

https://dspace.org/

Natural Sciences teachers' views on Indigenous Knowledge and How to use it in teaching and learning in South African Classrooms

Raphothe, Paseka Nimrod

2022

https://hdl.handle.net/10539/37033

Downloaded from a DSpace repository. https://dspace.org/

Natural Sciences Teachers' Views on Indigenous Knowledge and How to Use it in Teaching and Learning in South African Classrooms



by

Paseka Nimrod Raphothe

Student number: 71966

A dissertation submitted to the Faculty of Science, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Master of Science.

Supervisors

Dr. Femi Otulaja

Dr. Shalini Dukhan

Dr. Ida Risenga

Abstract

South Africa underwent much curricular change during Apartheid and post-Apartheid. The quality of education provided for black people was the worst during Apartheid; the education they received catered only for menial labour. However, the need to provide quality education to all strata of society took precedence when South Africa became a democratic state in 1994. Moreover, the need to respect different worldviews and knowledge systems from different societies came into focus at this time. Thus, post-Apartheid, revisions to the curriculum led to the current Curriculum and Assessment Policy Statement (CAPS), which mandates that teachers include Indigenous Knowledge (IK) in their teaching and learning of Science. Investigations are required to understand the level of guidance teachers receive on integrating IK into their teaching. The following documents were analysed for this study to examine the guidance provided to teachers CAPS, Annual Teaching Plan (ATP), and the Pacesetter. Three teachers were surveyed to explore their views as well.

The focus in this study was grades 8 and 9 Natural Sciences teachers. The study aimed to explore ways in which teachers could integrate IK in their teaching and learning of science to make science more accessible to their learners. The research took a qualitative case study approach and used theoretical frameworks as the lens. Aikenhead and Jegede's border crossing, Vygotsky's Social constructivism, specifically the More Knowledgeable Other (MKO) and Zone of Proximal Development (ZPD), and Piaget's Cognitive constructivism (a process of accommodation and assimilation). Data was collected using questionnaires and followed up with semi-structured interviews. Thematic content analysis was used to analyse data and develop themes that helped answer the research questions. Findings in this study indicated some misalignment between the different curriculum documents used by teachers with regards to IK. However, the study indicated

that teachers are integrating IK into their teaching, as mandated by the CAPS. Some teachers use their experiences learned in the communities they grew up in and integrated that knowledge in their teaching and learner discussion in a Science classroom. This study documents examples used by teachers in their integration of IK into their classroom practice and, therefore, can provide a resource for teacher development in this area. Moreover, documentation of these practical examples of IK integration into classroom practice can be helpful to teachers who seek to facilitate the students' access to science concepts taught in Natural Sciences.

Declaration

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

School of Animal, Plant and Environmental Sciences

SENATE PLAGIARISM POLICY

Declaration by students

I, Nimrod Paseka Raphothe (Student number: 711966) am a Student registered for Master of Science (Dissertation) in the year 2022. I hereby declare the following:

- I am aware that plagiarism (the use of someone else's work without their permission and/or acknowledging the original source) is wrong.
- I have read and understood the document containing plagiarism guidelines for students in the School of Animal, Plant and Environmental Sciences.
- I confirm that the work submitted for assessment for the above course is my own unaided work except where I have explicitly indicated otherwise.
- I have followed the required conventions in referencing the thoughts and ideas of others.
- I understand that the University of the Witwatersrand may take disciplinary actions against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or works in my writing.

Signature:_____  _____Date: _02 August 2022

Acknowledgements

- First and foremost, I give glory and honour to God for walking with me throughout this journey to the completion of this study.
- I wish to extend my sincere thanks to my supervisors: Dr Femi Otulaja, Dr Shalini Dukhan and Dr Ida Risenga for their endless support, insight, and wisdom throughout this study.
- My participants for taking their time and participating in this study, I thank all of them.
- To my mother and siblings for their constant support and prayers always.
- Flavia Kigozi my friend for her unending support and encouragement- Thank you.
- Mr Malefo for standing with me as a friend indeed at all times of need and all other friends and families, who in their special ways contributed to the success of my study. I thank you.
- Nonhlanhla Maseko is a very special someone to me, I would like to thank you for accommodating me and allowing me to use your space to complete my study.
- To Mrs Audrey Beukes thank you for always saying YES when I asked you to read my work. I am grateful and thankful.
- Last but not least I will like to thank me, for all the hard work I have put into completing this study. Well done mfana.

Table of Contents

Abstract 2

Declaration 4

Acknowledgements 5

Table of Contents 6

List of Appendices 10

Abbreviations 11

Chapter One 13

1.1 Introduction to the Study 13

1.2 Problem Statement 15

1.3 Purpose of the Study 16

1.4 Rationale for the Study 16

1.5 Significance of the Study 18

1.6 Research Questions 18

Chapter Two 22

Background and Literature Review 22

2.1 Introduction 22

2.2 Problems with the Integration of IK in South African Schools 25

2.3 Reasons for Inclusion of IK in South African Classrooms 29

Chapter Three 32

Theoretical Frameworks 32

3.1 Introduction 32

3.2 Border Crossing 32

3.3 Vygotsky's Social Constructivism 34

3.4 Piaget's Cognitive Constructivism 37

3.5 Summary of the Chapter 39

Chapter Four 40

Research Method 40

4.1 Introduction 40

4.2 Research Methods 40

4.2.1 Qualitative 40

4.2.2 Quantitative 41

4.2.3 Mixed methods 42

4.3 Research Design 42

4.4 Research Instruments 43

4.4.1 Questionnaires 44

4.4.2 Interviews 45

4.5 Data Collection 47

4.5.1 Credibility 50

4.5.2 Delimitations of the Study 50

4.5.3 Ethical Considerations for this Study 51

Chapter Five 53

Results and Discussion 53

5.1 Introduction 53

5.2 An analysis of policy documents for Curriculum and Assessment Policy Statement 2011 (CAPS), Annual Teaching Plan (ATP), and the Pacesetter to identify Indigenous Knowledge (IK)-related content for the Senior phase Natural Science curriculum 53

5.2.1 The Natural Sciences CAPS document 54

5.2.2 The ATP and Pacesetter 58

5.3 The Teachers' Definitions of IK, Their Views on What the Natural Sciences CAPS 2011 Document Mandates, and How IK Concepts Could be Used in Teaching Natural Sciences 59

5.3.1 The Teacher Definitions For IK 60

5.4 Teachers' Views on The Natural Sciences CAPS Mandate 75

5.5 Theme 1: Teachers' Reasons For Including IK in Their Classroom Teaching Practice 78

5.5.1 Integration of IK with Natural Sciences 78

5.5.2 Theme 2: Ways of Including IK in Their Classroom Teaching Practice and Content Discussion with the Learners 80

Chapter Six 85

Conclusion, Recommendations and Further Studies 85

6.1 Conclusion 85

6.2 Recommendations 88

6.2.1 Recommendations For Curriculum Developers 88

6.3 Further Studies 89

Reference List 90

Appendix 101

Appendix A 101

Appendix B 102

Appendix C 103

Appendix D 104

Appendix E 107

Appendix F 111

Appendix G 114

Appendix H 119

List of Appendices

Appendix A	GDE Clearance Certificate
Appendix B	GDE Letter Regarding Covid-19 regulations
Appendix C	WITS Ethics Clearance Certificate
Appendix D	Permission Letter for the School Principals
Appendix E	Participant Information Sheet
Appendix F	Participant Consent Form
Appendix G	Participant Questionnaires
Appendix H	Interview Schedules

Abbreviations

Annual Teaching Plan: ATP

Coronavirus disease 2019: COVID-19

Curriculum 2005: C2005

Curriculum Assessment Policy Statements: CAPS

Department of Basic Education: DBE

Department of Higher Education and Training: DHET

Further Education and Training: FET

Gauteng Department of Education: GDE

General Education and Training: GET

Human Research Ethics Committee (non-medical): HREC

Indigenous Knowledge: IK

Indigenous Knowledge Systems: IKS

Information and communications technology: ICT

Kwa-Zulu Natal: KZN

More Knowledgeable Other: MKO

National Curriculum Statements: NCS

Outcome-Based Education: OBE

Revised-National Curriculum Statement: RNCS

University of the Witwatersrand: WITS

Zone of Proximal Development: ZPD

Chapter One

1.1 Introduction to the Study

In the South African context, the Department of Basic Education (DBE) and the Department of Higher Education and Training (DHET) are responsible for running and managing the education system. The DBE focuses on primary and secondary schools, divided into two bands: General Education and Training (GET) and Further Education and Training (FET). The GET has three phases; the foundation phase, grades R to 3, the intermediate phase includes grades 4 to 6, and the senior phase is grades 7 to 9. The FET phase covers grades 10 to 12. The DHET focuses on higher institutions such as universities and colleges. This study focuses on the GET senior phase Natural Sciences in grades 8 and 9.

