts were read and re-read for significant statements that encapsulate the key elements of the participants' experiences. Researchers search for themes and patterns emerging across the interviews that encapsulate the nature of teachers' experiences of incorporating IKS into Natural Sciences teaching. In keeping with phenomenology, the researcher attempted to stay as close as possible to the participants' own words, allowing their lived experiences to speak for themselves. The aim was not generalisation but to attain insight into the personal and collective meaning that emerges from the teachers' experiences.

The report is structured around the themes that emerged, such as the challenges of integration of IKS, the perceived benefit to students, and the pedagogical and emotional transformation that occurred in the process. In conclusion, the interview process in this phenomenological study is directed towards uncovering the deep, lived experience of Grade 9 Natural Sciences teachers in going through the process of integrating Indigenous Knowledge Systems. Through reflective, open-ended questioning and extensive data analysis, the researcher attempted to build a rich and layered portrait of how teachers engage with Indigenous Knowledge and how it affects the way they approach the teaching of Natural Sciences.

3.9.2 Field notes

After multiple interviews, field notes were made to provide important new perspectives on the trends and themes resulting from participants' experiences. In phenomenological analysis, these notes are integrated with interview transcripts to help the researcher better understand the essence of the participants' lived experiences. They allowed the researcher to connect verbal comments to emotional and non-verbal signals, arriving at a more complete, integrated sense of how teachers live and work through integrating Indigenous Knowledge Systems into their classroom practices. Field notes in phenomenological research allow for a more subtle and whole description of participants' lived experiences. They capture the nuances of human interaction, context, and emotion that enrich the analysis and interpretation of the interview data, ultimately leading to a more profound sense of the phenomenon under study.

Following several interviews, field notes provide reflective commentary on the patterns and themes that cut across participants' experiences. In the phenomenological analysis, the notes could be merged with interview transcripts to enable the researcher to gain a better understanding of the essence of participants' lived experiences. What seems important from a phenomenological point of view is not a detached understanding of the phenomenon itself, but it is situatedness, and that the lived experience is always situated. Field notes provide for the collection of relevant contextual data that informs participants' experiences. That includes the literal setting of the interview, the time and place, and logistical details about it as well as social or emotional dynamics that can affect how the conversation flows.

In phenomenological research, the lived experience of the participant is interpreted not only from what they say, but also from their physical and emotional responses to the questions posed. The field notes also help the researcher to record non-verbal communication like body language, facial expressions, tone of voice, and silences. These convey more of the weight of the experience or the emotional value of the experience, which may not be captured in words. For example, one of the teachers talked at length about a successful lesson she had with IKS, but when the researcher picked up on the softening of her tone of voice or their eyes sparkling when describing a moment that was meaningful, it expressed the deep emotional connection the teacher has with her job. Such non-verbal signals helped identify feelings such as passion, frustration, and joy that are central to understanding lived experience.

Phenomenology calls for rich descriptions of experienced reality. The narrative from interviews represents spoken accounts, whereas field notes allow the researcher to record their contextual perspective on the experience, including the researcher's perceptions and feelings in context. These descriptions added detail to the interview data and brought the phenomenon being studied to life and squarely in three dimensions. One of the teachers was explaining, for instance, the difficulty including IKS into a prescriptive curriculum. The researcher noted the educator's body language crossed arms, a sigh which added depth to understanding the emotional labour of this struggle. These observations revealed an emotional complexity that goes beyond the words themselves.

In phenomenology, bracketing refers to the researcher's attempt to set aside his or her own assumptions, preconceptions, and beliefs to better understand the participant's experience. Another purpose of this space is for the researcher to transcribe their reactions, biases, and emotional responses as they collect data. By observing, the researcher noted down and clarified the impression of the data, to prevent bias from her end when analysing the data.

3.10. Data explication

Data interpretation for phenomenological research is an in-depth analysis of the data and a real finding of the essence of the participants' lived experience. This involves a repeated examination of the interview transcripts, field notes, and other data seeking out central findings, themes, patterns, and meanings present in the subjects' accounts of their experience (Kendall, 1999). In short, phenomenology aims to understand the essence of the phenomenon to see why it is as it is as it relates to what people experience rather than explain the phenomenon through independent theoretical constructs or concepts (Zahavi, 2018).These provide valuable non-question statements and emotional context to the interviews that help in their interpretation.in this method, data are examined in depth by the analyst who is immersed in the data to form a close and nuanced understanding of the participants' lived experience. That means reading and re-reading the field notes and transcriptions over and over to feel out the entirety of the experience, tone, and material. The initial task was to transcribe all the interviews word for word so that each word, pause, and inflection is as near to being correctly recorded as possible. Field notes, which recorded the researcher's impressions, thoughts, and contextual information, must be sorted and included in the analysis as well. This provided valuable non-verbal and affective background information for the meaning of the interviews.

In phenomenological research, immersing oneself in data is a step that brings one close to people's real life. In some respects, this means that it takes working over things tens of thousands of times to read and reread field notes, transcriptions. During the immersion phase, the researcher suspended any prior theory or assumptions (a procedure referred to as bracketing) and attended to the participants' lived experience as depicted in the data. The subsequent step in the explication of data is the identification of meaning statements that indicate the key points of the lived experience of the participants. These are statements that appear to embody the very nature of the experience, either by direct description, emotional response, or interpretation of the meaning of the experience. After identifying major statements, the researcher categorises them into themes or categories. These are general patterns or concepts that capture the essential elements of the participants' experiences. In phenomenology, one aims to find the universal themes that are present across participants.

The researcher synthesises the themes and meaning units to construct a general interpretation of the lived experiences of participants. This is where the researcher tries to unearth the essence of the phenomenon as experienced by the participants. The synthesis is typically in the form of a narrative that weaves together both the textural and structural aspects of the experiences. The narrative tries to express the shared essence of the phenomenon across participants while maintaining respect for the uniqueness of individual experiences.

In the process of explication of data, phenomenologists employ reduction (or epoché) and bracketing, i.e., suspending their own assumptions and biases in a bid to get into the participant's way of experiencing. This guarantees that the researcher stays focused on the participant’s lived experience, without imposing their own meanings or external theoretical frames on the data.

The final goal of data explication in phenomenology is to extract and express the essence of the phenomenon. This is a brief but descriptive statement that encapsulates the invariant core of the experience shared by participants. The essence is expressed through a synthesis of themes, meaning units, and descriptions that together form a coherent and insightful interpretation of the phenomenon under study.

The use of Giorgi’s method ensured fidelity to participants' real experience while still making possible the establishment of patterns between participants. Field notes and unstructured interviews were crucial in uncovering underlying beliefs, feelings, and challenges teachers face in incorporating IKS. Open-ended in nature, interviews allowed teachers to give anecdotal information that could not have been obtained in structured interviews (Smith, Flowers & Larkin, 2009).

3.11. Ethical clearance

The university approval was granted by the university Human and Social Sciences Research Ethics Committee (HSSREC) who scrutinised the researcher’s proposal to verify that the rights, dignity, and welfare of all participants will be safeguarded. University of Western Cape (UWC) also assisted in ensuring that the study was ethically carried out. The UWC ethical clearance process necessitated that the researcher submitted full documents that included the research proposal, interview schedules, information sheets for participants and consent forms. The ethical principles, including informed consent, voluntary participation, anonymity, and the right to withdraw, were thoroughly considered by the committee. The ethics approval was obtained only after extensive review and modifications. This consent further validated that the research adhered to national and institutional standards regarding the protection of the participants involved in human research. All along the study, UWC was the lead institution for ethical approval, and any deviations or ethical issues would have had to be reported to the committee. So, the organisation both gave the initial permission and became a moral compass for the course of the research.

3.12. Summary

This chapter outlined research design and methodology in which centred centred on a phenomenological method, namely Giorgi's method of data explication. It explained clearly how the research was conducted, with reference to how participants were selected and how data collected and to the ways in which data was interpreted. The researchers ontological and epistemological stance guided selection of research questions, selection of phenomenology as a research approach, and process of explaining data. Ethical issues were further considered, and the study was carried out in compliance with the requirements for studies with human subjects. This methodological approach laid the groundwork for the second phase of the study, that of a scrutiny of the data. Chapter four will present an explication of the data collected. Building on the methodology outlined in chapter three, this chapter will discuss the process in which the researcher interprets and explicate the experiences of the participant.

CHAPTER: DATA EXPLICATION

4.1. Introduction

Chapter three provided an account of the entire research methodology process. This chapter presents a step-by-step process of interpreting participants lived experiences based on the results of the interviews conducted in the previous chapter. This study employed Giorgi's method of descriptive phenomenological analysis which is a rigorous and systematic approach to analysing participants' experience. Giorgi's method is rooted in Husserlian phenomenology with the aim of describing experience as experience as it is lived, as opposed to explaining experience through preconceived notions from theory (Giorgi, 2009). This approach is applicable specifically this study research because it delved extensively into teachers' experience with the use of Indigenous Knowledge Systems (IKS) in the Natural Sciences.

4.2. Demographic information of participants

The demographic information of participants was important in providing insights into the characteristics of the sample of participants used.

4.2.1 Participants' Background

Participants consisted of Grade 9 Natural Sciences teachers from multiracial schools in the Metro North District where English is the primary medium of instruction. However, isiXhosa and Afrikaans are the two home languages recognised by the schools as dominant. These schools are populated by teachers who deal with a linguistically diverse classroom where learners may not always make a link between Indigenous Knowledge Systems (IKS) and science due to differences in language and cultural background. Based on this diversity, teachers tried ways to integrate IKS into the lessons to meet the home language and cultural perspective of the students. In addition to isiXhosa and Afrikaans, there are learners in these schools who are also able to speak Lingala, Sotho, Swahili, Ndebele, and French. But because isiXhosa and Afrikaans speakers dominate, the schools make isiXhosa and Afrikaans a home language. And for many of these learners, it is the first time they encounter Indigenous Knowledge Systems relevant to South Africa.

To provide context and deepen understanding of the participants involved in this study, Table 4.1 below presents a summary of their biographical information. This comprises information like participants' years of age, gender, race & home language, teaching experience, subject taught and teaching experiences. Knowing these background features will help to interpret their perspectives and experiences; in particular with regard to how they incorporate IKS in Natural Sciences lessons. This broad range of life, work experiences and cultural perspectives enriches and complicates the data collected.

Table 4.1: Participants biography - Exploring the lived experiences of selected grade 9 teachers' integration of indigenous knowledge in their science lessons in the Western Cape province.

Participant Name (pseudonym)	Gender	Age	Race and Home Language	Qualifications	Teaching Experience	Pseudonym of school	Current grades taught
Kamvelihle	Male	26	African Xhosa	BSc degree in analytical chemistry Postgraduate Certificate in Education	3 years	School A	Grade 9 Natural Science, Grade 10 Physical Science, and both Grade 10 and 11 Mathematical Literacy.
Blessing	Male	54	African Shona	Bachelor's degree in education and honours degree in education	32 years	School A	Grade 9 Natural Science, Grade 11 and 12 Mathematics, and Grade 11 and 12 Physical Sciences.
Tawanda	Male	51	African Ndebele	Bachelor's degree in Agricultural Engineering, Postgraduate Certificate in Education and Honours degree in education	26 years	School B	Grade 11,12 Mathematics Grade 10 Mathematical Literacy and Grade 9 Natural Sciences
Lusanele	Female	26	African Xhosa	Bachelor of Education (B.Ed.) degree	1 year and 9 months	School B	Grade 8, 9 Natural Sciences and Grade 10 English
Mischka	Female	31	Coloured Afrikaans	BSc degree in analytical chemistry Postgraduate Certificate in Education	5 years	School C	Life Sciences for Grades 11 and 12 and Natural Sciences for Grades 8 and 9.
Moegamat	Male	45	Coloured Afrikaans	Bachelor of Education (B.Ed.) degree	16 years	School C	Grade 8, 9 Natural Sciences and Physical Sciences Grade 10,11, 12

Participants biographical descriptive narratives

In qualitative research it is important to provide participants with a descriptive narrative so that the voices, experiences, and the contexts of the participants are presented in a manner that is rich and accurate. description narration refers to the detailed and rich accounts of participants' answers; direct quotations, or verbatim findings, are commonly used to make what participants say come alive. This further enables the researcher to contextualise the data in such a manner that reflects the depth and dynamism of the participants' lived realities, which is particularly significant within studies investigating personal or professional experiences, for example, IKS integration in science lessons. As explained by Merriam and Tisdell (2016), descriptive narration offers "thick description," allowing readers not only to know what was said, but in what context it was said with added credibility and transferability for the study. Creswell (2014) points out that bringing through the voices of the participants in detailed narration adds credibility in terms of the validity of the qualitative work since its findings can be grounded in the exact words of the respondents.
This is especially significant when working with underrepresented or marginalised viewpoints, when one seeks not just to understand, but to respect and honour the wisdom and insights of those being studied. Also, Braun and Clarke (2006) note that such rich description assists in supporting the thematic analysis process in aiding researchers in noticing patterns and in generating grounded themes from verifiable, lived experience. Descriptive narration then not only reinforces the credibility of a study but also empowers the participants in that it recognises as well as makes their individual contributions noticed.