Natural Sciences is one of the compulsory subjects in primary and secondary schools. In primary schools, it is offered from grades 4 to 7, and in secondary schools in grades 8 and 9. Natural Science is divided into four strands taught across the four terms in the year, i.e., Life and Living; Matter and Material; Energy and Change; and Planet Earth and Beyond (CAPS, 2011). Natural Sciences is one of the subjects listed in the NCS/CAPS document. The Curriculum Assessment Policy Statement (CAPS) document is a single comprehensive document that "guides or describes the teaching, learning, and assessment process in the South African Education system at both primary and secondary schools" (Oluwatoyin, 2021, p. 77). The CAPS has emerged after many iterations of policies that were used to govern education in South Africa over the years, i.e. during Apartheid and post-Apartheid. Likewise, there have been numerous iterations of the curriculum as curriculum development was considered in terms of quality of learning, the type of content that needed inclusion, and the issues of redress. As part of the redress, the current government has promoted the integration of IK into the teaching and learning of Natural Sciences to acknowledge and

accommodate the diversity of cultures in South African science classrooms. The integration of IK is not only happening in South Africa but it is happening across the world. In a study conducted by Ninnes (2000) he explores the representation of IK in secondary school science textbooks in Australia and Canada. In his study he reveled that it was possible to integrate IK into science curriculum material. In addition he states that an incorporation of this kind of material appears to have a positive albeit not unproblematic step which may help overcome the Western bias of previous text (Ninnes, 2000).

The Natural Sciences CAPS document (2011) mandates teachers to include IK in their teaching of Natural Sciences to help bridge the gap between sciences learned in the school classroom and the science accessible to students within their home and community environments. In essence, the aim of integrating IK into the prescribed school syllabus is to make science more relevant to the learners and thereby make science more accessible to learners within the classroom setting. My study aims to explore how Grades 8 and 9 teachers can integrate indigenous knowledge in the teaching and learning of Natural Sciences within one school in South Africa. Considering the mandate to include IK in classroom practice, it was necessary for me to examine the policy documents and supporting documents (i.e. CAPS, ATP, and the Pacesetter) to determine the guidance teachers received to implement the mandate. Data for this study was additionally generated from questionnaires and semi-structured interviews. The findings from this study are intended to contribute to the current dialogue on integrating IK concepts into the science teaching and learning curriculum in general within the high school and provide curriculum developers with insight into what is happening with the integration of IK in the science classroom and, therefore, make further informed decisions towards changes in the curriculum and its implementation where necessary.

1.2 Problem Statement

The Natural Sciences CAPS document (2011) mandates the inclusion of IK in the teaching and learning of science. On page 5 of the CAPS document for Natural Sciences, it is stated that "teachers should teach in ways that demonstrate the valuing of Indigenous Knowledge Systems (IKS) [by] acknowledging the rich history and heritage of South Africa as IKS contributed significantly and immensely to the nurturing of the values contained in South Africa's Constitution (p.5). The challenge is that NCS/CAPS seems not to provide guidance, instruction, or professional development on how teachers should or could include IK in their teaching of Natural Science (Du Plessis, 2012; Moodley, 2013). Furthermore, it is necessary to consider that learners in South African classrooms come from the most diverse cultures, causing the teacher to reflect on who's IKS should be used when teaching (Webb, 2013). Additionally, teachers have limited time as they need to complete specific topics within a time frame as stipulated in the Pacesetters and Annual Teaching Plan (ATP) provided by the DBE; this could leave little room for teachers to attempt to integrate IK in their science classrooms. Rogan & Graystone (2003) reported that, in South Africa, the curriculum process focuses too much on the curriculum itself at the expense of implementing the curriculum. In other words, the curriculum documents give teachers detailed guidance on what content they should teach, when they should teach this content, and how they should assess the content. However, there is little direction on how teachers should teach the content to the learners. It is, therefore, the focus of this study to investigate, during current times, the extent to which the curriculum documents provide guidance on when and how to include IK while teaching Natural Sciences. In this light, this study seeks to examine the tools provided to teachers to include IK in their teaching practice.

1.3 Purpose of the Study

The purpose of the study was to examine the Natural Sciences teachers' views of IK and their perception of the relevance for the integration of IK into their teaching, teachers' views on what the Natural Sciences CAPS document mandates, and how these views can be used to integrate IK into the teaching and learning of the subject by grades 8 and 9 teachers in the classroom. Teachers are acknowledged as gatekeepers of the curricular reform efforts by the Natural Sciences CAPS document in terms of the integration of IK in the classroom (CAPS, 2011). Hence, when looking at the integration of IK into curriculum delivery, it is necessary first to understand the teachers' views of IK and examine their views concerning curriculum delivery. Aikenhead and Jegede (1999) support the notion that the pre-existing IK teachers bring into the classroom could help learners engage or awaken their own IK. Hence, there is the need to explore the teachers' definitions for IK generally and within the context of their understanding of curriculum documents and their classroom teaching practices. Based on this need, I examine what IK teachers bring into their Natural Sciences classrooms. What teachers bring into the Natural Science classroom would also allow me to investigate the extent to which teachers include IK in their science teaching as mandated by the Natural Sciences CAPS document. Therefore, this investigation will shed light on the alignment between the mandate of the curriculum and teaching practices within the classroom in terms of the integration of IK. This is an important subject to investigate since it is believed that teachers can use IK to enable student access to science within the teaching and learning space at high school.

1.4 Rationale for the Study

When I started teaching at a secondary school, I was not aware of the specific mandate from the NCS/CAPS policy document. When I later read these requirements for IK in the NCS/CAPS policy

document, I started asking questions on whether teachers in the school system were in a position similar to my previous experience. I wanted to know if other teachers were aware of this mandate; what they had considered or done when they implemented IK's integration into their classroom teaching practice. As I read about IKS, I started engaging with the classes I taught at a secondary school. I found that the pre-service training and the qualification I studied for had not included aspects of how IK can be integrated into classroom teaching. From my more recent engagements with my students in my Natural Sciences classes, I have realised that seeking learners' prior knowledge related to their IK seems to challenge learners' understanding and reflection on the topic. In addition, it also tends to lead to learners' engagement in the classroom as they often start to ask questions and share their cultural knowledge on the topic. I began to realize that, for example, there are learners who come to the classroom knowing that at home there is no refrigerator so, to avoid food spoilage, they put the vessel containing food on the cold floor of a dark room so that the food could be preserved for an extended period. When a teacher introduces the topic ‘food preservation’, the teacher could start by questioning learners about what they know about food preservation from home and in the community and then build on that knowledge and include it in the science classroom teaching and learning space. By doing so, learners are more likely to engage with the teacher and their learning. My questions on IK integration into my teaching practice, as mandated by CAPS 2011, has led to me wanting to know what teachers understand about the mandate concerning the integration of IK into classroom teaching for Natural Sciences. Further, I wanted to check the alignment between the mandate and what is done in the classroom. Additionally, I wanted to determine how teachers could incorporate the use of IK for learner access into Science.

1.5 Significance of the Study

Considering that South Africa has been a democratic country for over 25 years and that the constitution has called for equal education opportunities, this study is significant in examining the extent to which IK is valued and brought into the Natural Science teaching and learning paradigm in secondary schools. The findings from my study may contribute to the growing knowledge about teachers' views and their level of awareness on IK, what the CAPS mandates, and integrating IK in classroom teaching and learning practices. It could provide insight to help curriculum developers who seek out information on teaching practices within the classroom and what more can be done to refine the curriculum to enrich the learners' classroom learning experience and provide learners with access to concepts taught in Natural Sciences.

Furthermore, usually, IK is passed down via oral tradition, rather than written text, and therefore may be lost as it is passed from one generation to the next. By capturing the teachers' voice on IK in my study I would be documenting a part of our African history which has been passed down from generation to generation, this documentation is required for the preservation of this knowledge in written form.

1.6 Research Questions

Qualitative research questions tend to be open and probative and must reflect the study's intent. Research questions should be manageable and contain appropriate restrictions, qualifications, and delineation. Therefore, this study aims to explore grades 8 and 9 Natural Sciences teachers' views on IK and possibilities of integrating IK into the everyday teaching and learning of Natural Sciences at school. I made use of qualitative research instruments in the form of questionnaires and interviews as tools to collect data. Hence in this study, I aim to answer the research questions that follow:

1. What links exist in the CAPS 2011 mandate and the Annual Teaching Plan (ATP), and Pacesetter in relation to the guidance indicated on these documents for the integration of IK into classroom teaching?
2. What are the grades 8 and 9 Natural Sciences teachers' views on IK?
3. What are grades 8 and 9 teachers' views on what the Natural Sciences CAPS document mandates?
4. What are the teachers' views on how IK concepts could be used to teach Natural Science content to the learners?

Conceptual considerations: Natural Sciences; IKS; IK; Curriculum; Black people; African people

Outline of Chapters

In Chapter One, I introduced the study and gave a brief overview of the whole study. I discussed the problem statement, purpose, rationale, significance of the study, and the research questions that guided my study. I ended this chapter with a summary.

Chapter Two provides the background of the study by giving a historical view of the development of the study. I then discussed the concept of Indigenous Knowledge and Indigenous Knowledge Systems. Following that I then discussed the problems with the integration of IK in South African classrooms. I later discussed the reasons for including IK in the South African classroom and I closed this chapter with a summary.

In Chapter Three, I discussed the various theoretical frameworks that grounded the study. I discussed the theories, how I intended to use them based on what I find in the study. The theories used are learning theories and they are as follows: 1) Border Crossing, 2) Vygotsky's Social constructivism theory, which includes the Zone of Proximal Development (ZPD) and the More

Knowledgeable Other (MKO), 3) Piaget's Cognitive constructivism and I concluded the chapter with a summary. In Chapter Four, I discussed the research methods. The research methods included the research design I used to collect and analyse data. In the research design section, I discussed the research instruments which I used namely questionnaires and semi-structured interviews. From there I discussed data collections. I later discussed the credibility of the study, delimitations, ethical considerations and concluded wih a summary.

In Chapter Five, I presented the research findings. The findings addressed the research questions outlined in chapter one. I first disccused the policy documents which are being provided to teachers namely the Curriculum and Assessment Policy Statement 2011 (CAPS), Annual Teaching Plan (ATP), and the Pacesetter and analysed how they are each related to one another and what they say about IK. From there I began exploring the teachers definition of IK. Two themes were developed concerning the teachers' definitions for IK. After I then discussed the teachers' views about what the Natural Sciences CAPS documents mandates them to do. Then lastly I discussed teachers views on how IK concepts could be integrated to teach Natural Sciences. Two themes emerged as I analysed data for the last research

In Chapter Six, I discussed the conclusion for the study, recommendations, as well as further studies. The recommendations are for the curriculum developers.

Summary of the Chapter

The purpose of the study was to examine the Natural Sciences teachers' views of IK and their perception of the relevance for the integration of IK into their teaching, teachers' views on what the Natural Sciences CAPS document mandates, and how these views can be used to integrate IK

into the teaching and learning of the subject by grades 8 and 9 teachers in the classroom. The study took place in a school in a township in South Africa. Three teachers who are teaching the subject Natural Sciencecs were purposefully sampled and invited to participate in the study. The rationale for the study was to seek teachers understanding with regards to what the CAPS 2011 mandates them to do and in addition to check the alignment between the mandate and what is done in the classroom, so that they can enhance learner's experiences and make classroom science more accessible and meaningful to learners lived-experiences. Considering that South Africa has been a democratic country for over 25 years and that the constitution has called for equal education opportunities, this study is significant in examining the extent to which IK is valued and brought into the Natural Science teaching and learning paradigm in secondary schools. In addition it is a start in documenting our IK as this knowledge is being passed down from generation to generation verbally and not being documented.

Chapter Two

Background and Literature Review

2.1 Introduction

During the Apartheid era, i.e. (1948-1994), the education system in South Africa was hugely disparate in the unequitable provision of education to different parts of society (Fiske & Ladd, 2004). It had 14 independent departments, and each one of them had its individual requirements for education, budget, and curriculum. The quality of education provided for Black people was generally the worst compared to the Indians, Coloureds, and Whites (Cross, et al, 2011) With a minimal budget, overcrowded classrooms, and a curriculum that focused on developing only menial labour skills, the development of professional and higher cognitive ability was not a focus generally for Black people, unlike the provisions made for whites (Cross et al, 2011). The use of IK to engage with students was not allowed during Apartheid, and IK was not considered as connected to the school science curriculum since it was not seen as part of science (Breidlid 2003; Soudien & Baxen 1977). Instead, it was considered a pseudoscience (de Beer & Whitlock, 2009; Mothwa, 2011; Regmi & Flemming, 2012).

According to de Beer & Mothwa (2013), IK is referred to as “knowledge about the world around us which has been developed by local cultures and has been used to sustain their lives” (de Beer & Mothwa, 2013, p.454). This knowledge is developed within a culture and is passed down from one generation to another and is often practiced within the culture and at home before learners come into the classroom to learn the science taught at school. Quite interestingly, learners first learn and understand the sciences (albeit informally), values, and norms at home or in the community before they enter formal schooling. Taking this into consideration, Ownu & Mosimege (2004) defined IK as knowledge that includes technological knowledge (agriculture, engineering,

medicine), mathematical and social knowledge that a local community uses for its social and economic activities. Ogunniyi (2007) defined IK as the knowledge that

"Reflects the wisdom about the environment developed over the centuries by the inhabitants of South Africa. Much of this valuable wisdom is believed to have been lost in the past 250 years of colonization and 50 years of Apartheid. This now needs to be rediscovered and utilized to improve the quality of life for all South Africans" (Ogunniyi, 2007, p.1).

Matsika (2012) defines indigenous knowledge (IK) as "the traditional and local knowledge that exists and is developed through the experiences of the local community in the process of managing the conditions or context that challenge the people's everyday life" (Matsika, 2012, pp.209-210).

Hoppers (2005) defined IKS as a traditional knowledge which includes "agricultural, meteorological, ecological, governance, social welfare, peace building and conflict resolution, medicinal and pharmaceutical, legal and jurisprudential, music, architecture, sculpture, textile manufacture, metallurgy and food technology" (p. 3). In other words, IKS is a body of knowledge rooted in the African philosophical thinking that belongs to indigenous people within a certain geographic area and has survived for thousands of years regardless of colonialism (Khupe, 2014; Mapara, 2009). These bodies of knowledge "are developed through the processes of acculturation and through kinship relationships that societal groups form and are handed down to the posterity through oral tradition and cultural practices such as rituals and rites" (Mawere (2010, p. 211). In addition, Ogunniyi (2007a) defined IKS as "a conglomeration…a redemptive, holistic, and transcendental view of human experience with the cosmos…" (p. 965). Thereby, making IKS a "combination of knowledge systems (Ahanonye, 2021, p.49).

These definitions emphasizes how indigenous knowledge develops over time due to a community's engagement with its environment, experiences, observations, and trial and error or testing that may not take place in laboratories. Like Taylor & Cameron, 2016 IK and IKS are terms that are used interchangeably. This study will view IK(S) both as conservative and dynamic in nature because as useful traditional knowledge is preserved. This highlights a significant concept in African indigenous knowledge, which developed, tested, and applied knowledge despite the lack of laboratories and modern scientific equipment and technology (Matsika, 2012). It is this kind of indigenous knowledge that learners bring into the classroom. Teachers need to nurture and build upon the students' prior knowledge and IK that the learners bring into the classroom to enable learners to have a better conceptual understanding of scientific concepts. This has led many researchers, such as Ankiewicz (2015), de Beer & Bolaji (2013), Ogunniyi (2007), & Ronoh (2017, especially in the African context, to research why IK is not given a more substantial platform in pure science teaching in the school curriculum and why IK was considered a pseudoscience.

When the democratic government was elected to power in 1994, its mandate was to change the entire education system so that there were equal opportunities for access to quality education for all the different ethnic groups. To start, the democratic government had to develop an education system that would accommodate everyone and therefore the focus was on equality and access to education that was provided to all parts of society. During the Apartheid era, IK was not included in the science classroom because it was not considered a science (Gorelick, 2014). The democratic government wanted to do away with this notion. In the NCS/CAPS (2011) policy document, one of the mandates is to include IK in the school science curriculum so that our African knowledge can also be valued by our African people (NCS, 2011), and in doing so, we would be preserving

our African culture, and helping teachers and learners better understand science. However, many challenges emerged with the implementation of IK in the teaching and learning of science.

2.2 Problems with the Integration of IK in South African Classrooms

The reiterative evolution of the South African curriculum over a brief period posed a challenge for teachers. Not only did the content and expectations for curriculum delivery change, but so did the education system as a whole (Msila, 2007). The country underwent significant changes post-Apartheid. The South African people gained their freedom, and one of the foci of the Constitution was to provide quality education for all members of society. The education curricular changed from missionary education to Bantu education during the years of Apartheid in South Africa. Post-independence, there have been revisions to the school curriculum as well, i.e. in 1997 there was Outcome-Based Education (OBE), then in 1998 the Revised-National Curriculum Statement (RNCS) came into being, and this was replaced in 2004 by the National Curriculum Statement (NCS). In 2012 the Curriculum and Assessment Policy Statement (CAPS) was introduced and it is the curriculum used to date. During the evolution of these policy documents learner-centeredness took center-stage. Of importance to this study is the inclusion of Indigenous Knowledge Systems (IKS) in the science curriculum in the post-independent education system.

The OBE curriculum was a learner-centered one which broadly defined the teaching method that shifts the focus from instruction by the teachers to the learning outcomes for learners (Msila, 2007). This was unlike the previous curriculum where the focus was on a teacher-centered approach, i.e., where activity in the classroom is centered on the teachers and their teaching practice. The reason for the adaptation and implementation of the OBE teaching approach in South Africa by the education department was to improve the quality of education and address the demands for an increasingly skilled workforce in post-Apartheid South Africa (Botha, 2002). Further, the OBE

curriculum was introduced to address issues of quality of the curriculum and inequality based on South Africa's historic imbalances where education was used as a means to oppress the masses (Msila, 2007). Lastly, it was introduced to emancipate learners and teachers from a content-based mode of operation and respond to international trends in educational development (Botha, 2002).