The researcher gave a description of each participant to document their individual experiences and perceptions in detail. The process helped the study present rich, individual narratives that clarify how every teacher approach and comprehends the incorporation of IKS in Grade 9 Natural Sciences lessons. The researcher included the precise words of participants and contextual settings in order to ensure that their voices were accurately portrayed prior to determining common themes in the data.

Kamvelihle's biographical descriptive narrative

Kamvelihle is one of the few Xhosa speaking male Mathematics and Science teachers who did not set out with the ambition to be one. He began his studies with a qualification in Analytical Chemistry at the University of the Western Cape (UWC) as he is always fascinated by science; more particularly Chemistry and that is because of one high-school teacher. He found himself unemployed on graduation, looking for a job that he describes as depressing and emotionally exhausting for a first son. The pressure of having to support his family and not make any money was a lot. Desperate to break the trend, he completed a Postgraduate Certificate in Education (PGCE) with NSFAS funding him and not out of love for teaching, but because the circumstances dictated so. It was then, while teaching lower-level learners, that he unexpectedly fell in love with teaching and enjoyed explaining things to people and getting them to understand.

Currently Kamvelihle holds a position as a high school teacher teaching Mathematics, Mathematical Literacy, and Natural Sciences. With a formal background in science, he draws on the rich Indigenous Knowledge his grandmother shared with him, which included traditional practices such as the use of cow dung to heal wounds. Through these incidents, he learned to respect the importance and knowledge in Indigenous ways. But he confesses, he does not have the pedagogical expertise to know how to properly introduce IKS to the curriculum. He occasionally attempts to integrate IKS into Natural Science in his teaching practices but in a way that does not bring any meaningful integration and harmony between the two knowledge systems of Western and Indigenous science. Learners frequently show interest and enthusiasm when IKS is introduced but recognise that there is disconnection in both content and in instruction design due to the gaps of curriculum assistance and training on how to bridge these divisions in appropriate manner. Kamvelihle’s perspective is that IKS should be systematically in the curriculum with supporting professional development opportunities for teachers. He is careful to emphasise the demand for a re-orientation of curriculum, practical examples and official guidance for teachers to help integrate IKS into classroom practice. But, despite his passion and his own engagement with Indigenous knowledge, pressure to complete the curriculum, meet formal assessment inclusion and drive learner performance, often prevents him from engaging deeply with

IKS. His life story portrays the teacher who became a teacher in the face of barriers but finds meaning and purpose in teaching especially when it is more inclusive, culturally responsive, and able to consider Indigenous ways of knowing.

Blessing's biographical narrative description

Blessing is a male teacher from Zimbabwe who speaks the language of Shona and has been living in South Africa for more than 22 years. Even though he has been in South Africa for more than two decades, he is still firmly grounded in customs, traditional values, and the cultural heritage of his home. His entry into teaching was shaped by societal expectations as well as life experiences. Back in the olden days, as he puts it, there were merely two highly valued occupations in the village teaching and nursing and teachers were highly respected members of the community. He distinctly remembers taking note of and admiring his neighbouring teacher who wore formal attire each day and always wore a tie and commanded utmost respect from both adults and children alike. This respect heaped on the profession earned from the village community gave him the idea to pursue the teaching option. Nevertheless, the choice to be a teacher was very personal. He experienced a tough time learning as a child, his teacher even if very intelligent used the teacher-centred teaching method, talking and going on and on without interacting with learners or giving opportunities to learners to pose questions. This made learning hard, not only for him but also for the whole class. Lack of communication and assistance left him lagging behind, and he chose to be in the teaching line solely to research and alter that negative learning experience to learners in the future. With 33 years of teaching under his belt, he is now teaching Mathematics, Physical Sciences, and Natural Sciences, and brings to the classroom rich knowledge and commitment. He is familiar with IKS and is aware of how vital and relevant it is, particularly with regards to the learners of Africa. He has tried in vain to infuse IKS in what he teaches from the background of his own culture and understanding. He is, however, teaching in a multiracial school where language issues have been a big challenge; he finds it hard to translate some Indigenous concepts to language that will speak to all learners and so there is no confidence in getting IKS to work. Although learners are more interested and active in class during and after introductions are made of IKS, he is pegged down by the fact that the curriculum is silent on how to meaningfully blend Indigenous knowledge with Western science. Consequently, he has lacked the pedagogic skills in doing so effectively. He is further hindered by the need to cover the curriculum in good time and the inability to allocate time to exploratory work or excursions and so he is forced to draw strictly from what is in the textbook. He feels the system is rigid and that extra support is required to allow space in teaching in culturally inclusive ways. He is firm in his opinion that the curriculum needs decolonising and demands on-going workshops and assistance to bring teachers like him on board to connect IKS meaningfully. His testimony has a deep commitment to transforming educational injustices of the past and yearning to teach in such a manner that will speak to both science and culture also shows how system constraints and deficiency in support have made this ideal hard to accomplish.

Tawanda's biographical descriptive narrative

Tawanda is a male aged 51 a teacher by profession; he comes from Zimbabwe and speaks the Shona language. It was not an easy decision for him to relocate but he had to do that for his family. He was motivated by the need to provide for his family; he took a brave decision to find greener pastures in a foreign land. He had an academic base in a Bachelor of Agriculture Engineering which gave him a strong background in scientific and technological subjects. That he has been teaching for 26 years is all the more remarkable considering his original career plan was to be an engineer not a teacher. But life took his path elsewhere. At least in his native village, teachers were the father figures (it could be mothers as well) with a kind of good leadership skills, and were respected by mothers, parents and children. It was a normal, acceptable, situation where children were inspired by their parents to become educators, and this societal convention, along with the presence of his father, had a large influence upon his eventual transition into an educator. Eventually he became passionate about teaching and became dedicated to his work by attending school.

Nowadays teaches Mathematics, Maths Literacy and Natural Sciences. He deliberately selected these subjects to be challenging, subjects to which students are not exposed to get students from least to at most exposure, particularly sensitively, on the African continent. His job is to up end that perception and demonstrate to learners that these subjects are attainable and doable. His education was extremely influenced by his father who though never went through a formal education used IKS to describe things. He describes his father's practice of assisting him in his studies by telling stories, singing and other vivid examples, such as the time when he was teaching light refraction in physics: though his father never got to explain refraction in physics terms, he told of how light bends when it hits water and a fish appears to be in different position. This definition, based on general knowledge and experience, he said helped to make sense of the idea.

Growing-up in a traditional village with traditional knowledge and practice he laid a strong grassroots foundation in IKS through hunting, fishing and even learning to start veld fires on his own with cow-dung. He is currently experimenting with ways of incorporating IKS in the classroom and has learned that often learners get enthusiastic and want to learn more. But he teaches in a multi-racial school, and this mixed context can sometimes pose cultural challenges, with IKS elements feeling alien to some learners not natural, even uncomfortable. He feels that he ends up having to explain and re-explain himself for the benefit of all learners which wastes up precious minutes and does not give him the opportunity to stay on pace with the ambitious lesson. He says although IKS is included in the curriculum, there are no clear examples or teaching guidance, he feels underprepared and is not equipped with the pedagogy to connect Western science with Indigenous knowledge. He thinks that teachers need a revised curriculum and professional development workshops, preferably those that include contributions from IKS holders, for them to feel confident and successful in integrating IKS into their teaching so that they have exposure to practical understanding and real-life examples. His narrative is a testament to a passionate commitment to change making education and the recognition of Indigenous knowledge in the science curriculum but moreover to have all learners not be resistant on their learning journeys.

Lusanele's biographical descriptive narrative

Lusanele is a female teacher, aged 26, who speaks isiXhosa and is from the Eastern Cape. A few years later, her family relocated to Cape Town in another search for a better life and the experience became formative for much of her life and perspective. She has been teaching for 1 year and 9 months and is a Natural Science and English teacher in a multi-racial English medium school. She is frustrated at the language barrier, because when she describes difficult scientific concepts, she knows that the learners sometimes do not understand because of the language, and that really gets her angry because that affects the quality of learning. She felt like it was a more respected occupation compared to when she was growing up and her motivation, nevertheless, is based on her own life experience as a learner, in that while in school, it was very hard for her to voice herself or share her challenges with the teachers, who, in her opinion, are not only teachers but also mothers, fathers, social workers, and psychologists. She noted that learners today are closer to teachers and most view teachers as support systems, counsellors, and emotional anchors. This difference in her own schooling life, where she felt isolated and lacked support, particularly during the periods her parents were unemployed and there was no one to turn to, was something that defined her to become a teacher. Her dream is to be that support system for her learners and to be a source of more than book knowledge, but emotional and psychological support as well. Despite always wanting to be a teacher of Natural Sciences, she detested studying the subject while in school because of how it was taught. The learning environment was tense, disinteresting, and teacher-centred, with teachers who employed traditional methods and did not care about whether or not learners comprehend the subject matter.

She wanted to be a teacher because she wanted to help raise the next generation. But she also acts on an even more personal impulse: her own experience as a learner, which taught her that when she was in school. She had a very hard time both describing herself and showing the teachers what kind of learner, she was. Teachers, as she sees them, are not just teachers. They are also social workers, mothers, fathers, and psychologists. She observed that the bond between teachers and today's learners is typically stronger and that many regard teachers as their support system, confidants and emotional anchors. This contrast to her own time in school where she was alienated and lacked support, especially as her parent's unemployed and she had no one to turn to, acted as the defining force in propelling her to teaching. She wants to be that mentor for her learners, someone who not only teaches but provides an emotional and psychological support base. She relied on memorising facts solely to pass exams and tests and never actually understood what was being taught. As far as IKS are concerned, she acknowledges that, while in schools and even in university, she was never introduced to it. There was no formal support or training offered for incorporating IKS in her practice in the classroom. Although sometimes she uses examples that may qualify as IKS, like describing the fact that there are many more ants during summer than in winter in discussing weather patterns, she is not aware of these methods as IKS because of not having received proper information or support. These examples are time demanding and considering the pressures of the curriculum, she will resort back to the textbook, and this has nothing to do with IKS. She is in disorientation regarding what exactly IKS is and how it is supposed to integrate with Scientific knowledge from the West. However, firmly in her convictions, she feels that IKS must be incorporated in lessons, particularly in Natural Sciences, because it may enhance learners' engagement, performance since learners lose interest in studying science. She recommends that there should be excursions and workshops in professional development to train teachers with concrete skills and methods in how to teach IKS. Despite her current shortcomings, she wishes to learn more and feels that with the right training, curriculum support, and materials, she would be able to meaningfully incorporate IKS in her lessons and could help science be more understandable and engaging to the learners.

Mischka’s biographical descriptive narrative

Mischka is a 32-year-old coloured female teacher, born and raised in the township of Delft, in Cape Town. She comes from a mixed society, with mixed cultural and language backgrounds in the area. Her home language is Afrikaans, and she speaks it most readily and fluently. Nevertheless, because of early socialisation in a crèche with isiXhosa toddlers as the majority, as well as in the general community environment, she also learnt how to speak isiXhosa. This bilingual heritage has added to her linguistic flexibility and cultural competence in her neighbourhood. She is a Natural Sciences and Life Sciences teacher in a multiracial English medium school, with six years teaching experience. Teaching was not anything she ever really wanted to do at first. She has a bachelor's degree in Analytical Chemistry, which she hoped she will end up in a lab or scientific field. However, she found it hard to get a job after she graduated, and so she applied for a PGCE to make herself more employable and increase her future career prospects. It was not until her PGCE days that she somewhat surprisingly found a love for being in the classroom and ever since, her attitude to teaching began to change. Her current enthusiasm aside, as a learner in Physical Sciences and Natural Sciences in a previous life, she found science learning to be bewildering and demoralising. She remembers being lectured by teachers who put in videos and did not involve learners, and if she asked questions because she did not understand, they responded with annoyance and frustration instead of help. This made her feel disheartened, misunderstood, and academically handicapped throughout her school life. Now, as a teacher herself, she's determined not to perpetuate those dynamics. With time, she has developed new, more successful and interesting ways of teaching, with a focus on learner involvement and the promotion of an interactive approach. As far as IKS is concerned, she has some basic idea of what it is all about, but she is not very sure how it relates to the formal curriculum of science. She is aware of the utility of IKS, particularly how it excites and motivates learners when issues pertaining to culture and tradition are addressed yet is not sure of incorporating it in the curriculum. She believes that we are living in a modern 21st century and there is uncertainty around where Indigenous knowledge fits this modern world of education a modern, western world of education. However, she acknowledges that learners are excited when IKS forms part of classroom dialogue. She sees that even shy learners voice themselves, debates take centre stage and cultural pride is aired by one and all: But these instances are time intensive, as there is no explicit mention of IKS in the ATP or textbooks. She thinks that it wastes valuable class teaching time that is supposed to be used to cover the curriculum because some learners find it difficult to connect IKS to science lessons. Her greatest challenge is that she was never taught to teach IKS and there are no guidelines or resources available as to how to meaningfully integrate it into her Natural Sciences teaching. she recognises the importance of digital storytelling in enhancing the diversity of ways to address digital inclusion and learner engagement but has the challenge to integrate it into her lesson planning. She feels a new curriculum is needed. One that officially integrates IKS with western science, providing explicit instructions, examples and teaching methods. Secondly, she emphasises the need for professional development workshops that teach teachers about the value of IKS, how to use it in the classroom, and how it may be used as additive knowledge and not in opposition to it. Finally, while she believes that IKS is rich culture and will connect learners with heritage, her lack of certainty, training, confidence and curriculum constraints do not afford her the opportunity to use IKS. She imagines a learning space where Western science and IKS live alongside one another, not in competition, but as a pair of complementary systems that can collectively enhance science education and create a deeper understanding among learners.

Moegamat's biographical descriptive narrative

Moegamat is a coloured male teacher aged 45 who speaks Afrikaans and teaches in a multiracial school. He is half-Tswana and Coloured, though he feels that he is Coloured because he feels more connected with the coloured side of his family and to the side he has closer relationships with. He never connected with his father because of constant fights between parents, and this deficiency shaped many things in his life while he was growing up. He teaches Natural and Physical Sciences and has more than 15 years of teaching experience. Teaching was far from his first option he wanted to be an engineer, but bad grades saw him out of other options. But he started teaching children in his neighbourhood at a young age and it was teaching in this community that he found his love and passion for teaching.

His own educational experiences were anything but idealistic; his teachers found it hard to simplify Natural Science and Mathematics for him, instead using chalk and talk, thus making the lessons uninteresting and without stimulation. His own experiences at school meanwhile could not be further from perfect, the teachers who taught him Natural Sciences and Mathematics only made things so hard to understand, preferring to use only chalk-and-talk methods – lessons which left you with little of the tools to engage and that all-important interaction. In his learning, he had to memorise by heart instead of grasping. It was these personal challenges that influenced his teaching philosophy, and he wanted to make learning easier and more interesting. He thoroughly knows IKS, and he refers to it as culture, traditions, and orally transferred knowledge from generation to generation. They brought him up surrounded by stories, he says, in his family's home, where his maternal grandparents told tales of their own at night by the fire tales that helped hold the family together, and transferred vital knowledge and life lessons in between. It is these deep-seated experiences of oral tradition and cultural knowledge that have made him realise that integrating IKS into teaching of sciences is a way of making the content of the subject more meaningful and real to learners. He is a firm supporter of the inclusion of IKS in the Natural Sciences curriculum, explaining that such integration will enable learners to relate what they see and experience in their daily lives with what they are taught at school. While he has tried to integrate IKS into his teaching, he found it difficult to implement as most learners did not understand how IKS could be related to western scientific knowledge.

He confesses that he doesn't possess the pedagogic training and skills to integrate IKS in a manner that will be effective and proper for all learners. That is why he points to the need for systematic guidance, step-by-step procedures, and explicit examples from the Department of Education. He is of the view that the Department should also think about engaging with expert members of the community like traditional healers or cultural experts who may work with teachers on a regular basis and ideally twice every month to assist in the incorporation of IKS. In addition, he is a passionate supporter of IKS workshops and professional development, saying that many of the teachers they work with were never taught how to incorporate Indigenous knowledge in their teaching. He is of the opinion that such training is required for teachers to be adequately skilled and confident to successfully use IKS in Natural Sciences, thereby bridging the cultural and formal science education divide.

4.3. Development of a research key

For the sake of making this process systematic and manageable, the researcher created the research key based on the core interview questions. This research key was intended to offer a systematic framework through which to identify and sort meaning in the data. As guided by the research key, the researcher first established and separated the NMU; these are pieces of text that bear one single, consistent meaning or idea regarding the research questions. For purposes of clarity and order, each NMU was labelled with a letter. Use of the letters facilitated easy reference in subsequent stages of categorisation and analysis. After making the NMUs distinct and assigning them with letters, the researcher sorted the NMUs manually into categories that were representative of the thematic contents in the respondents' interview responses. These were not pre-conceived, but were drawn from the data, and were in keeping with the phenomenological approach of keeping room for participants' lived experiences. Each one of these categories was built from patterns and common meanings ensuing across the participants' different narratives. This facilitated adherence to the phenomenology approach that values the subjective meaning and experiences of the participant. Development and application of the research key therefore contributed importantly to ordering and making sense of the data in systematic and consistent fashion. It forms the basis of deeper analysis and explication of the themes that ensued subsequently and enabled the researcher to engage substantively with the participants' lived experiences. The list of research keys used to direct the process of data explication is shown below.

Factors Influencing the IKS education

a. work overload
b. No strategy for IKS
c. Textbook gaps
d. Disconnect Between Western Science and Indigenous Knowledge
e. Indigenous Knowledge Value
f. No IKS training

4.4 Identification of central themes

The researcher used a thematic analysis approach to interpret data that were gathered through interviews with participants based on the NMU model, and research questions. The research questions served as a guiding framework to focus attention to some of the key issues such as teachers' experiences with IKS, the problems faced and their reactions. For example, the repeated statement of heavy curriculum load. At the NMU stage, the researcher started categorising similar remarks and ideas, making inferences about what these patterns in the data were telling us about teacher identities, challenges in pedagogy, and gaps in curriculum. Ultimately, in the process of Understanding, these grouped insights were distilled into wider central themes that accurately represented the underlying challenges emerging from the data. The NMU process enabled the researcher to bridge the surface-level responses and ensure that the resultant themes not only were grounded in participants' voices but were deeply linked to the purposes of the study. The researcher assigned each meaning unit with an equivalent research key by categorising and aggregating them under wider central themes. For example, multiple NMUs coded with research keys like "work overload" this thematic coding enabled the researcher to meaningfully organise the data and observe how often and across where each theme appeared and therefore explicate the underlying meaning of teachers' lived experiences with IKS.

The following table below presents a structured summary of the data explanation, where each NMU extracted from participant interviews is aligned with a corresponding Research Key, a conceptual label representing recurring ideas and organised under broader themes that capture the core meanings of the teachers' lived experiences with integrating IKS into Natural Sciences lessons.

4.4.1 Participant's transcript with NMUs alongside the research Key applied and the resulting theme.

Table 4.2: Kamvelihle's transcript for interviewee 1

Research key	Natural Meaning Units (participant' own words)	Central theme
a)	*"We are always rushing to complete the curriculum. There is no time for extra discussions."*	Time Constraints
b)	*"I do not know which strategies to use when teaching IKS… I just guess sometimes."*	Lack of pedagogical skill
c)	*"The curriculum does not really support IKS. We teach what is in the textbook, we are following the curriculum, it is not our rule. We are being told what to do IKS is left out."*	Curriculum Limitations
d)	*I am at a loss when dealing with the section of the curriculum pertaining to the implementation of Indigenous Knowledge Systems (IKS) in the classroom because I have no expertise. I have no clue how to apply Western knowledge as well as IKS in the teaching process, I am confused and at loss. I do not know how to link science with IKS. There is no connection shown."*	Epistemological divide between IKS and western
e)	*"If IKS is integrated in the science lessons it can help learners see how science works in their daily life. For instance, the moment they hear something from their culture, their eyes light up."*	Relevance of IKS
f)	*"I feel that for IKS to be effectively mainstreamed in Natural Sciences, teachers will have to be trained and developed through organised workshops the Department should have for formal workshops and training explaining the content of IKS, its significance in the fields of science and the environment, as well as concrete ways of incorporating it in day-to-day teaching."*	Professional development need

Table 4.3: Blessings' transcript for interviewee 2

Research key	Natural Meaning Units (participant' own words)	central theme
a)	*"We rush through the syllabus. IKS feels like something extra."*	Time Constraints
b)	*"I want to use IKS, but I do not know how to teach it scientifically, more in a multiracial school. There is no training, no clear way to bring it into class."*	lack of Pedagogical Skills
c)	*"The existing curriculum has a Western scientific worldview at the centre and treats Indigenous knowledge either as secondary or optional instead of making it a part of the integral learning experience. The Department needs to introduce a revised curriculum that incorporates IKS fully within the teaching of Natural Sciences in a meaningful and practical manner. Even if I want to include IKS, there is no time allocated for it."*	Curriculum Limitations
d)	*"Sometimes I feel Western science and traditional knowledge are speaking different languages."*	Epistemological divide between IKS and western
e)	*"They love it when I talk about traditional practices; they become more involved but sometimes I feel confused."*	Relevance of IKS
f)	*"There has not been any workshop done systematically and any training sessions among the educators regarding how it should be done effectively and how it should be integrated within the sciences classes so that it does the students a good deed."*	Professional development need

Table 4.4 Tawanda s transcript for interviewee 3

Research key	Natural Meaning Units (participant' own words)	Central theme
a)	*"We are supposed to cover all of it, even though the learners do not understand it, the curriculum is overloaded."*	Time constraints
b)	*"The curriculum leaves room to incorporate IKS but not guidelines, plans, or methods of teaching and learning that will assist us in integrating it in a meaningful way. The curriculum is not really supportive towards IKS. We are advised to follow what is in the book."*	Lack of Pedagogical Skills
c)	*"I want to include stories from elders, but it is not in the curriculum."*	Curriculum Limitations
d)	*"There is no training on how to bring IKS into Natural Science. There is no guidance on how to link the two types of knowledge."*	Epistemological divide between IKS and western
e)	*"IKS shows learners that science is everywhere not just limited in the classroom"*	Relevance of IKS
f)	*"There is a need for the Department of Education to be proactive in empowering teachers in offering workshops, extensive learning content, and practical demonstrations about how to incorporate IKS and scientific content in a way understandable for learners."*	Professional development need

Table 4.5: Lusanele's transcript for interviewee 4

Research key	Natural Meaning Units (participant' own words)	central theme
a)	*"There is never enough time to include traditional knowledge.*	Time Constraints
b)	*"The curriculum needs to incorporate the importance of IKS with clear priority, not simply an afterthought or tick-box exercise, but as an integrated part of learning. If we show its importance to science in the present and environmental issues, both the learners and the educators will come to see its value."*	Lack of pedagogical skills
c)	*"We were not taught how to use cultural knowledge in science class.*	Curriculum Limitations
d)	*"I am completely in the dark about IKS. It is something that was never included in my training as a teacher, and I have never been provided with any guidance and materials about how to integrate it in the lessons."*	Epistemological between Western and IKS
e)	*"The traditional scientific modes of operation and Indigenous knowledge exist in a language and cannot directly be translated in Western languages like English and hence end up being lost in translation. Many learners have been trained in ways of thinking and living in a Western direction and hence end up down-valuing and discarding Indigenous knowledge."*	Relevance of IKS
f)	*"We need workshop training, materials, and mentor programs that do not simply teach us about IKS but also show us how to include it in the curriculum in such a way that makes sense."*	

Table 4.6: Mischka s transcript for interviewee 5

Research key	Natural Meaning Units (participant' own words)	Central theme
a)	*" The pressure to cover all required content within a limited class period forces teachers to rush through lessons, making it almost impossible to elaborate on IKS from a teacher perspective.*	Time constraints
b)	*"We are not trained to use IKS properly in science. I can acknowledge the fact that I do not have the teaching skills necessary to merge these two systems of knowledge in a manner that makes the lessons exciting. And it is disappointing after all these years of teaching, but I continue to struggle with this.*	Lack of Pedagogical Skills
c)	*"A new curriculum should be drawn up that incorporates IKS with proper instructions and guidelines. The curriculum should be drawn up together with Indigenous people for the purpose of making it more realistic and meaningful with proper instructions and guidelines for teachers while planning for the flexibility of local adaptation."*	Curriculum limitation
d)	*"There is no space in the CAPS document where IKS is clearly placed."*	Epistemological Between Western Science and IKS
e)	*"I have tried repeatedly to make the knowledge come alive, to give it relevance, but every single time, I end up feeling like a failure. I just cannot see how the dots can be joined from the IKS to the Western knowledge in a meaningful fashion in the teaching."*	Relevance of Indigenous Knowledge

f)	*"To begin with, more such workshops should be organised that talk about the significance of IKS and the ways it should be integrated within lessons of the natural sciences."*	Professional development need

Table 4.7: Moegamat s transcript for interviewee 6

Research key	Natural Meaning Units (participant' own words)	Central theme
a)	*"IKS takes more time when teaching in a multiracial school, but we are always rushing to finish the curriculum."*	Time constraints
b)	*"I need to be given proper direction on what to do, step-by-step, with examples and guidance on how to effectively incorporate IKS into my science class in the proper way. I do have knowledge of IKS myself, but I lack the necessary teaching strategies to effectively incorporate it into my lessons in a meaningful way.* The curriculum does not say what IKS to teach hence sometimes I avoid it."	Lack of pedagogical skills
c)	*"The curriculum leaves no room for the proper integration of Indigenous knowledge, creating frustration and underscoring an urgent need to make changes that could bring enough time both for finishing off work with little practice. I do not know how to link science with IKS. There is no connection shown.*	Curriculum limitation
d)	*"When I look at the curriculum there is no space in the CAPS document where IKS is clearly placed."*	Epistemological between Western Science and IKS
e)	*"I have tried to integrate the Indigenous Knowledge Systems (IKS) into the Natural Sciences subject but was not able to continue with it because most of the learners were not in a state to grasp the connection of IKS with Western science knowledge.* They were not in a state to appreciate the relevance, and it was not easy	Relevance of IKS

	for me to continue with the classes. There is something I have noticed learners understand quicker when I use local examples.”	
f)	*The Department of Education should provide workshops and professional development programs for educators. Many educators were not trained to incorporate IKS, so ongoing training is essential to equip them with the necessary skills and knowledge. These workshops should include hands-on activities, lesson plan development, and guidance on assessing Indigenous knowledge alongside Western science.’’*	Professional development need

4.5. Explication of data

During the process of explication, themes inductively grew as the researcher saturated the transcribed interviews. Consistent with descriptive (transcendental) phenomenology in the tradition of Husserl as implemented through Giorgi's approach, attention was paid to isolating participants lived experiences as they experienced them, and not as interpreted by the researcher. By respecting the original narratives provided by the participants, the authenticity of the data analysis and phenomenological purity were upheld. These first-hand accounts lend themselves to the concretion of themes in participants' experiential worlds and respect the nature of the phenomenon at stake. The addition of rich verbatim excerpts from the participants does not only provide depth but also assures epistemological soundness and descriptive validity (Giorgi, 2009; Neubauer et al., 2019).