The challenge with the implementation of the OBE teaching approach was the context at the time did not allow for any significant changes as the country itself was undergoing substantial changes in its political and thus governmental administration. During this time there were further deliberations on how the curriculum could best serve the needs of society and to restore a more equitable education system. This then led to the curriculum revision were Curriculum 2005 was put in place (C2005). The implementation of the C2005 was to resolve the issues that the OBE curriculum was faced with (Moodley, 2013). Hence C2005 policy document aimed to upgrade the curriculum and come up with innovative ideas. C2005 was based on providing learners with access to schools, as well as equity and development of learners' learning. In short, C2005 had a mandate to re-shape and re-arrange the OBE curriculum, which did not meet the objectives that were set. However, the difference between C2005 and OBE is that C2005 teachers are more involved in curriculum implementation. The C2005 curriculum documents and policies provided the space for teachers to select the content and methods through which the learners could achieve the outcomes (Botha, 2002).

In the year 2000, a review committee was established by the DBE to deal with factors that affected the education system and the C2005. Chisholm (2003) indicated that "the Review Committee proposed the introduction of a revised curriculum structure supported by changes in teacher orientation and training, learning support materials and the organization, resourcing, and staffing of curriculum structures and functions in national and provincial education departments" (p. 4).

The development and establishment of a Revised National Curriculum Statement were aimed to promote conceptual coherence, have a clear structure and be written in an understandable and clear language, and design and enable the "values of a society striving towards social justice, equality and development through the development of creative, critical and problem-solving individuals" (Chisholm, 2003, p. 4).

In the same breath C2005 also had its problems that led it to be phased out. It used difficult language and unfamiliar terms to replace familiar ones; it focused mainly on outcomes but neglected "inputs" for the subject content of the curriculum; it introduced a very complicated method for teachers to prepare their classroom which many teachers did not understand and lastly it did not set levels of achievement for learners in each learning area in each grade. This meant it was difficult to assess whether learners made enough progress from one grade to the next (Argus, 2000). For these reasons C2005 was phased out as it was no longer served the purpose it was intended to, which then led to the NCS/CAPS design and implementation.

There is now a focus on IK in the CAPS document and it mandates that teachers include IK in their teaching and learning of Science, it is necessary to understand the level of guidance teachers have for this implementation in classroom practice, this study focuses on this knowledge area.

IK in the classroom is a necessary tool in a changing South Africa (Naidoo, 2010), it functions as a source of knowledge within the context of the learner. However, teachers are still not well versed in the type of training that could help facilitate the learning process in the classroom, inspiring learners to be more active and engaged (Sithole, 2017). IK has the potential to empower diverse learners of different cultures, enhancing their individual growth and development in the application of Natural Sciences in their own lives and their interpretation in the classroom (Botha, 2012). In South Africa where most of the classes are multilingual, one of the greatest challenges of the

curriculum is how to prepare pre-service teachers to deal with the complexity of indigenous knowledge teaching (Setati, 2001). Training teachers to effectively implement an IK integrated curricula remains a major demand for inclusive teaching, the current curriculum fails to serve the current needs of our diverse South African cultures and society as a whole (de Beer & Whitlock, 2009). Hewson & Oguniyi (2011) also argue that there are no structured courses aimed at creating pre-service teacher awareness of what it means to bring in IK into the formal Science context taught within school classrooms.

Science does not need to be a distanced and depersonalized experience for learners. The interrogation of IK in the classroom could serve itself as a tool of self-awareness for learners, with their school work reflecting back the complexities of their daily life and elements of their community's practices and ways of being. The fear of pseudoscience in the classroom is a result of our post-colonial curriculum that does not function independently outside of western values (de Beer & Whitlock, 2009). IK speaks to the core of our lived experiences and of those who existed before us, when we lose this, we lose parts of ourselves that cannot be replicated (de Beer & Whitlock, 2009).

Science teachers in South Africa and globally experience difficulties with the integration of indigenous knowledge into their science lessons—a requirement of many science curricula. One of the reasons for this may relate to the views teachers hold about indigenous knowledge. Such views can form a barrier against successful inclusion of indigenous knowledge in the science classroom (de Beer & Ankiewicz, 2015). When teachers are trained in Natural Sciences, there is a lack of instructional methods with the inclusion of IK in teaching to coexist with that training. It is clear that some science teachers fear that they will be teaching pseudoscience when integrating indigenous knowledge into the classroom, they feel conflicted as the formulation of indigenous

knowledge is not based on scientific methods (De Beer & Whitlock, 2009; Regmi & Fleming, 2012). As such we will look at some of the reasons why teachers include IK in their teaching of Science.

2.3 Reasons for Inclusion of IK in South African Classrooms

According to the CAPS (2011), all knowledge grows out of the view of how the world works. The differences between modern science (and technology) and traditional knowledge is that these knowledges have their origins in different worldviews. Learners need to understand how the learning was developed in their cultural context and use that knowledge to make meaning of what is going on around them (Sjøberg & Schreiner, 2006). It is important for learners to understand how learning was developed in their cultural context because learners first experience learning within their home and community. The knowledge they acquire could be used to enable them to understand sciences within the school classroom, as shown in the example I used when referring to food preservation in an earlier chapter. Therefore, the need for learners to understand where their knowledge stems from and how this knowledge has come to be is important.

This means that for learners to understand the knowledge system within their cultural context, they first have to be exposed to the historical events of science and other IK worldviews of science so that they could start to make connections between these different worldviews or start to understand how their underpinnings in their conceptions of knowledge match up to what they are learning within the science classroom setting. To achieve this, learners' have to be exposed to how things were done in the past in their culture and at the same time be exposed to other cultures and worldviews that are different from their own. Furthermore, the learners need to see how the knowledge that they acquire within their experience outside formal schooling aligns with the

knowledge they learn in the classroom (Hoppers, 2004), teachers can intentionally scaffold this process. By doing so, learners could get a better understanding of their own IK.

It has been said that scientific knowledge and understanding have been developed over time by people who were curious and who persevered with their quest for knowledge (CAPS, 2011). In the same breath, this includes our forefathers in that they were also curious about many things and conducted their experiments though trial and error methods, and came up with conclusions (Cronje et al, 2015). Hence, as these authors explain, today, we know different things in the environment, such as knowledge of giving birth, plants to use to cure certain illnesses, different seasons to plant different plants, to mention a few examples.

IK needs to be included in our school science curriculum to re-establish the value system of African people (Cronje et al, 2015). From the observations that I have made with the classes that I teach, I have realized that the inclusion of IK in my Natural Sciences classroom helps learners to understand not only scientific concepts in class, but also makes them aware of their cultural knowledge and enables them to apply classroom concepts in real-life situations. With educational and environmental problems becoming more diverse and complex every day (Maila, 2001: p. 2), it is imperative that all ways of knowing, whether indigenous or modern; Western or African, be explored and their valuable capital (skills, values and wisdom) be integrated into all educational frameworks that would take a people forward (Le Grange, 2000).

Summary of Chapter

In this chapter I gave a background of how the education system was in South Africa especially for black people. There was 14 different education departments and each department had its own budget and curriculum. The curriculum for the black people was the worst it had minimal budget,

over crowded classrooms and the curriculum only focused on menial labour skills, development of professional and higher cognitive ability was not the focus. During the Apartheid era, the use of IK to engage learners was not allowed as it was not considered to be connected with school science science (Breidlid 2003; Soudien & Baxen 1977). Instead, it was considered a pseudoscience (de Beer & Whitlock, 2009; Mothwa, 2011; Regmi & Flemming, 2012).

I then provided various definition from various scholars of IK and IKS and also mentioned that this study will make use of IK and IKS interchangeably. The IK that learners bring into the science classroom, teachers need to nurture and build upon it.

Since IK was not allowed to be taught in school science, the notion then lead many researchers such as Ankiewcz (2015); de Beer & Bolaji (2003); Ogunniyi (2007); and Ronoh (2017) especially in the African context to then research more on why is it that IK is not given the same platform in school science curriculum.

When the democratic government was elected into power in 1994, its mandate was to change the entire education system so that there were equal opportunities for quality education for all ethnic groups. In doing so it started implementing different curriculum changes in a very short space of time. However, in the many curriculum changes that were introduced, the integration of IKS in the teaching and learning of science it remained in all the official documents.

Even though the curriculum documents in South Africa shows the value for IK in the curriculum there need to be investigation on the guideline provided to teachers and how teachers implement and interprete them in the classroom.

Chapter Three

Theoretical Frameworks

3.1 Introduction

A theoretical framework is a specific collection of thoughts and theories related to the phenomenon under investigation (du Plooy-Cilliers Davis, & Bezuidenhout, 2014). I decided to investigate teachers' views on IK, teachers' views on incorporating IK into teaching Natural Sciences for Grades 8 and 9, and also teachers' views on how that knowledge can be used to improve not only learners understanding of scientific concepts but also to help learners make links of what they learn in the science classroom and what they experience in their everyday lives. To achieve this I adopted frameworks from Aikenhead's border crossing, Vygotsky's Social constructivism (i.e. More Knowledgeable Other (MKO) and Zone of Proximal Development (ZPD)), and Piaget's Cognitive constructivism (a process of accommodation and assimilation).

3.2 Border Crossing

When learners enter the science classroom, they cross borders, physically and cognitively (mentally). This is important for teachers to note because in knowing and recognizing the inherent border crossing between the learners' lived-world, subcultures and the subculture of science, teachers can have awareness into border crossing (Aikenhead, 1996; Le Grange, 2007). In other words, when a learner goes to school, they are physically moving from their home and sometimes communities and go into a different society with a different culture from the one to which they are accustomed. This movement then has the potential to build the learner or discourage the learner. In other words, when learners move into the formal school environment they could encounter challenges as they move from their own cultures to the subcultures of a science classroom or the subculture of science itself.

After recognizing the learners' culture and subcultures, teachers could then help learners make connections between what they know from home or within their community and what is learned in the science classroom (Aikenhead,1996). Cobern (1991) alludes to this by stating that to understand a "student's worldview is to anticipate what meaning in a science curriculum will appear plausible and which will not be (p. 42)". In other words, knowing and understanding the culture that learners are coming from could help the teacher to plan ahead for a lesson in a science classroom. This knowledge enables the teacher to anticipate the questions that learners are likely to ask and why they ask those questions.

When the teacher understands the learners' cultural background, the teachers could be more likely to use examples from the learners' cultural experiences in their classroom teaching practice. For this study, the focus is only on the teachers' perspective in relation to research questions 2-4 which is based on their views on what IK is and how they can use it in their teaching of Natural Sciences. This is because teacher practice could provide learners with more epistemological access within the formal Science learning context at school. Aikenhead (1996) further states that most students are not about to risk altering a practical common sense conception favouring a counter-intuitive abstraction advanced by a teacher or textbook.

Border crossing, in simple words, implies leaving behind the safety of cultural, theoretical, and ideological assumptions that one knows. In an educational context, border crossing means teachers have 'to take leave of the cultural, theoretical, and ideological borders', and become homeless' (Giroux, 1992, p. 18). Just as teachers are meant to become 'homeless' it is possible that there is a similar expectation of students, i.e the cause of this move (homelessness) in the education system would be that learners should forget their cultural, religious, and ideological backgrounds and be transformed through new conscientization to come out of the situation. In this light and considering

the time of publication of the quoted text, i.e. during Apartheid rule, it can be considered that western science that governed the schooling system, was at the time, trying to enculturate learners into its subculture of science. This can be seen to be the case since for the expected transformation to take place, teachers and learners needed to detach from what they knew already, which is their background belief, and be ready to learn Western science as presented in that curriculum. In the next paragraph I looked at how learning occurs and to do that I used Vygotsky social constructivism.

3.3 Vygotsky's Social Constructivism

The Zone of Proximal Development (ZPD) is "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p.86). In other words, the difference between what a learner can do on his or her own and what he or she can achieve with the help of a teacher is known as the ZPD, i.e. this is a zone where a learner in a classroom can perform a particular task with scaffolding or the help of a teacher or a peer. For example, in the grades 8 and 9 Natural Sciences classrooms, learners might know what a periodic table is, and also, they might know chemical symbols and how to write their equations. However, when introducing the topic of balancing chemical equations, learners might not know how to balance chemical equations, but with the help of a teacher, after a few examples together, the learner could work out more examples independently. When the learner can balance chemical equations on his/her own, we say that the learner is in the zone of proximal development for solving or balancing chemical equations.

According to 'Vygotsky's theory of cognitive development, children learn through social interactions that include collaborative and cooperative dialogue with someone more skilled in a given task; hence in Sesotho; there is a saying '*ngwana mechanic eba 'machenic'* directly translated 'a child of a mechanic becomes a mechanic.' What this means is that the child learns by first observing then doing what s/he saw being done, similarly in a classroom setting, we do a few examples with learners to see what is being done and, most notably how it is done, then they can attempt doing it on their own afterward.

The more knowledgeable other (MKO) refers to someone who has a better understanding or higher ability level than the learner concerning a particular task, process, or concept (McLeod, 2019). The MKO therefore guides the learner with learning. Although the assumption is that the MKO is a teacher or an older adult, this is not necessarily the case. The MKO can be anyone who has more knowledge about a particular task, process, or concept, and it can be a peer, a coach, or even a child. Some authors such as Moll (2001) also consider the MKO to be inanimate things like a textbook that can aid the learner to understand new concepts. This means the MKO according to different authors, could be animate or inanimate objects.

Furthermore, based on Vygotsky's sociocultural theory the idea of scaffolding was developed and is linked to the concept of ZPD. According to Raymond (2000), the instruction offered by the ZPD can be seen in the "role of [the] teacher and others in supporting the learner's development and providing a support structure to acquire development" (p.176). Therefore, scaffolding can be seen as using the learners' knowledge and understanding and directing it towards what is being taught in class at the time. For instance, say you are explaining the concept of "work" in a physical sciences classroom, a teacher could ask what learners understand by the concept work and then evaluate the learners' understanding based on the answers received. The teacher can then scaffold

the students' learning towards a more accurate interpretation or development of understanding towards the right solution and thus help the learners determine the correct explanation for the definition of work. An important aspect of scaffolding is that it is temporary because as the learner's abilities increase, the structure provided by the more knowledgeable other is progressively withdrawn (Brits et al., 2016). The learners should be able to complete the task independently once the learning outcome is achieved. However, the teacher's goal when using the scaffolding strategy is to make learners understand and master concepts alone.

In addition, scaffolding is a strategy that can be acquired in schools and in our everyday, life within our communities or at home. Teachers use scaffolding to engage learners in the learning process. Bransford et al., (2000) stated that the learner does not learn in isolation, instead social interactions strongly influence learning. He also noted that a child develops his/her intellect through internalizing concepts based on his/her interpretations of an activity that occurs in a social setting and occurs through good communication from adults (Bransford et al., 2000). Hence, when learners come into the classroom, they already have a foundational knowledge about concepts which they either learned from home or the community they came from. From my experience the concept of lightning in a Natural Sciences classroom is always interesting to teach because here learners give answers according to their cultural background. This alludes to the point made by Vygotsky that social interactions strongly influence learning.

Vygotsky recognised that the distance between doing something independently and with the help of another is related to stages of development. In this way he regarded an instructors "teaching of a student not just as a source of information to be assimilated but as a lever with which the student's thought, with its structural characteristics, is shifted from level to level" (Yaroshevsky, 1989, p.283). Chaiklin (2003) states that Vygotsky asserted that consciousness is constructed through a

subject's interactions with the world. Development cannot be separated from its social and cultural context. This led to the idea that we can only understand mental processes if we understand the social interaction and tools and signs that mediate them. According to Vygotsky, the most important part of children's psychological development is acquisition of the culture to which they belong. Everything that is manufactured and created by people in a culture, that is, all cultural products, is labelled an artifact and it is through these artifacts that the culture influences development.

Teachers should approach the classroom with an open mind and not always have very specific expectations of their learners, allowing them space to self-explore answers so that the learners have room to develop. ZPD and scaffolding can be utilised effectively and creatively in subject areas where creativity is encouraged, and learner-led shaping of the outcome can more readily occur (Daniels, 2016). This section helped me to answer the research questions in that I used Vygotsky's ideas to show how the same ideas affect the teachers in today's context and in addition integrate them to explain the results that emerged from my study.

3.4 Piaget's Cognitive Constructivism

Constructivism is widely touted as an approach to probe for children's levels of understanding and to show that their knowledge can increase and change to higher level thinking (Amineh & Asi, 2015; Mvududu & Thiel-Burgess, 2012). Simply put, constructivism refers to the 'how' of learning and thinking. It describes how learners make sense of what they are taught in class and how what is taught can be made simple so that learners understand it.

Piaget (1977) states that learning does not occur passively; instead, it happens by active construction of meaning. He further explains that when learners encounter an experience that is not in line with how they think, the learner moves from a state of equilibrium to one of

disequilibrium. What happens then is that learners need to alter their thinking to restore equilibrium. For this reason, learners make sense of the new knowledge by assimilating it with what they know, that is, by attempting to incorporate it into what they already know. Assimilation is when learners align new information to their pre-existing knowledge, while accommodation changes their mental constructs to accommodate the latest information. Assimilation and accommodation are complementary processes kept consistent by equilibrium – the biological drive to reach a state of alignment.

The focus of this study is on teachers' views on what IK is, views on what the CAPS document mandates and also ways in which teachers can integrate IK into their teaching and learning of Science. The first part focuses on the teachers' IK which is known as a social knowledge (Rata, 2011) because of their cultural background and practices.

Since learners will be learning Science at school this kind of scientific knowledge cannot be merely discovered by learners on their own. It is the duty of the science teacher to facilitate the empirical knowledge to enable learners to discover how knowledge claims are validated and generated (Ahanonye, 2021, p. 83).