Upon phenomenological explication of interview data -in which each transcript was thoroughly read, divided into NMU and reformulated and synthesised-, six central themes emerged. The following are descriptions of each central theme with detailed paragraph rooted in participant's words:

4.5.1 Curriculum Constraints

This theme centred on the relentless pace of the curriculum. participants repeatedly described how the inflexibility of the CAPS and the ATP left little room for any additional content outside of the set topics. Kamvelihle described it as "*There is never enough time to fit in traditional knowledge." "The ATP plans every single week and if I break in with an IKS example, I won't be able to cover the next topic on time for exams."* Moegamat stated, "*Our exams only assess textbook material. Anything IKS-based comes across as a diversion from what learners need to learn to pass".* These NMU were classified under the research key "Curriculum Constraints," demonstrating how systemic pacing and assessment pressures compel teachers to focus on examinable material above valuable, culturally relevant knowledge.

4.5.2 Lack of Pedagogical Skills for IKS Integration

One of the dominant underlying patterns of discourse revealed by the explication of data was that teachers lacked specific pedagogical skills aimed toward integrating IKS. Participants consistently expressed feelings of unpreparedness while trying to draw up and conduct lessons that incorporated IKS in meaningful ways in conjunction with Western science material. Moegamat confessed, *"I don't know what activities or probes to use if and when I bring in traditional practices in my lesson",* and Lusanele said, *"We didn't have any examples in training, no model lesson plans or classroom strategies in IKS".* Tawanda described, "Whenever I try to incorporate IKS, I end up asking myself, am I doing it right?' since I don't have the methods of teaching to support it". These units of meaning were coded under the research key "No strategy for IKS," revealing the disconnect between teachers wanting to integrate IKS and the capacity to do so in practice. Without concrete frameworks of pedagogy, model lesson, or explicit professional development, teachers resort to old lecture or textbook-dependent methods and reduce IKS to brief anecdotal descriptions instead of active, interactive learning experiences. Closing this skills gap will necessitate that curricula begin to include explicit pedagogic guidance, hands-on workshops, and opportunities for mentoring that provide teachers with instructionally relevant tools to integrate Indigenous and Western knowledge systems into integrated, learner-centred science lessons.

4.5.3 Curriculum limitations

Analysis of the narratives of participants indicated the thematic underpinning of a constriction of the curriculum including a realisation of the gap between the formal Natural Sciences curriculum and the infusion of IKS. Moegamat repeatedly emphasised that, *"the inflexible pacing and curriculum saturation of CAPS allowed no space for meaningful treatment of IKS."* Tawanda expressed, *"I want to incorporate stories from elders, but it is not on the curriculum."* and Kamvelihle commented, *"the curriculum does not really do IKS justice. We are teaching as per the textbooks. We are following curriculum; it is not our rule ". We are being told what to do IKS is sidelined.*" This NMU fell under the research key "textbook gaps" which summarises how the formal curriculum almost entirely sidelines IKS. When there are no curriculum guidelines, examples or assessment criteria that refer to Indigenous perspectives, it is the opinion of these teachers that they must stay close to western content and represent IKS as an optional add-on and not as a fundamental characteristic of science education.

4.5.4 Epistemological Divide Between Western Science and IKS

The explanation of participants' accounts revealed the deep-seated epistemological gap that teachers encounter in attempting to synthesise IKS and the paradigm of Western science. Blessing articulated this tension briefly: *"Science demands proof and experiments, but IKS comes from belief and stories passed down by elders".* Kamvelihle *commented, "Learners could not believe that we can use cows' dung to heal wounds. They laughed at me while others were covering their noses when we talked about traditional medicine. There is a clear division in how they view knowledge"*. Mischka noted, *"When I look at the curriculum there is no space in the ATP document where IKS is clearly placed."* These NMUs were organised under the research key "Disconnect Between Western Science and Indigenous Knowledge" capturing the core obstacle of integrating two knowledge systems that are taught as mutually exclusive. The divide manifests not only in classroom instruction where textbooks and assessments privilege empirical Western methods but also in learners' and teachers' internalised beliefs about what constitutes legitimate knowledge. Without deliberate strategies to bridge this gap such as dual-perspective lessons or comparative analyses IKS remains marginalised and misunderstood.

4.5.5 Relevance of IKS

A general theme which came out of the analysis of data was the significance of IKS in making Natural Sciences relevant and meaningful to the learner. Teachers reported that when scientific concepts were anchored in everyday cultural examples, learners' interest and understanding were greatly enhanced. For example, Tawanda mentioned, *"When I explain the use of cow's dung in fire making learners understand immediately and are attentive"*. Blessing mentioned, *"using example when the ants are no longer seen roaming about, the cold season (winter) has come or is nearby."* These NMUs were categorised under the research key "IKS value", demonstrating how Indigenous knowledge, if incorporated reflectively, can act as a channel between remote scientific principles and learners' concrete realities. This relevance not only enhances instantaneous engagement but also enhances conceptual understanding in the long run, as learners are able to compare new information against existing cultural frameworks.

4.5.6 Professional development in Integrating IKS

Across participants, there was a persistent and definite need for professional development that was expressed by teachers describing the absence of formal training in teaching IKS. Lusane said, *"We were not trained on how to bring IKS into the classroom,"* Moegamat said, *"There is no workshop or example that shows us step-by-step how to blend IKS with the CAPS outcomes," and noted the lack of concrete, curriculum aligned guidance."* These NMU were all classified under the research key "no IKS training", noting the subject of inadequate training and support. Without access to targeted workshops, model lesson plans, or support from knowledge holders in the communities, teachers report feeling unprepared to craft lesson plans that reflect IKS fused with Western-style science.

4.6. Summary

Chapter four explained data collected using in-depth interviews with purposively selected Grade 9 Natural Sciences teachers. The researcher deduced and interpreted using Giorgi's phenomenological analysis the lived experiences of the participants in incorporating IKS in teaching. The biographical stories of each participant were presented in the chapter to establish setting and insight into what motivated them, what troubles them and what they think about incorporating IKS. The process of data explanation involved extracting meaning units of significance from transcripts of interviews, converting them to psychological text, and synthesising them into key themes. These themes encapsulated major elements of the lived experience of the findings such as what they understood about IKS and what troubles them in incorporating it due to constraints in the curriculum. The chapter provided a detailed and analytical representation of teachers' perception and effort towards incorporating Indigenous knowledge in science class and how tensions between Western science content and local culture knowledge inform their perception. The chapter also showed a sense of frustration among all the participants about a lack of training in teaching methodologies and support in structure to meaningfully integrate IKS. in this next chapter, themes derived are discussed critically and in relation to literature reviewed in chapter two and to ideas in those theories whose bases this study was built on. The chapter relates people’s own views to other researchers' theoretical and empirical contributions to deepening description of this study’s core issues. The findings in chapter five are also systematically used to answer questions posed in chapter one. By relating lived experience of participants to wider academic perception and assumptions and to theoretical constructs made in this and other studies, discussion provides critical reflection concerning the practicality of incorporating IKS in science teaching. This serves to shed insight into not only troubles but also potential in creating a more inclusive; relevant and transforming science education in South African schools.

CHAPTER 5: FINDINGS AND DISCUSSIONS

5.1. Introduction

In Chapter four the researcher interpreted data using Giorgi's descriptive phenomenological approach to uncover selected Grade 9 Natural Sciences teachers' lived experience of integrating IKS in their teaching. Furthermore, the provided a thorough analysis of the narratives of the participants in identifying the key meaning units and themes that shed light on opportunities and challenges confronting teachers in their endeavour to integrate IKS within the formal curriculum constraints. Based on this groundwork, chapter five outlines and discloses the major findings resulting from the process of data explication. These findings are interrogated in connection to theorised explanatory frameworks and literature reviewed in Chapter Two. The chapter explains how the participants' lived experiences correspond to, diverge from or extend existing knowledge on the IKS integration, multicultural education, science pedagogy in South African schools. The findings of the study were used to answer the questions stated in Chapter One. Through this analysis and discussion the chapter sought to provide a clear understanding of the implications of IKS integration on teaching practice, curriculum planning, and policy in schools. By doing so, it closes the gap between empirical data and scholarly reflection and sets the scene for final recommendations and conclusions in chapter six.

5.2. Reflection

Using the phenomenological lens enabled the researcher to explore the participants' own reality, to give voice to their successes, challenges, hesitations, and world views. Through lengthy interviews, teachers explained their understanding of IK as valid scientific knowledge or as cultural tradition, whether or not they understand it this way, and the way this is reflected in the way they teach, lesson plan, and practice in the classroom. Such understanding is only possible with qualitative, phenomenological methods where meaning making is prioritised over measurement. In order to capture the richness and depth of these lived experiences, the study used phenomenological research methodology. Phenomenology, as Van Manen (1990) and Creswell (2013) describe it, aims to describe, and explore the meanings people bring to those experiences. The rationale for this approach was that the study was interested in more than mere frequency of usage by teachers of IK, or strategy usage, but in how the teachers experience the inclusion of Indigenous Knowledge, make sense of it, perceive its value (or lack of it), and integrate it into their understanding of the notion of science education. The predominant source of data was unstructured interviews combined with the phenomenological approach, facilitated an understanding of the way in which Grade 9 Natural Science teachers experience, perceive, and conceptualise Indigenous Knowledge. Phenomenological approach allowed honouring the richness of teacher experience, providing rich data that was richly meaningful, from which to develop the future curriculum, to train teachers, to develop policy to decolonise science education.

Goals of the study were to:

- To explore Grade 9 Natural Sciences teachers' experiences of integrating Indigenous Knowledge Systems (IKS) in their classrooms.
- To explore how teachers understand Indigenous Knowledge as scientific, cultural, or spiritual and how this impacts their teaching.
- To identify the challenges and barriers faced by teachers when trying to integrate Indigenous Knowledge with Western science in the curriculum (e.g. lack of time, lack of resources, lack of clarity in the curriculum).
- To analyse the extent that curriculum policies and instructional guidelines support, or not, the inclusion of Indigenous Knowledge in the teaching of science.
- To investigate the tensions teachers, experience between the dominant Western scientific worldview, and Indigenous worldviews, and how do these tensions play out in the classroom.
- To be part of a science education that seeks to be more inclusive but also transformative one that values multiple ways of knowing, especially in post-colonial contexts such as South Africa.
- On how the meaningfully integrated IKS into science education could inform teacher training programs, curriculum reform and policy.

The purpose of this phenomenological study was accomplished by answering the research question. Key research question:

What are the lived experiences of selected Grade 9 teachers in integrating Indigenous Knowledge into their Natural Sciences lessons?

The research questions were to be answered by the study were:

iii. How do Grade 9 Natural Sciences teachers conceptualise Indigenous knowledge?
iv. How do Grade 9 teachers integrate Indigenous knowledge into their Natural Sciences lessons?