Vygotsky's emphasis on this MKO shows that a learners' understanding of a concept in the Science classroom is as a result of the teacher's, intervention and mediation in the classroom. (Ahanonye, 2021, p. 84). In relation to MKO, Vygotsky mentions the notion of the ZPD whereby the child receives encouragement and guidance from the teacher or a more skilled peer. The study focused on teachers' views on what IK is, views on what the CAPS document mandates and also what are some of the ways in which IK can be integrated with Natural Sciences. As such the theories are related to the study as teachers are embodiment of their culture, they bring their own cultural knowledge to the classroom and it influences their teaching practice. Social and cognitive

constructivism theory deals with teaching and learning in this context the teaching and learning takes place not only in the classroom but also in the community which learners are coming from. Therefore, these theories helps us in understanding how teachers assist learners in making meaning of what is being taught in the classroom.

3.5 Summary of the Chapter

Theoretical frameworks are vital as they aid the researcher to support and ground their studies. These frameworks can help the researcher discuss the results obtained from the research and the methods they choose for data analysis. The chosen theoretical frameworks for this study are border crossing, Vygotsky MKO and ZPD, Piaget's cognitive constructivism.

Constructivists believe that people construct their realities (meanings) based on their lived experiences. As such, the social development theory by Vygotsky theorizes that learners learn from the social interactions they have when they engage with more knowledgeable others (MKOs) such as teachers, parents, or their peers in society. Learners establish mental constructs after interacting with MKOs (McLeod, 2012). Piaget's cognitive theory of development explains the changes learners go through when they construct their mental realities.

When indigenous learners enter into the school classroom to learn science, a subculture of western society, they cross-cultural borders – a process that can be smooth, managed, hazardous, or impossible, depending on the type of support they receive from the teaching and learning environment.

This study used these theories as the lens for this research and as such I refered to them during analysis, interpretations, and discussions.

Chapter Four

Research Method

4.1 Introduction

A research method is a comprehensive approach to a study, and it includes the plans, design, data collection, and analysis that the researcher used to conduct the study (Creswell & Creswell, 2011; Muza, 2014). In this chapter, I discuss the research method that I used for this study and I also give the advantages and the disadvantages for each of the methods I outline. I further discuss the research design and the instruments that I have used for the study. Lastly, I discussed data collection and analyses then provided a summary of the chapter.

4.2 Research Methods

All research conducted have systematic approaches that help researchers answer the questions through intensive inquisitions (Queirós et al., 2017). The type of data collected depends on the method used (Hancock et al., 2001). Researchers can choose three approaches when conducting studies, i.e. qualitative, quantitative, and mixed methods (Creswell & Creswell, 2011).

4.2.1 Qualitative

A qualitative method uses a descriptive approach from social perspectives to help researchers understand why things happen in a particular way in the world (Hancock et al., 2001). The core objective of qualitative methods is to explain peoples' lived experiences (Mack, 2005). Therefore, to understand what drives society, it is crucial to understand social behaviours such as beliefs and attitudes (Choy, 2014). For this study, I engaged the qualitative method to be able to provide a thick description of the teachers' views of IK and discuss what transpired from the follow up interviews we had. The advantage of the qualitative method is the ability to probe for underlying

values and beliefs in people's lived experiences in the form of textual data (Choy, 2014; Mack, 2005). This method allows participants to respond in their own words and allows the researcher to ask the 'how' and 'why' questions (Creswell & Creswell, 2011). The disadvantage of this method is that data collection can be time-consuming, and certain important issues may be missed during analysis (Choy, 2014). This might be because qualitative researchers tend to start off with self-reflections and by positioning themselves in the society they study; this positioning might lead to biases during data analysis and discussions, causing researchers to overlook certain issues (Choy, 2014).

4.2.2 Quantitative

The quantitative method is used to measure variations and predict relationships (Mack, 2005). This method tests for objective theories by predicting relationships among variables. Variables are numerical and are calculated using statistical processes (Mack, 2005; Neville, 2007). Advantages of using this method is that findings are likely to be generalized to a whole population or a sub-population because it involves the larger sample which is randomly selected. In addition data analysis takes less time to work with since you can make use statistical software to analyse it (Rahman, 2020). Some of the disadvantages of using the quantitative method are it fails to give deeper underlying meanings and explanations. It also tends to take snapshots of a phenomenon, meaning it measures variables at a specific moment in time (Rahman, 2020). It also requires a large sample size and some factors that influence the research problem may be meaningfully reducible to numerical data, these include beliefs, perceptions, and identities, therefore this method was not suitable for this study.

4.2.3 Mixed methods

Mixed method is a combination of qualitative and quantitative methods where the researcher believes that simultaneously using both methods yields more comprehensive results than when either method is used independently (Creswell & Creswell, 2017). Johnson & Onwuegbuzie (2004) argued that the purpose of this approach is not to replace either the qualitative or quantitative methods but rather to magnify the strengths of each and to decrease their weaknesses. In so doing, the method might yield more genuine findings (Cropley, 2015).

For this study, I used the qualitative research method to give in-depth descriptions of teachers' view on IK, teachers' views on what the Natural Sciences CAPS document mandates and lastly how IK concepts could be integrated into the teaching of Natural Sciences. Considering that my study focuses on understanding this phenomenon in an in-depth manner rather than providing generalizations it was required that I take the qualitative rather than the quantitative approach.

4.3 Research Design

According to Creswell (2017), research design is a type of inquiry that provides specifications and directions of the procedures to be taken in a research process (Cresswell & Creswell, 2017). Research designs are important in that they help us plan how we will conduct the research. A research design aims to ensure that the evidence obtained enables researchers to answer the initial questions, test a theory, evaluate a program, or accurately describe some phenomenon. Qualitative researchers can choose from a number of research designs when conducting a study: ethnography, grounded theory, case-study, phenomenological, narrative, and self-study (Cresswell &cresswell, 2017). The next section presents the commonly used research designs in qualitative methods after which I describe the design that was suitable for this study.

Ethnography is a strategy of inquiry. The researcher studies a cultural group in a natural setting over a prolonged period of time by collecting primarily observational and interview data (Cresswell, 2009, p. 13). Grounded theory is a strategy of inquiry in which research derives a general, abstract theory of participants. On the other hand, phenomenological research is a strategy of investigation in which the researcher identifies the essence of human experience about a phenomenon described by participants. Narrative research is a strategy of inquiry in which the researcher studies the lives of individuals and asks one or more individuals to provide stories about their lives.

A case study, which this study used, is a strategy of inquiry in which the researcher explores a program, event, activity, process, or individual. A case study is a design where the researcher analyses events, programs, or techniques (Creswell & Creswell, 2011). Case studies offer a good opportunity for innovation and challenge current theoretical assumptions. Such studies are conducted in their natural settings and are bound by time because they center on a single representative of a group (Hancock & Algozzine, 2017). Case studies are classified as intrinsic and or, instrumental. An intrinsic case study is when the researcher does not intend on generalizing findings. In contrast, instrumental case studies are used to provide general explanations of phenomena based on a sequence of events (Harling, 2012). This study used the intrinsic case study design to investigate the teachers' views on IK at one township secondary school in Gauteng (South Africa), views on what the CAPS document mandates and how IK concepts could be integrated into the teaching and learning of the subject Natural Sciences.

4.4 Research Instruments

Research instruments are tools that researchers use to enable them to collect data to answer research questions. According to Hagan (2014), for a researcher to find suitable research tools for

their study, the researcher must read materials similar to their research to get an idea of instruments used and how they are used (Hagan, 2014). In this study, the research instruments that I used were questionnaires and interviews.

4.4.1 Questionnaires

A questionnaire is a research tool used to acquire information to determine people's lived experiences, values, and beliefs (Janes, 2001; Jankowicz, 2000). However, researchers use different types of surveys; commonly used ones include questionnaires and interviews (Leong & Austin, 2006).

Questionnaires are written surveys that contain questions related to the study objectives. They can be self-administered or be administered by a trained administrator who will explain the study to participants and answer any questions the participants may have (Mathers & Hunn, 2007). The advantages of using questionnaires are that they are cost-effective, easy to administer, and a practical way to gather data, which means that they can be used to collect large amounts of data at little cost. Limitations to using a survey instrument as a form of data collection are the difference that could exist between the understandings of the researcher who designs the survey and the respondent who interprets and answers the survey. Participants may not fully understand the questions or have a different understanding version of those questions. For this study, a questionnaire was developed in line with the NCS/CAPS documents to understand Natural Sciences teachers' views on IK and how their views influence their teaching practices in the classroom. The survey comes from a larger study that one of my supervisors is involved in, and the survey was validated for that larger study. Additionally my supervisors and I discussed the design of the questionnaire before I send them out for data collection. To minimize the limitations

on the questionnaire, I followed up with the participants by having a face-to-face conversation to verify what the participants wrote and what was asked in the questionnaire.