The free-response questions were asked to each participant in their interviews and the components are linked to the central topic and research question, how do Grade 9 Natural Sciences educators integrate Indigenous Knowledge Systems (IKS) into their practices? By delicately shaping questions that included all aspects of teachers' knowledge, pedagogy, curriculum involvement, challenges, and personal reflections regarding IKS, the study delivered a rare inside look into the role that IKS plays in environmental instances. The rich diversity of participants' responses to the questions highlighted the multiple dimensions of lived experiences, making possible a nuanced interrogation of what it means to integrate IKS into a curriculum that is still largely based on a Western paradigm. Several clear themes emerged from the data:

- Pre-service Pedagogical Knowledge before Integration into teaching: teachers might not be confident about integrating IKS into their practice.
- Instructional uncertainty and curriculum confusion: there is an acute lack of direction to teachers about content, and how to instruct what might be viewed and identified as IKS.
- Bridging the epistemological divide: engaging with the clash of Indigenous and Western Knowledge Systems
- Collateral learning: teachers and learners struggle to conduct both knowledge systems side by side, without actual integration,
- Limited Classroom Discussion: there is a lack of critical discourse during IKS lessons, which hinders the depth of understanding.
- Insights through a phenomenological lens: the study emphasises the emotionality, culture, and lived experiences of teachers as they engage with IKS integration.

These are the themes that allow for a broad portrait of the opportunities and challenges educators face and that lend shape to the study’s findings and recommendations. Further, they provide a grounding in the theoretical concepts used in the research and highlight the importance of social constructivism, border crossing and collateral learning in merging Indigenous and Western knowledges in education.

5.2.1 Conceptualisations of Indigenous Knowledge among Grade 9 Natural Sciences teachers

These findings indicate that Grade 9 Natural Sciences teachers conceptualise Indigenous Knowledge (IK) in diverse, fragmented and at times, contradictory ways. One of the most prevalent themes that emerged from responses was that of IK as knowledge passed down between generations, rooted in cultural practices and traditional ways of knowing. Teachers tended to refer to IK as "knowledge from long ago," "what our ancestors used to do," or "things that were not written down but which our grandparents knew." For example, Kamvelihle said, "Indigenous Knowledge is all about traditional methods by which our people used to solve challenges before science existed. If we have flu, we use umhlonyane, which is wormwood, to steam out the flu, rather than using something such as Med lemon." This is in keeping with thinkers such as Hoppers (2002), who refer to Indigenous Knowledge as local cultural-traditional sources existing in localised forms sustained through verbal transmission. Likewise, Dora Hoppers (2001) and Semali and Kincheloe (1999) confirm that IK is locally based, holistic, often spiritually based, existing apart from but equally as legitimate and valued as Western-scienced knowledge. The participants' accounts tended to reflect these assumptions, but uncertainty about how to speak or integrate these concepts in formal science class exists.

Yet, despite some acknowledgement of the worth of IK, there existed clearly an epistemological tension in teachers' perception about how scientifically legitimate IK is. One of the most important themes that arose from the data was the epistemological tension between Indigenous and Western systems of knowledge. Some participants had difficulty defining IK in a scientific context, often referring to it as "traditional," "ancestral," or "cultural" rather than "scientific." Mischka stated, Indigenous Knowledge is learned from older people and there is no relation to science that I teach in the classroom.” On the other hand, participants refused to qualify IK as "scientific" or legitimate to include in mainstream science content. One of the teachers said, “It is good for culture, but we are teaching science so how do we combine it with stories and presumptions that are not proven?” This reflects the epistemological opposition Aikenhead and Jegede (1999) have described between Indigenous knowledge systems and Western science. For these scholars, many teachers work in an epistemological framework that makes Western science objective, universal, and testable, with IK being subjective, anecdotal, or even mythical. The results of this work confirm that such binary thinking exists in classrooms too, as teachers attempt to synthesise values and modes of working in Indigenous knowledge with those of formal science education. The assumption that IK is not as rigorously empirical as science makes teachers view it as peripheral to science education. This is indicative not only of how dominant Eurocentric epistemologies are in education, as scholars such as Snively and Corsiglia (2001) and Cobern and Loving (2001) maintain, but also how much epistemic justice is needed in educational reform. This epistemological divide is further reinforced by the schooling system, which tends to position Western science as objective, quantifiable, and universal, and Indigenous thought as subjective, unproven, and situational. Many teachers derived from a system that has trained their mind to see science through a positivist lens and therefore, struggle to accept IK as equal (Ogunniyi, 2007). Many teachers in this study articulated this struggle. Tawanda, for example, confessed that although she is aware of traditional knowledge due to her upbringing, “I *do not know how to connect it to the CAPS content. It feels divorced from what I am supposed to teach.”* This indicates not just an epistemological discomfort but leads into the second major theme curriculum ambiguity.

Even though South African education policies (such as CAPS) encourage integration IKS into the learning process, participants in this research indicated that the curriculum lacks explicit direction regarding what IK (and its states) constitutes, how it can be adopted and how it corresponds to what is studied in science. That vagueness makes a lot of it reliant on teachers’ discretion and experience. Some of the interviewees said that the curriculum talks about IK by motivational words without really mentioning how it is supposed to be meaningfully included as well as requiring it to be evaluated. Kamvelihle asserted, *"We use cow droppings for swollen fingers, for the feet, and for pimples.*" This way of conceptualising is highly aligned with phenomenological views, which focus on subjective, lived experience. van Manen (1990) highlights that meaning is derived from lived experience, and in this research, participants' perception of IK tended to be derived from what they had witnessed, heard, or gone through in their communities. Such experience-based insights demonstrate that IK is not merely theoretical or abstract but highly embodied and contextual. In addition, the research revealed that teachers envisioned IK as an asset to contextualise science content but did not know how to bring this meaningfully to class since they lacked guidance in pedagogy. Teachers recognised that IKS would help make science more meaningful to learners, particularly for topics such as health, agriculture, and environment. Blessing, *"I understand that it is important, but how do I describe spiritual and ritualistic behaviour of weather phenomena when all that the curriculum is asking is how does high, low-pressure area affect weather?"* Droughts can be interpreted as evidence of imbalance or misconduct, and rituals or offerings might be carried out to request rain or to restore balance with nature. The same is not written in the textbook. This ambivalence reflects what Ogunniyi (2007) refers to as the gap between policy, curriculum, and practice, in which document policies promote IK but offer few clear guidelines, examples, or assessment methods. Keane (2008) also points out that teachers are left to reinterpret policy intent in the absence of supporting structures, resulting in variable and reluctant implementation. Therefore, even where teachers have an enriched conceptualisation of IK, their capacity to realise this in their teaching is limited by a lack of instructional guidance and supporting structures.

These results also found that multicultural classrooms make it difficult to make this border crossing. Participants were worried that bringing particular cultural knowledge into these classrooms will alienate or offend learners across different backgrounds. This corroborates Aikenhead's (2006) point that border crossing is not only cognitive, but socially and emotionally as well. Lusanele said, *"I am a very traditional man, but I cannot bring that into my class because it is so multiracial."* It indicates that absent intercultural pedagogy and assistance, teachers will hesitate to make this crossing of cultures.

Moreover, there are structural issues with the curriculum as well. Teachers indicated that textbooks and formal curriculum hardly make evident connections to Indigenous knowledge, thus reinforcing epistemological disconnection. This supports Keane (2008) and Kaya & Seleti (2013), who theorised that science curricula in postcolonial education still favour Western epistemologies at the cost of Indigenous ways of knowing. From a theoretical point of view, these observations broaden the scope of Aikenhead's (1996) border crossing and Jegede's (1995) collateral learning theory. Whilst these theories are both learner-focused, this study indicates that teachers need assistance as well to make epistemological crossings. Several teachers exhibited signs of parallel learning, where both IKS and Western science co-existed but were delivered separately as a result of lack of training or fear of controversy. Teachers are thus placed at odds with themselves concerning whether to emphasise scientific expertise or cultural significance. As a result, this tension eventually erodes both forms of knowledge and reduces science education's impact within African schools. As proposed by experts like De Beer & Petersen (2016), integration will flourish with professional development that accepts pluralism and offers educators training to be cultural mediators. The results concerning border crossing and the epistemological divide reiterate the deep effect of unresolved conflict between Western science and Indigenous science in the Grade 9 Natural Sciences curriculum. Educators are suspended between two cultures, frequently with little pedagogical skills and institutional backup to facilitate bridging. The research expands Aikenhead's theory of border crossing and Jegede's collateral learning, with emphasis that educators, similar to learners, need to be epistemologically scaffolded to negotiate and combine various forms of knowledge.

This ambiguity contributes to the third prominent theme an absence of pedagogical supports and approaches. The teachers interviewed in this research mostly reported having never received formal professional development on the topic of teaching IK, planning lessons with IK, or assessing integration of IK into lessons. A few educators tried to incorporate IK in their teachings, as they spoke about traditional medicine or farming practices; however, these were arbitrary and not connected to the overall lesson objectives. These findings are consistent with those of Snively and Williams (2008), who argue that teachers need structured support, such as lesson materials, professional development workshops and working collaboratively with Indigenous knowledge holders in order to appropriately integrate IKS to their Teaching Science. The effect of the epistemological divide, curriculum ambiguity, and lack of pedagogical support results in the sporadic and inconsistent adoption of IK in Natural Sciences education. They respect IK it is known that they exist within the communities but are not taught to integrate these practices in the curriculum. This status quo perpetuates ongoing marginalisation of IK, even in spaces where inclusive policy development is intended to take place. As highlighted by Dei (2000) and by Hoppers (2002) not only is the integration of IK into science education supported by policy but it also rests on the philosophical shift in valuing and transferal of knowledge within schools. Thus, without interrogating deeper epistemological tensions and developing more concrete approaches in support of pedagogy, IK continues to exist on the edges of science education.

5.2.2 How do Grade 9 teachers integrate Indigenous Knowledge (IK) into their Natural Sciences lessons?

In this section, the study findings are discussed within the context of integrating IKS within Grade 9 Natural Sciences classes. The analysis draws on literature and examines how teachers try to integrate IK into their classes through teaching styles, lesson planning, class activities, and interpretation of the curriculum. The evidence indicates that there is a general appreciation of IK by teachers, but the nature and scope of its integration is varied. This variance is attributed to personal epistemological beliefs, insufficient pedagogical training, curriculum uncertainty, as well as shortages of time. The discussion is organised from emergent themes from the evidence and how they converge with or diverge from the current literature.

The integration of IK into Natural Sciences starts during lesson planning. The research indicates that many teachers are left uncertain as to where IK is supposed to fit into the curriculum, as the CAPS document makes sparse, often ambiguous, mention of Indigenous knowledge. There was confusion from participants as to precisely what defines IK from a science point of view, as well as how it would relate back to formal content. Teachers reported a deep disconnect between the curriculum's call for IKS inclusion and the absence of practical information on how it can be done. Lusanele explained, "*The Department of Education says we have to teach IKS but do not tell us how. We are confused. We do not even have materials or time.*" This everyday experience of uncertainty fits with Husserl's (1931) notion of reality being interpreted through one's consciousness and everyday experience. While IKS inclusion is promoted on paper, teachers are faced with a fragmented reality where there is no support for making the vision a reality. This is further contrary to constructivist expectations that policy will be passed into practice through professionals' agency (Vygotsky, 1978), as it indicates the phenomenological mismatch between expectation and practice. In the research, Naidoo and Ramsaroop (2017) further highlight that while IKS is recognised within curriculum documentation, there is still a deficiency of epistemological clarity and pedagogical strategies, meaning educators must work within this space uncertainty. Tawanda said, *"Even though I want to include IKS, I am forced to rush over things because of curriculum deadlin*es. IKS discussion is time-consuming, and we do not have extra lessons for that." This is corroborated by Letlape and Pitsoe (2014) who argue that uncertainty among teachers is caused by ambiguity of the curriculum as well as uneven instructional routines. Without a given outcome for how to integrate IKS in science alongside examples, teachers have to navigate through a complex instructional landscape with no maps. But the same is echoed even louder by the work of Keane (2008), citing how curriculum developers fail to bridge epistemologies, leaving the responsibility of decoding and implementing IKS by themselves. Lack of instruction works to hinder pedagogical innovation as well as disempower the development of culturally relational instruction. Based on a constructivist approach (Piaget, 1970), such curriculum disallows learners' self-constitution of knowledge from respective Indigenous as well as Western epistemologies.