4.4.2 Interviews

Interview, as described by Cohen & Manion (1985), is a conversation between two people where the researcher asks the participants some questions which are related to the research question (Cohen & Manion, 1985). The aim here is to obtain explanations and interpretations from the participants (Kvale, 1996). Researchers can extract meanings from what participants say depending on the type of interview they choose. There are different types of interviews that a qualitative researcher can choose from depending on the purpose of the study. Those are namely unstructured, structured, and semi-structured interviews.

Unstructured interviews involve general, open-ended questions relating to the research questions being asked and is where there is no pre-determined, strict set of questions used to guide the interview (Chilisa, 2019; Whiting, 2008). Here the questions that emerge are based on the conversation that occurs during the interview between the researcher and the participant/s. Structured interviews make use of the questionnaire format, meaning it is formal and might come with close-ended questions. Close-ended questions are mainly used for quantitative studies and participants with special needs, such as those with speech or language impairments (Whiting, 2008). Semi-structured interviews involve open-ended questions and allow the researcher to ask clarity-seeking questions as the interview progresses (Whiting, 2008).

The advantages of using interviews are that it allows participants to express themselves as, in most cases, participants cannot write down their thoughts in full. So interviews give participants this freedom. They also allow the researcher to observe the participants and take down field notes, and lastly, they enable the researcher to ask clarity-seeking questions. This is done to allow the

researcher and the participants to agree on what is being said, and that there is mutual understanding in the questions and the response provided. This study made use of questionnaires and semi-structured interviews. Questionnaires was used to get a baseline insight into the teachers understanding of IK and the semi-structured interviews were used to focus more indepth into the teachers perceptions of what IK is, how it can be used in the classroom and what the actual classroom practice is as this enables participants to be able to express themselves and give full, meaningful answers to the questions asked.

The table shows Questionnaires and Interview questions and which research question they were related to.

	Research question 2	Research question 3	Research question 4
Questionnaire questions	What do you understand by the Indigenous knowledge part and its relationships to science or Natural Sciences?	What do you, as a teacher, understand by this policy statement in the CAPS? Can this be achieved? ___ "Yes" or ___ "No"(Check one √) If Yes, How?	How do you think that you, as a teacher, can do this in the Natural Sciences classroom? How could you, as a teacher, engage with and use of indigenous knowledge in teaching Natural Sciences in South African school?
Interview questions	The CAPS document speaks about the integration of Indigenous Knowledge with Natural Sciences, can you tell me about your interpretation of what this means to you? What do you understand about Indigenous Knowledge? a. As an individual	The CAPS document speaks about the integration of Indigenous Knowledge with Natural Sciences, can you tell me about your interpretation of what this means to you?	Is it necessary to include Indigenous Knowledge into the teaching of Natural Sciences? If no, why not and if yes why and how do you do it? How do you include Indigenous Knowledge into the teaching and learning of Natural Sciences?

	b. As s science teacher Is Indigenous Knowledge important in a. Your personal life b. Your practice in teaching of Natural Sciences Is Indigenous Knowledge science? If yes why do you say so, if not why do you say so? What do you think are the similarities and differences are between Indigenous Knowledge and Science taught in the classroom are? How does Indigenous Knowledge relate to Natural Sciences?	When were you aware of this mandate? What is Natural Sciences in your own understanding?	Can you give 1 or 2 examples of concepts that you use when including Indigenous Knowledge? Is there any other way to include Indigenous Knowledge in the classroom? If possible, what are those things that you have actually said to them to show that you have done/included Indigenous Knowledge? If there are concepts that you do not include Indigenous Knowledge, why is it so?

4.5 Data Collection

Data was collected from one public, township secondary school in quintile 4. This means that this is a no-fee paying school compared to schools that are in quintiles 1-3. The school has been allocated additional land by the government which the principal of the school indicated will be developed for building a school hall and sports facilities. The school had a computer laboratory which was recently build, the school did not have a library. Three teachers who taught Natural Sciences voluntarily participated in this study. Initially three schools were invited to participate in

the study but the other two schools declined the invitation and only this particular school showed an interest and three teachers from the school were willing to participate. The teachers were all males and two of them were coloureds and one was black. All the teachers had more than four years' experience of teaching the subject Natural Sciences and had more than 10 years of teaching experience. The teachers are given pseudonyms when they are referred to in this study, this is done to protect their identities. Table 1 below presents information on the study sample.

Table 1

Participants	Gender	Subject	Grades	Years of experience
Teboho	Male	NS/LS	9,11,12	30
Koketso	Male	NS/Geography	9,10,11,12	35
Neo	Male	NS/LS	8,10	13

NS= Natural Sciences; LS= Life Science

The participants were provided with a questionnaire via email initially however I eventually printed the questionnaire for participants, as detailed on the delimitations section below. Following the questionnaire and with their consent, an interview was set up telephonically with the participants to discuss the participants' responses to the questionnaire. During this study, due to the COVID-19 pandemic, data was collected telephonically for the interviews, and the interviews were audio-recorded with permission from participants. Textual and audio data were collected. Textual data were collected using questionnaires. Questionnaires were reviewed with the participants before they are administered. Upon administering the questionnaires, I discussed a

convenient time with the participants for me to collect them. Audio recordings of the interview/conversation were transcribed and shared with the participants for reading and validation as a form of member-checking.

Data Analysis

Data from questionnaires and transcripts were analyzed using content analysis. Content analysis is the process of organizing and summarizing textual data as well as uncovering themes that represent appropriate interpretations used to answer research questions (Cohen et al., 2002; Flick, 2013). There are three types of content analysis as stipulated by Hsieh and Shannon (2005) and those are; conventional, direct and, summative content analysis. This study made use of the convetional data analysis. With this type of analysis codes are extracted from the whole data set which was collected from questionnaires and interview transcripts.

In analysis content data I followed the six step provided by Maguire and Delahunt (2017) and they are as follows: 1 becoming familiar with the data; 2 generating codes; 3 searching for themes; 4 reviewing and; 5 defining themes and; 6 final write up of the thesis. The first step involves going through the results a number of times to familiarize yourself with it and also taking down notes of any impressions that may arise. The second steps involves generating codes. The third steps involves arraging the generated codes into themes. According to Braun and Clarke (2006) and Zhang and Wildemuth (2009) themes are articulations of ideas that are in the forms of single words, phrases or paragraphs that exhibit patterns related to the research questions. Step four involves arranging the themes based on what they mean and their relevance to the research questions. Step five defining themes includes figuring out what the themes are about and how do they relate to one another. The last step involves writing up your dessirtation using the generated themes as guidelines.

4.5.1 Credibility

The credibility of a research refers to how reliable the research methods and findings are considered to be (Alant, 1999). Credibility is one of the criteria used to assess the authenticity of a qualitative research (Nnaidozie, 2009). In this study, steps were taken to improve credibility, as shown below.

Cohen et al., (2017) posit triangulation as the method of using two or more data collection methods. In this study the method of triangulation was used to ensure credibility. The different data collection methods were discussed in chapter four, under research instruments and these include questionnaires and interviews. The data gathered through the use of the different methods mentioned was used to check research findings before conclusions were drawn.

Credibility is established when other people understand and interpret a study's findings in the same way that the researcher does (Toma, 2011). This concept was used in the current study. The researcher discussed with participants the understandings that emerged from the data collection phase. The researcher also discussed with the supervisors the research data and findings to ensure that the researcher's interpretations of the findings were consistent across all discussants (Naidozie, 2009).

4.5.2 Delimitations of the Study

When the study was conducted we were in the middle of the COVID-19 pandemic and as such face-to-face meetings were prohibited. I had to email the questionnaires to the teachers and the expectation was that the completed questionnaires would be returned within a week, however, that was not the case as some of the participants only indicated that they could not print the questionnaire and others indicated that they do not have access to a computer to answer the questionnaire when it was time for me to collect these surveys. Arrangements were made with the

participants to send them hard copies of the questionnaires for them to complete and send them back within a week. So, I printed out the questionnaires and physically delivered them to the teachers. Teachers still could not send the answered questionnaire within the given time and that resulted in more time allocation for data collection. However, I provided extended time for the participants to complete their questionnaire. I collected the questionnaires from the teachers.

4.5.3 Ethical Considerations for this Study

Creswell (2012) points out that empirical research in education inevitably carries ethical issues because it involves collecting data from people and is about people. Ngxola (2012) further points out that "ethics has to do with the application of moral principles to prevent harming the subject that is involved in the research" (p. 43). Hence, for my study, the process of collecting data only started after getting ethics approval from the University of the Witwatersrand Human Research Ethics Committee (non-medical) and Gauteng Department of Education (GDE). I started first by applying for ethics approval from the Human Research Ethics Committee (HREC) at the university.

I was conducting research at a public school and engaging with teachers in this process, therefore, I needed to apply for permission through the GDE ethics committee. An explanation was provided to the participants that participation was voluntary and that they were allowed to withdraw from the study at any time for any reason. Participants had to sign a consent form if they chose to participate. The school is given a pseudonym to protect its identity. Individual privacy is maintained in all published and written data resulting from the study. Copies of the GDE clearance certificate, GDE letter regarding covid, WITS clearance certificate, the permission letter to the principal, participants' information sheet, participants' questionnaire and an interview schedule are available in appendices A, B, C, D, E, F,G and, H.