Constructivism advocates for knowledge being constructed by experience and interaction, though not providing enough space within the current curriculum for such epistemological interaction. To contrast, teachers reported that curriculum documents mention IKS vaguely, generally, with little or no mention of instructional strategies. For instance: Blessing stated, *"I know that curriculum includes Indigenous Knowledge, but it does not tell me how or give me any example. Therefore, I do not know how to do it."* Tawanda added, *"I have worked as a teacher for many years, and I still do not know where the IKS falls within the curriculum. It is as though we have to make a guess."* This is consistent with the view of Ogunniyi (2007) and Keane (2008) that curriculum documents within South Africa mention Indigenous Knowledge superficially, though providing little guidance as to how it is to be implemented. Hence, teachers interpret the curriculum themselves, thus inconsistent, tokenistic inclusion of IK. There were some attempts by participants to outline lessons involving samples from customary practices. However, such inclusions tended to be short and not well developed through lack of confidence rather than lack of content knowledge. The evidence indicated that most teachers did not have systematic teaching strategies for integrating IKS. Teachers integrated IK through casual narration or referred only back to indigenous cases once learners had introduced them. Mischka described, "*I allow learners to speak of what they know within their communities, such as using herbs or traditional methods of making fire. But I do not plan for it because I am not trained."* What is noted here is the absence of pedagogical scaffolding for teachers, a problem noted by De Beer and Whitlock (2009), who call for IKS inclusion as part of teacher education programs so teachers can manage epistemological diversity within the classroom. Other teachers relayed their own anxiety causing them to avoid class discussion, meaning learners' voices went unquoted. Moegamat revealed: *"Sometimes learners pose good questions relating to traditions, but I just bypass them because I do not know the answer."* What is encountered here is how teachers' enacted fears directly control discussion and participation, constricting argument, dialogue, and jointly constructed meanings. In theory of argument, learner interrogation and dialogue are essential tools for meaning production (Driver et al., 2000). But the phenomenological observation is that teachers' emotional state, rather than confidence, prevents such opportunities. Waghid (2014) contends that practical wisdom, reflecting wise practice rooted in ethical and reflective teaching, is necessary for managing such emotional and ethical complexities. What this study indicates is that there exists a discrepancy between the romanticised cultural identity of the teacher as conceived by teacher education programs, as compared with how the same identity is enacted through the emotional experience of teaching. Many of the teachers employed discursive methods, getting their learners to share their family-knowledge, passed from their parents through generations. This created relevance and learner participation, particularly for learners from rural areas who could connect with the illustrations. But without a pedagogical framework for connecting such knowledge to official science, the discussions became anecdotal. Those teachers whose philosophy of education had a more constructivist bent than those who assumed learners constructed knowledge from their day-to-day experiences were more receptive to letting learners transfer their own knowledge into the classroom, even where they had no idea how "scientific" it could be validated.

In contrast, teachers who had a fixed, content- centred teaching style were reluctant to involve IK in their classes. Lusanele expressed, *"I fear that if I do talk of things traditionally, the learners will get confused. Science is fact, not belief."* This observation indicates what Aikenhead (2006) would refer to as an epistemological split where Western and Indigenous knowledge systems are considered incompatible. Consequently, these teachers defaulted to textbook, transmissions teaching, with restricted exposure for learners from diverse modes of knowing. In spite of the challenges, several participants gave evidence of how they integrated IK positively into their curriculum through activities within the classroom. For example, Moegamat stated: "*When I do Life and Living – Biospheres, ecosystems, biodiversity I would usually take my learners out to Kirstenbosch Garden so that I can link IKS as well as western science. When I do go out with learners into Kirstenbosch National Botanical Garden, I am not simply providing a change of view; I am taking the learners out deliberately and merging Indigenous Knowledge Systems with Western scientific ideas within a living context. This excursion becomes a living classroom where learners see the interconnectedness of ecological science, botany, and cultural heritage*." Through this activity, the teacher is able to show learners that IKS is not unscientific, primitive, but actually complementary to Western botanical science. The learners start perceiving worth in local knowledge that is frequently devalued or discounted within the formal curriculum. Taking learners through the gardens, feeling the leaves, smelling the herbs, listening to stories of how their ancestors made use of these herbs, learners make emotional as well as intellectual links that the textbook is not able to provide.

In accordance with Ogunniyi and Ogawa (2008), science educators not only need to deal with the content of science, but with the worldviews that are contained within the systems of knowledge. This teacher's approach confirms such an approach by giving respect to the epistemological value of IKS, indicating that science is not only confined within laboratories, but is intricately embedded within nature, as well as culture. This method of teaching is also coherent with constructivist pedagogy, where learning is experiential and revolves around the learners themselves. Knowledge is constructed by learners through being engaged with their surroundings, posing questions, and relating latest information to existing cultural knowledge. It is coherent with decolonising curriculum by giving African systems of knowledge parity with global science discourses. On the contrary, Mischka opined that while teaching the subject of weather patterns within the curriculum, one of the best strategies is starting the lesson with an open-class discussion, where learners are encouraged to share their own personal observation and everyday experiences pertaining to the weather. such an approach generates learner participation, draws on their prior knowledge, and respects Indigenous ways of observation and interpretation of natural phenomena, for example, bird's movement, animal's behaviour, or the emergence of specific clouds. These notes of observation are based on several generations of local knowledge and have worked for communities for centuries for predicting the pattern of the weather for agriculture, fishing, or for day-to-day activities. This way of teaching reflects what Vygotsky (1978) highlights as the social aspect of learning one acquires meaning through interaction, as well as social conversation. By raising such questions that are akin to their day-to-day activities, the teacher stimulates learners' Zone of Proximal Development (ZPD) and makes a link between home knowledge as well as educational science.

These are reiterated through the findings of Snively and Corsiglia (2001), where they stipulate that including IK in the science classroom can promote science education that is culturally relevant, strengthens identities of learners, and makes science understandable. They contend that IK is not "pre-scientific" but is another form of science based on long-term observation of the world around one, coupled with stewardship of the environment. Yet the challenge for many educators is integrating such practices through curriculum goals while still upholding academic standards. As Lusanele said, "It is not easy to infuse IKS and western knowledge. Hence there are no examples in the textbook."

The other challenge confronting IK inclusion was the timetable demand for covering the curriculum and readying learners for exams. Most of the participants confessed that they did not include IK because it is not directly examined nor included on past papers. An observation of one teacher captures it well: *"I would love to spend more time on Indigenous Knowledge, but the learners must pass. I have to concentrate on what is in the exams."* This is echoed by research by Le Grange (2004), who believes the high-stakes nature of South Africa's standardised assessments compels teachers to "teach to the test" rather than allow for innovation and contextualisation. Added to this is the curriculum uncertainty noted above. Teachers believe that incorporating IK will retard coverage of content or detract from “proper” science. The consequence is that IK will not be included, or, where included, will be made only brief mentions which do not do it justice nor ascribe the richness it deserves. Until curriculum policy and assessment protocols are changed, formally taking Indigenous Knowledge into account, curriculum developers will struggle with its inclusion.

One of the most hopeful findings was the willingness of teachers to work with community members or holders of traditional knowledge, although none of them had previously done so. Blessings described a successful lesson where he had invited a close friend who is a qualified botanist and practicing traditional herbalist to lead a lesson for his Grade 9 learners. The motivation behind his partnership was the desire for a rich learning experience that connects Western scientific knowledge with Indigenous ecological practices. This is echoed by the research of scholars such as Agrawal (1995) and Snively & Corsiglia (2001) that contend that Indigenous knowledge is not cultural lore, but a complex system of knowledge of the natural world based on generations of observation, experimentation, and living with the surrounding ecosystem. By Odora Hoppers (2002) such knowledge must not be pushed to the periphery of education but rather established as an epistemologically equivalent alternative to Western epistemological systems. The lesson proved that the inclusion of local knowledge holders could lead to deeper curiosity as well as validation of learners' culture, hence enhancing the inclusivity of the science classroom (Keane, 2006, Ogunniyi, 2007). The learners dealt with it with enthusiasm and curiosity. Most of them had a fascination with how the traditional healing practices were reflective of scientific concepts they had learned back in class, such as extraction, active compounds, as well as biological functions. The herbalist discussed sustainable techniques of harvesting as well as spiritual and communal obligations accompanying plant use aspects often left out of mainstream science curricula. The holistic teaching moment sustains the notion by Aikenhead and Jegede (1999) that science education can be made more richly significative as well as relevant through embracing "border-crossing" an epistemological approach where learners are encouraged to traverse between Western science as well as their own cultural systems of knowledge.

For all its success, the project had, however, flagged up the structural constraints within the curriculum. According to Shava (2013) and Khupe & Keane (2017), the CAPS curriculum fails to direct educators as to how best to integrate IKS in a pedagogically appropriate way, nor how to do so epistemologically, i.e., with respect for the knowledge being brought into the academy. Teachers therefore have recourse, frequently, to individual effort, local networks, or makeshift strategies for incorporating IKS. Since formal policy support and teacher professional development is not forthcoming, their involvement of herbalists to strengthen the content, underscores, however, the need for urgent policy support as well as teacher professional development support for this purpose. The visit by the herbalist not only enriched learners' knowledge of plants but demonstrated how Western and Indigenous systems of knowledge can complement each other. It also showed how powerful science education can be for communities with such involvement, as noted by Le Grange (2007) calling for such "decolonised curricula" that capture diverse ways of knowing. But it also revealed gaps between pedagogical training and curriculum guidance, confirming the contention of De Beer & Petersen (2016) that IKS can only be meaningfully integrated through systemic change, not individual teacher endeavour. This underscores the promise of community involvement as IK integration resource as posited by Shizha (2013) and Semali and Kincheloe (1999) who propose "culturally responsive pedagogy", where the school becomes a site of cooperation between formal educators and cultural knowledge holders. But such a model depends on systemic support from the Department of Education, e.g., permissions, logistical assistance, as well as curricular flexibility.

5.2.3 Answering the main question

Grade 9 Natural Sciences teachers' experiences as they introduce Indigenous Knowledge Systems (IKS) into their classrooms are an enriching mix of professional ambiguity, curriculum demands, and sensitivity to diverse cultures. Natural Sciences teachers had high regard for IKS and valued its essence in contextualizing science, rendering it meaningful, and making it tangible for learners. Yet, much as they appreciated it, they found it difficult to incorporate IKS in a meaningful manner, faced by multiple challenges. A key issue was a lack of professional development and training, with participants noting that they were never shown how to implement IKS in their teacher education. Therefore, they lacked confidence in how to teach the subject matter since they had no proper guidance on how to approach it or materials on which to base their methods.

This made them uncertain about approaching the topic, as well as teaching materials, hence the reluctance and inadequacy. Classroom diversity made things even more complex, particularly in multiracial schools where learners hail from different linguistic and cultural communities such as isiXhosa, Afrikaans, Lingala, Swahili, Ndebele, as well as French. Although the schools only acknowledged two home languages (isiXhosa and Afrikaans), this limited acknowledgment hindered teachers from attending to the wider field of Indigenous knowledge that learners may bring from their communities. The teachers reported various instances on how to use cow dung as a face mask in their traditions or as a wound-healing agent, or singing other older traditional songs during cultural days, implying that IKS is very much real in communities, though not necessarily easy to apply to formal concepts in science. Other teachers confessed that they do not incorporate IKS at all because they are lost if they are to apply it meaningfully to curriculum content. The curriculum appeared rigid and packed, as teachers complained that they are stressed to cover the curriculum prior to exams, with no time to delve deeper into topics around IKS. This pressure compelled them to advance to the popular topics in preparation for exams, though they acknowledged the value in including IKS. It caused them to feel self-generate personal tensions, like feeling strongly attached to the values of their own traditions but finding it hard to find those values within a multiracial class where students do not have the same cultural background. All these problems caused the teachers to feel frustrated, guilty, and resigned, because most of the teachers felt they could do better but felt constrained by the system. Their experiences strengthen the need for system support in the form of policy reform, curriculum alignment, and professional development activities that assist teachers in confidently and effectively integrating IKS in the Natural Sciences class.

5.3 Summary

In this chapter the main findings of the data explication are described and revealed. The findings are explored through the lens of the theoretical frameworks and the literature covered in Chapter Two. The findings provide main insights into teachers' experiences with the incorporation of IKS in the teaching of Natural Sciences. The next chapter six summarises the main findings and how they contribute to an understanding of the phenomenon. It also discusses the significance of the study, makes suggestions for future work, and provides a personal reflection on the research process.

CHAPTER 6: CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

6.1. Introduction

In the previous chapter, the findings of the research were discussed to provide some conclusive findings in the integration of IKS in the Natural Sciences lessons. The narrative embodied the participants lived perspectives, relating them to chapter two theoretical framework and the literature reviewed. Through the discussion of challenges and possibilities, the answers to the research questions (Chapter five) are provided and the implication for curriculum planning, teaching and educational policy was addressed. Chapter six takes a step back to reflect the key findings and discuss the implications for the demarcation of the issue of the integration of IKS into Science lessons. This chapter concludes the discussion, providing an inference of the findings of the study and what they mean for Natural Sciences curriculum. It also suggests areas for future research that may further illuminate and further explain the findings of this research. also provide a personal reflection on the process of the study, sharing the challenges met and the lessons learned and how the researcher evolved the study. Chapter six concludes the dissertation by sharing a list of recommendations for teachers, policy makers and future work to carry on the work of studying and enhance IKS integration in education.

6.2. Overview of the study

The study examined the lived experiences of selected grade 9 Natural Sciences teachers on the integration of IKS into their lessons. The main aim of the study was to explore how the teachers perceive, experience and try to integrate IKS in the Natural Sciences lessons in their classes and what the challenges are in attempting to do so. The research adopted a phenomenological design as the guiding perspective to provide a rich understanding of the participants' personal and professional worlds. The issue problematised were despite policy affirmation of Indigenous Knowledge, there is a huge divide of intention and practice of the curriculum in the class. Teachers are often not prepared with the pedagogical techniques, time, support, and resources to successfully incorporate IKS with Western science content, which is a lost opportunity to make science more culturally responsive and responsive to the needs of learners.

To address this problem six experienced Natural Sciences teachers who integrated or demonstrated an interest in IKS as an instructional aid, were interviewed in detail. The participants were selected purposefully according to their backgrounds, experience, and openness to recounting their personal stories. The data were gathered through unstructured interviews and were examined according to Giorgi's phenomenological approach through a process of repetitive readings of the transcriptions, isolating meaning units, and synthesising themes representing the meaning of the participants' experiences. The researcher also crafted biographical narratives in a view to gaining a finer-grained insight into each participant's history, motivations, and context realities. Chapter One provided background to the study, problem statement, framed the research questions, and clarified the significance and scope of the study. Chapter Two considered literature on Indigenous Knowledge, curriculum integration, and phenomenology and provided the theoretical framework based on phenomenological philosophy. Chapter Three detailed methodology with a description of the research design, sampling, data collection, and analysis. The data was interpreted in Chapter Four in-depth through Giorgi's phenomenological steps with emphasis on teachers' lived experience in incorporating IKS into formal science. Chapter Five outlined findings and discussed them in response to literature to answer the questions framed in this study. Lastly, Chapter Six provided a summary of the study, reflected on its contributions, discussed limitations, and made recommendations for future studies and educational practice.

6.3. Summary of findings

This chapter provides a detailed synthesis of the findings in response to the main questions of inquiry in this study, detailed in the previous chapter. Based on Giorgi's phenomenological approach, this study examined the lived experience of selected Grade 9 Natural Sciences teachers in incorporating IKS into their teaching. The findings indicate that although teachers appreciate the value of incorporating science to become more relevant and culturally connected science, they encounter numerous obstacles in incorporating it into their teaching. The most persistent theme was the *lack of appropriate guidelines and pedagogical scaffolding for teachers to confidently integrate and meaningfully relate curriculum-linked IKS to what is already taught*. The responses from teachers indicated the negative effects of time constraints highlighting how fast-paced curriculum coverage constrained teachers from teaching additional content such as IKS to be taught even where it has potential to make science more understandable and culturally attached. The study also found resistance by teachers in connecting IKS to Western science concepts owing to the presentations of these systems of knowledge in a standalone form in the curriculum without any discussion on strategy towards integration. Some teachers also mentioned a lack of training or exposure to Indigenous knowledge in formal education courses in addition to hesitation and a sense of vulnerability to try teaching it. Despite barriers to integration, however, findings also point towards a clear desire and interest by teachers to adopt Indigenous Knowledge especially with support through community outreach and expertise. The study in conclusion highlights both potential and complexity in integrating IKS in Natural Science classrooms along with a need for policy support through curriculum reform, teachers' training, and community outreach to effect viable implementation. The findings are directly in response to chapter one's title questions and lay a solid platform for recommendations and reflection provided in this final chapter.

6.3.1 Key Challenges in Integrating IKS

Lack of Pedagogical Skills: This study highlights that Grade 9 teachers struggle with integrating Indigenous Knowledge Systems (IKS) in Natural Sciences lessons due to a lack of pedagogical skills. Many participants in your study expressed feeling lost, unsure of which teaching strategies to apply. This suggests a need for structured guidance, professional development, and curriculum support to help teachers effectively merge IKS with Western science education.

Curriculum Ambiguity: All the participants in this study complained that there is no guidance or clear instructions on how to integrate Indigenous Knowledge Systems (IKS) into Natural Sciences lessons. Although IKS is mentioned in the curriculum, no one has ever provided practical, clear guidance, leaving teachers feeling completely lost. Even those with more than 10 years of teaching experience remain clueless about what the curriculum actually says regarding IKS implementation in the classroom, it provides no structured resources or guidance, leaving teachers uncertain about how to implement it.

Language Barriers: All the participants complained that teaching in a multiracial school makes it extremely challenging to integrate Indigenous Knowledge Systems (IKS) into lessons because of language barriers. They highlighted that when teachers do not use their native language during the integration of IKS, the meaning can be lost or become senseless. Since many of the learners come from culturally and traditionally rich backgrounds, switching to a medium of instruction that is not their native language can lead to different interpretations and significant confusion. Participants stressed that this language inconsistency dilutes the intended cultural context and essence of IKS, ultimately affecting the teaching and learning process. They believe that adopting a bilingual approach or using the appropriate language in the classroom would help preserve the true meaning of Indigenous knowledge and make its integration more effective.

Perceived Conflict Between Knowledge Systems: Participants in this study highlighted that it is difficult to create interconnections between Indigenous Knowledge Systems (IKS) and Western knowledge. They see Western knowledge as fundamentally opposing IKS, noting that the frameworks, epistemologies, and teaching methods underlying each are often at odds with one another.

Unavailability and credibility of resources: Further, participants complained about the unavailability and credibility of resources. Others attempted to incorporate traditional knowledge through the invitation of community residents, but the same is not always available because of the lack of time, logistics, or institutional resources. The unavailability of reliable textbooks or educational materials based on local Indigenous knowledge forces teachers to depend on unofficial sources, which the teachers do not consider to be long-lasting.

limited time available: Another major concern raised was the absence of sufficient teaching time within the teaching calendar. Educators complained that the curriculum is already packed, and there is an expectation to finish all the topics well in advance of the assessments. This provides no space to include in-depth discussions and practical activities regarding IKS, so teachers tend to either leave out or rush over IKS in lessons.

6.3.2 Time constraints

In the wake of the time constraint that was witnessed while carrying out the study of teachers' experiences with Indigenous Knowledge Systems (IKS) for the study of lessons of Natural Sciences, the challenge and lessons learned are the following. The challenge of the constraint of time pervades education research while carrying out complex cases such as the use of IKS that demand intensive immersion with the life of the teachers and classroom life. The constraint of time influences the richness of the gathered data and the study at the macro perspective (Creswell, 2013).

One of the most prominent reflections that emerge from the study are the challenges of reconciling the need for extensive data collection with the limitation of the short duration of the teachers' involvement. To give just one example, when interviewing teachers, the study at times needed to be crammed into tight schedules, especially when teachers were coping with their classroom workloads, curriculum needs, and other professional commitments. The tight schedules were such that it was challenging to undertake multiple follow-up interviews that might have unlocked more insight into the evolution of teachers' practices over the years.

Secondly, the analysis of the study came under the pressure of the constraint of time. Phenomenology requires careful examination of lengthy descriptions of people's experiences for the purpose of identifying themes and patterns within the experiences. The analysis of such experiences requires lengthy effort and much concentration of the analyst. With the study under the constraint of time, the analysis of the data at times came at the expense of depth of analysis and the exploration of emergent themes at times (Balfour, 2018). The constraint of time nonetheless pushed the study toward more intense study and compelled the study of the most critical aspects of the study questions while the study focused more on the most critical data that required collecting and analysis.

6.3.3 Fieldwork

It was clear from the fieldwork that while interest for the integration of the IKS into the Natural Sciences does exist, teachers require more resources and support for the successful implementation of it. The teachers with prior knowledge of the Indigenous knowledge and the relationship with the people of the place seemed to find it easy to identify the linkages between the science content and the IKS. Empowering the teachers with the required resources and teacher development are the solutions for overcoming these challenges. The students were open to the integration of the IKS but required more integrated and inclusive approaches that bridge the cultural and academic divide.

6.4. Conclusions

Main Challenges in the embedding of IKS It is a great challenge however, to incorporate IKS into the Natural Sciences, as it has become apparent from the participants' stories in this article. One of the most cited issues by educators is the absence of explicit curriculum guidance and official backing in the Department of Education. Although these policy documents may reference IKS, they do not give prescriptive tips or resources to help teachers integrate IK meaningfully and systematically into their curriculum and classes.

Other issues that re-emerge is the absence of training as well as teaching skills. A number of teachers also reported that they had not learnt about IKS on their teacher education programmes, nor had they learnt how to integrate IKS with western science content. In consequence, it is difficult to know which teaching strategies to use, to know how to connect IKS with formal science and how learners' integration of knowledge can be judged.

Lack of time in an overpacked curriculum was also identified as a significant "blockade". There is also often a sense among teachers of the pressure to cover the formal curriculum prior to exams, which often does not leave spaces for Indigenous knowledge to be studied reflectively, or within a context. This leads to ignorance of IKS implementation in the classroom. In addition, a number of teachers mentioned that learners face difficulties in connecting with IKS, particularly in multiracial schools where cultural diversity makes it challenging to choose generic IKS examples that all learners can relate to.

Another issue is the lack of partnership with Indigenous knowledge holders, such as traditional healers or community elders. Teachers expressed that community involvement is important and that resource persons should be invited and they must be knowledgeable enough to enable them to explain and relate IKS to modern day situations. But lack of formalised collaboration, and its place in the curriculum, means these efforts seldom last.

Finally, there is the more general question of perception and legitimacy. There is resistance among some teachers and learners to its inclusion in science education classrooms, perhaps reflecting a perception that IKS is outmoded and unscientific. This begs for a change in cultural attitudes to how knowledge systems are rated and placed in education, especially as a multicultural and post-colonial country as South Africa. In conclusion, such challenges indicate that successful integration of IKS in the Natural Science curriculum will require a collaborative approach such as curriculum development, teacher development, time allocation and community involvement.

6.5. Limitations

One of the main limitations of the study is its restrictions to a single district that hinders the ability of the results to be generalisable outside of the area or education context. With the study concentrated within a single district, it determines the practices and experiences of the teachers within the specific area but does not consider the diversity of the teachers' perspectives and challenges within different areas of the country, different cultural environments, or types of schools. The deficiency suggests that the conclusions drawn are unlikely to be generalisable to the schools within the metropolitan area or schools within different cultural or socio-economic environments, within which the implementation of Indigenous Knowledge Systems (IKS) might be implemented differently.

The teachers within the areas with more of the Indigenous population or more exposure for the implementation of the IKS might be different from the teachers within the districts with fewer exposures or resources for the implementation of the indigenous modes of knowledge. The district-specific study might overlook the regional characteristics of the resources' availability, the possibilities for the teachers' professional development, the population participation, and these aspects' impact upon the implementation of the IKS by the teachers within the lessons. Secondly, the focus of the study within a single district means that it does not consider the broader national trends of the incorporation of the IKS into the Natural Sciences. Therefore, while the conclusions are valuable for gaining insight into the local teachers' practices within the district, they are not necessarily transferable to the broader population of teachers or education systems. Future research should be able to correct this by expanding the study over multiple districts or locations such that the challenges and success of the incorporation of the IKS are well known within varying environments.

6.6. Recommendations for Successful Implementation of IKS

To address these issues, the following are suggested recommendations:

6.6.1 Educators Training and Professional Development

- Professional development programmes should be conducted by the Ministry of Education for teachers' acquisition of pedagogical competence for the integration of IKS.
- Universities should include modules of IKS within teacher education courses so that new teachers are properly prepared to integrate Indigenous knowledge into science education.

6.6.2 Curriculum Revision and Resource Development

- Curriculum should contain clear guidelines for the integration of IKS with Western science and should be consistent for schools.
- There should be real-life examples of science applications of IKS in the textbook and study materials, such as Indigenous farming systems and traditional ecological knowledge.

6.7.3 Indigenous Knowledge Holder Collaboration

- Schools should collaborate with the local Indigenous communities to incorporate traditional healers, farmers, and elders into science education.
- Student-led projects ought to challenge students to learn about and present Indigenous knowledge within their home communities.

6.8.4 Breaking Down Language and Cultural Barriers

- Multilingual materials should be provided for educators that facilitate the translation of the principles of IKS into the teaching medium.
- Schools should adopt culturally responsive instruction that addresses the diversity of the students' backgrounds.

6.7. Recommendations for future studies

- Explore the long-term impact of IKS integration on learners' scientific understanding.
- Explore teacher attitudes and experiences within different education environments.
- Assess the effect of varying pedagogical approaches for the incorporation of IKS.

6.8. Further research emanating from the study

This research investigated Grade 9 Natural Sciences teachers' lived experiences of incorporating IKS in their teaching, identifying numerous challenges, as well as limitations, such as lack of time, deficit of pedagogical skill, as well as misalignment of the curriculum. These results suggest further research in several areas. First, future work could explore experiential models of practice or frameworks that facilitate effective IKS integration in Natural Sciences classrooms, particularly in the context of the existing CAPS curriculum constraints. Second, research can be done with learners' experiences and views of IKS in science learning to examine in detail what influences their engagement, identity, as well as performance. Third, longitudinal studies can ascertain the effectiveness of teacher development programmes that focus on the integration of deliberate IKS over time. In addition, cross-province or nation replications could help demonstrate how divergent cultural communities understand and apply IKS to science with differing experiences. Finally, partnerships between educators and traditional knowledge holders (e.g. healers, elders, and community leaders) should be examined to establish sustainable school-community partnerships for environmental and cultural education. This research would enhance our knowledge of how IKS can be more significantly integrated into science education in a manner that respects both Indigenous knowledge and formal scientific inquiry.

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APPENDICES

Appendix A: Ethical Clearance Letter

FACULTY *of* EDUCATION
UNIVERSITY *of the* WESTERN CAPE

Office 119
School of Science and Mathematics Education
Faculty of Education
University of the Western Cape
Private Bag X 17

10 May 2025

Postgraduate Office and Exams Department

University of the Western Cape

Private Bag X17

Bellville

Dear Madam/Sir,

SUBMISSION OF A DISSERTATION FOR ATHANDILE MAGADE

This is to confirm that I have satisfied myself with the scholarship and all requirements for the submission of her dissertation for examination.

I wish him well in this stage of his study.

Yours sincerely,

Dr Kwanele Booi

Contact: kkbooi@uwc.ac.za;

Tel: 0767373599

BELVILLE

Dean: Professor Rajendran Govender
Tel: +27 (0) 21 959 3888
Fax: +27 (0) 21 959 2647

Website: www.uwc.ac.za
Email: rgovender@uwc.ac.za

University of the Western Cape, Private Bag X17, Bellville 7535, South Africa.

Appendix B: Request Letter

The WCED and Principals' Name of school

Dear Sir/Madam

REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN YOUR SCHOOL

Project Title: Exploring the lived experiences of selected grade 9 teachers' integration of indigenous knowledge in their science lessons in the Western Cape province.

Researcher: Athandile Magade

My name is Athandile Magade who is currently enrolled for a master's in education degree at University of Western Cape in South Africa. I am requesting permission from you to conduct this research in your school with the teachers. The research is entitled: The lived experiences of selected Grade 9 teachers' integration of Indigenous knowledge into their Natural Sciences lesson. This study will be conducted under the supervision of Dr K. Booi and Dr S. Dinie at the University of Western Cape.

I am making this application in request to be granted permission to conduct an interview, and comments will be written to record what was observed. The interview will last no longer than 30 minutes and will be audio recorded. It will be conducted at your school at the end of the lessons in the afternoon or at times which will not disrupt the normal teaching and learning process of the school. Only the educators will be interviewed and not the learners and the parents.

I truly promise I will maintain strict confidentiality and anonymity among all the participants at all levels of this research. There will be no limit on any benefit that the participants may receive as part of their participation in this research project. Real names of the participants will not be used, but symbols such as A, B, C will be used to represent participants' names. The participants will be free to withdraw from the research at any time without any negative or undesirable consequences for themselves. The participants will not be under any circumstances forced to reveal what they do not want to reveal and there will be no audio or video recording made without your permission.

Your positive consideration in allowing your teachers to participate in this project will be highly appreciated. Should you agree with the teachers to participate, please read and sign the informed consent attached to this letter.

Please contact me or my study supervisors, Dr K. Booi and Dr S. Dinie Faculty of Education, University of Western Cape, if you have any questions regarding this study (+27 21 959 2911/ 27 21 959 3734). My contact number is 071 1500 982 and my email address is 4416280 uwc.ac.za.

Yours Sincerely

Athandile Magade

Appendix C: Turnitin Report

Turnitin Originality Report

Processed on: 09-May-2025 22:35 SAST
ID: 2671568834
Word Count: 44525
Submitted: 1

The lived experiences of selected Grade 9 teachers' integration of Indigenous knowledge into their Natural Sciences lessons By Athandile MAGADE

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Angaama, Daniel Angwe. "Effects of using a dialogical argumentation instructional model to teach grade 11 learners some concepts of sound by means of indigenous musical instruments", UWC, 2012

< 1% match ()
February, Florence. "Exploring the effect of a Dialogical Argumentation Instructional Model in enhancing grade two learners' understanding of the day and night cycle", University of the Western Cape, 2016

Appendix D: Language Editing and Technical reading Certificate

Certificate of Editing

This is to certify that the Masters in Science Education Thesis

The lived experiences of selected Grade 9 teachers' integration of Indigenous knowledge into their Natural Sciences lessons

by

Athandile Magade

Student number: 4416280

has been proofread and edited for English language usage and has undergone comprehensive technical editing.

Date: 10 MAY 2025

Moses Moyo
PhD, MSc & BSc, MPhil Ed & BEd

Appendix E: Research Instruments

Interview Questions

Project Title: Exploring the lived experiences of selected grade 9 teachers' integration of indigenous knowledge in their science lessons in the Western Cape province.

Researcher: Athandile Magade

Demographic information

1. Teachers' demographic characteristics
   i. gender
   ii. age
   iii. race
   iv. qualifications
   v. years of experience
   vi. Current grades taught.

2. Teachers' qualification
   i. Why did you become a teacher?
   ii. Which institution did you train as a teacher?
   iii. When did you achieve your teaching certification?
   iv. Why did you choose to become a Natural Sciences teacher?
   v. How many years have you been teaching?
   vi. What were your views and feelings about teaching when you first started

out?

3. Perceptions and understanding

i. What Is your understanding of the term Indigenous knowledge?
ii. What role can the incorporation of Indigenous knowledge play in science lessons in South African Schools?
iii. Should Indigenous knowledge be formally incorporated in science curriculum education? If no, why not? If so, how, and why?
iv. What encounters might you have experienced in the integration of IKS in the Natural Sciences classroom?
v. Have you ever attempted to use the IKS approach in your classroom? Yes/No. If yes, what were the responses of your learners to the IKS method you used in the classroom?
vi. What in your opinion do you think should be done to inspire educators and learners to value, honour and spread Indigenous knowledge in order to improve environmental education within the school curriculum?

Appendix F: Information Sheet: Teachers

Project title: Exploring the lived experiences of selected grade 9 teachers' integration of indigenous knowledge in their science lessons in the Western Cape province.

Dear Teachers

I, Athandile Magade, am pursuing my master's degree in the Department of education at the University of the Western Cape, South Africa. I would like to invite you to take part in my research project. Please take time to read the following information carefully, and please feel free to ask questions if anything you read is not clear to you or if you would like more information.

What is the study about?

This study will explore how Grade 9 teachers integrate Indigenous knowledge into their Natural Sciences lessons to enhance the understanding and value of this knowledge. The study's main premise is that the entire science curriculum is composed of Western ideas that dominate the traditional knowledge.

Why am I being invited to participate in this study?

The Natural Sciences teachers are specifically selected for this study because they are in the ideal position to interact with the study's objectives. This is consistent with the phenomenological study because it focuses on investigating the lived experiences and views of people who have first-hand expertise of incorporating IKS into science education.

What will I be expected to do in this study?

Participants are expected to carefully review and understand the informed consent form provided by the researcher. They must voluntarily agree to participate in the study based on their understanding of the study's purpose, procedures, risks, benefits, and their rights as participants. If you consent to participating in this study, then you will be asked to engage in a 30-minute face-to-face interview at a safe and convenient venue.

What are the potential risks involved in this study?

The researcher's primary goal is to explore and comprehend people's lived experiences and the meanings they ascribe to them. Therefore, the foreseeable risks involved in this study are likely minimal. Phenomenological research carries certain risks, but these are typically more emotional and ethical in nature than they are legal or physical.

What are the potential benefits involved in this study?

There will be no direct benefits for the participants in this study. However, the results of this study will provide information or recommendations on how to integrate Indigenous Knowledge in Science curriculum which could be used to improve the teaching of Grade nine Natural Sciences.

How will my details be kept confidential?

The data will remain anonymous and will not be shared with any other teachers. Digital copies of the consent forms and the data will be transferred to OneDrive and safely kept. Participants are free to stop participating in the study at any time, and in that event, the information they have submitted up until then will not be used in this particular study. Their data will be deleted if they choose to leave the research.

What type of personal information will be collected?

It is possible for participants to share their phone number, email address, and name. To keep in touch and facilitate communication during the study, this information is required. Age, gender, race, and educational attainment are all included in this. These particulars aid in the comprehension of the participant group's features by researchers and facilitate data analysis based on demographic variables. However, participant’s name, address, contact information and other direct personal identifiers in their consent form will not be disclosed at any time. Therefore, the researcher will use pseudonyms throughout the study.

Who at UWC is responsible for collecting and storing my personal information

It is the researcher's responsibility to ensure that materials generated and collected from the research activities are stored securely in a durable and accessible format and in a manner that ensures its authenticity and integrity as well as meeting all legal and confidentiality requirements. With the help of the researcher’s main supervisor will take on the primary role of overseeing data management. This includes setting up data storage systems, ensuring data integrity, and managing data access and security. The co-supervisor would assist with data management tasks, such as maintaining data entry standards, monitoring data quality, and helping with data analysis.

Who will have access to my personal information outside of UWC?

The personal information of the researcher will not be shared with outside parties and will only be utilised within the University of Western Cape. Therefore, it means that only the departments within the institution will have a legitimate need to access that information. The administrative staff will also have access for requirements related to record-keeping and compliance. Research coordinators will also have access to the confidential data of researchers while managing or overseeing the project.

How long will my personal information be stored?

The storage of electronic data will be kept on the researcher's and supervisor's password protected computer for five years and deleted thereafter. Hard copies will be kept in a locked drawer for five years and shredded thereafter. all protocols around confidentiality in line with the POPIA act will be followed. The data, that is, the identity of the schools and teachers, will not be revealed.

How will my personal information be processed?

Participants' personal information will be collected based on the parameters outlined in the research protocol and informed consent form. The researcher will transcribe key words, phrases, and statements to allow the voices of research participants/informants to speak. Which includes the length of pauses in between answers, or any non-verbal cues made by interviewees during the interview can turn accounts of interviews into vivid descriptions. The findings will be used to complete my masters' qualification and to present it at a conference and to write a book chapter. The data will not include any personal details or identifying information. All information collected from you will be stored, analysed and reported in compliance with the Data Protection Act (1998).

Whom do I contact for further information?

Should you require any further information, please do not hesitate to contact me, Athandile Magade on my cell phone (071 150 0982) or via email (4416280@myuwc.ac.za). Alternatively, you may also contact my supervisor, Dr K. Booi and Dr S. Dinie in the Department of Science, University of the Western Cape (UWC), Sdinie@uwc.ac.za and KKbooi@myuwc.ac.za, (+27 21 959 2911/ + 27 21 959 3734).

To report any serious or adverse events (SAE) emergent from this research, please contact the Humanities and Social Sciences Research Ethics Committee via the Research Development and Postgraduate Support office below:

Tel: 021 959 4111
Email: research-ethics@uwc.ac.za
Mailing Address: University of the Western Cape Private Bag X17
Bellville 7535

This information sheet is for you to keep so that you can be aware of the purpose of the study. With your signature on the attached consent form, you indicate that you understand the purpose of the exercise.

ETHICS REFERENCE NUMBER : HS24/6/42

Appendix G: Research participant: Interview consent form

UNIVERSITY of the WESTERN CAPE FACULTY of EDUCATION UNIVERSITY of the WESTERN CAPE

Research participant
Interview Consent Form UNIVERSITY OF WESTERN CAPE
(Confidentiality Binding Form)

Project Title: Exploring the lived experiences of selected grade 9 teachers' integration of indigenous knowledge in their science lessons in the Western Cape province.

Researcher: Athandile Magade

Please tick each box to show agreement with the following statements:

1. The study has been described to me in a language that I understand. ☐
2. Any questions I may have about the study have been answered. ☐
3. I understand what my participation entails and I agree to participate of my own choice and free will. ☐
4. I understand that my identity will not be disclosed to anyone by the researchers and that I may withdraw from the study at any time without giving a reason and without fear of negative consequences or loss of benefits. ☐
5. I hereby agree that my anonymized responses collected through the interview can be used in future research. ☐
6. I agree for the anonymized data collected to be used in future research. ☐
7. I agree to be audio-recorded. (*Circle your answer)*. Yes / No ☐

In terms of the requirements of the Protection of Personal Information Act (Act 4 of 2013), personal information will be collected and processed:

☐ I hereby give consent for my personal information to be collected, stored, processed and shared as described in the information sheet.

☐ I do not give consent for my personal information to be collected, stored, processed and shared as described in the information sheet.

Name of Participant (*or legal representative*)	Date	Signature
________________	________________	____________________
Name of person taking consent *(If different from lead researcher)*	Date	Signature
________________	________________	____________________
Supervisor	Date	Signature

All participants will receive an information sheet which explains and outlines this project. The information sheet is for you to keep. You will find all contact information and relevant information on the information sheet. A copy of this consent form will be filed and kept in a secure location for research purposes only.