4.6 Summary of the Research Method

In this chapter, I have discussed research methods, research designs and how I collected and analysed my data. I have discussed three research methods which are as follows; qualitative, quantitave and mixed methods. Qualitative method is a method that enables the researcher to collect textual data, whereas, quantitative method enables the reaseacher to collect numerical data and this is then analysed using statical programmes and lastly mixed methods, it enables the researcher to collect both textual and numerical data.

From here I then discussed research design which is a type of enquiry that provides specification and direction of the procedures to be taken (Creswell & Creswell, 2017). Amongst the commonly used research design I discussed the following, ethnography; grounded theory; case-study; phenomenological; narrative and; self-study. This study made use of the intrinsic case study design to investigate the teachers' views on IK.

After I have discussed the research instrument that I used in this study. The research instruments used were questionnaires and interviews. Following research instruments I discussed how data was collected, how many participants were involved in this study and since this study was conducted during the COVID-19 pandemic what are some of the safety measures that were taken.

I then discussed how I ensured credibility in the study. Thereafter, I discussed delimitations of the study. One of the delimitations was the study was conducted during the COVID-19 pandemic and as such face-to-face meetings with the participants was not possible. Finally I discussed ethical considerations, I asked for permission from Gauteng Department of Education (GDE) as well as the University of Witwatersrand Human Research Ethics Committee (non-medical) before conducting this study.

Chapter Five

Results and Discussion

5.1 Introduction

This chapter will elaborate on the study's findings from interviews conducted for this study and literature reviewed in Chapter 2 and the themes are arranged as follows: An evaluation of what the policy documents mandate and the type of guidance that teachers receive from the mandate regarding IK and its integration into the Natural Sciences classroom. The first section of the study examines the policy documents to determine how each of the documents focuses on IK. The second section consists of three parts where I examine: i) teachers' perceptions of IK, ii) teachers' views of what the Natural Sciences CAPS document mandates, and iii) teachers' thoughts of how IK concepts could be integrated into Natural Science teaching, and how they have incorporated this into their classroom teaching practice. In the form of a discourse, the findings are combined with additional literature to address the research questions raised in Chapter 1.

5.2 An analysis of policy documents for Curriculum and Assessment Policy Statement 2011 (CAPS), Annual Teaching Plan (ATP), and the Pacesetter to identify Indigenous Knowledge (IK)-related content for the Senior phase Natural Science curriculum

The first research question for my study concerns document analysis of three documents, i.e. CAPS 2011, the ATP, and the Pacesetter. My analysis of the Natural Sciences CAPS document shows that this document outlines what teachers should teach, how they should assess what they are teaching, and how much time each subject and topic should take. The teaching and learning of the subjects have specific aims, skills, it indicates the focus of content areas, and the weighting of

content areas. As indicated on the CAPS, the main objective of this document is to lessen the administrative burden on teachers and ensure consistency and guidance for teachers when teaching.

The Annual Teaching Plan (ATP) is a document formulated from the Natural Sciences CAPS document. It specifies the context according to the following four strands presented in the Natural Sciences curriculum: Life and Living, Energy and Change, Matter and Material, and Planet Earth and Beyond. These strands are taught throughout the four terms of the year for grades 8 and 9. The ATP further indicates whether that specific topic falls under the formal assessment or not.

Lastly, the Pacesetter is also linked to the Natural Sciences CAPS document and represents a yearly calendar as it has weekly schedules to show what content is to be taught weekly. The Pacesetter has topics according to the strands and the specific content that needs to be taught.

There is an alignment between the content provided in the CAPS, ATP, and the Pacesetter. For this study, it was necessary to examine all three documents in relation to the integration of IK on the documents and on how teachers used each set of documents as part of their teaching practice. In the following section, I explore what instruction was provided to teachers and how this guidance was laid out for teachers by these documents, regarding the integration of IKS in their teaching of Natural Sciences. I therefore proceed to analyse the policy documents in order to examine the extent of guidance provided to teachers concerning the integration of IKS in the Natural Sciences classroom.

5.2.1 The Natural Sciences CAPS document

The Natural Sciences CAPS document mandates that teachers should include IK in their everyday Science teaching and learning. Page 5 of the Natural Sciences CAPS 2011 document states that

"valuing indigenous knowledge systems and acknowledging the rich history and heritage of this country as important contributors to nurturing the values contained in the Constitution". IKS is acknowledged as an essential part of the curriculum which speaks to the values enshrined in South Africa's Constitution. This is further supported on page 16 of the Natural Sciences CAPS 2011 document, it reads,

> "Teachers have the freedom to expand concepts and to design and organize learning experiences according to their local circumstances…Examples of indigenous knowledge that teachers select for study should, as much as possible, reflect different South African cultural groupings. They should also link directly with specific contents in the Natural Sciences Curriculum".

In addition to encouraging the use of IK-related content in the teaching and learning of sciences, the Natural Sciences CAPS 2011 document says that teachers are free to add any IKS content they choose as long as it is aligned with the curriculum. However, when analysing the statements from the Natural Sciences CAPS policy documents concerning the advice instructors receive, it remains unclear how teachers may implement IK in the classroom setting as there are little to no examples of IK in the curriculum or how IK could be used in classroom teaching practice.

There could be benefits and drawbacks to the teacher not receiving explicit guidance on integrating IK into teaching practice. This level of freedom for the teacher to choose the examples related to IK within the teaching and learning context is advantageous as it affords flexibility for the teacher by giving room for creativity in the science classroom. It is possible that if the curriculum developers had dictated specified examples of IK to use when teaching specific topics in the classroom, it might work for some classes but not for others. This would depend, in part, on the diversity of learners from different cultural backgrounds within different classroom settings. For example, when considering the topic on fermentation, an explanation that includes "umqombothi"

could work well in a classroom of 'black' learners (i.e., the Coloured, Zulu, Xhosa, Tswana, Basotho, Bapedi, Venda, and Tsonga populations, as well as a few learners from neighbouring countries such as Zimbabwe) as it is usually something that is familiar to them within their communities. However, the same example may not work well at a school where there are 'Indian' or 'White' learners as part of the cohort since this is not likely to be part of their cultural background. Therefore, the learners from Indian of white backgrounds would probably not know what this fermentation process is about based on cultural inference related to their indigenous knowledge backgrounds. For such learners, the teacher could find a different example of fermentation that learners are familiar with from their background, or ask students to speak about any examples from their home or community which relates to the topic taught in class. Thus, leaving the freedom of including IK as part of classroom practice in the teacher's hands could be a promising idea as it could allow for flexibility in the science classroom, this is because teachers could customize the examples used in teaching according to the class needs.

On the other hand, leaving the teacher to decide which IK concepts and examples to include in their science teaching can be disadvantageous because teachers educated in western education systems may lack the required knowledge structure held within indigenous knowledge systems for some communities (Shizha, 2008). In other words, it is unlikely that teachers would be aware of a great variety of IK from different cultural or racial groups apart from their own. This is because most of the more experienced teachers in the schools in South Africa in current times would have attended teacher training programs during the days of Apartheid that did not allow for the inclusion of any other knowledge systems like IK, and even nowadays there is still skepticism on including IKS since it is accorded the status of being pseudoscience (Mothwa, 2011). This was because IKS was not considered necessary to educate non-white learners in areas like Science. However, when

South Africa became a democratic country, emphasis was placed on acknowledging the knowledge of all groups of people and that IK could also be used to enable non-white populations to access concepts and learning within the field of Science (Tomlin, 2016). The issue is that teachers who were educated under the Apartheid system may not have received any training on how IK can be integrated into classroom teaching (Tomlin, 2016). There is also the debate that teachers may be sceptical about the need or value of integrating IK into formal teaching and learning practice (Mothwa, 2011; Ogunniyi, 2007; Naidoo & Vithal, 2014). In addition, Mbuli reported in 2015 that teacher training programmes seem to not focus on how pedagogic practices can integrate IK into how teaching is planned and directed within the classroom context, this is still representative of the teacher training programmes even in current times. As a result, this study is meant to determine the extent to which teachers were provided with guidance, based on curricular documents from the Department of Basic Education's (DBE), on integrating IK into the Science curriculum presently.

My findings based on document analysis show that the DBEs call for teachers to include IK in their science classroom is salient on the CAPS 2011 document. According to studies such as that by Sakayombo (2014) the inclusion of IKS in the schools remains ignored. My analysis of documents suggests that this could be because the Natural Sciences CAPS 2011 document hardly provides any indication, guidance, or instructional material to achieve integration, these results are supported by Timba (2000), as cited by Ngcobo & Mavuru, (2020). Without the advice and professional development workshops on how teachers could include IK in their science teaching practice, this could discourage some teachers from even attempting to include IK in their everyday teaching. Seeing that these reports were published in 2014 and 2000 respectively, my study shows

that there has been no substantial change up until current times in the guidance provided to teachers via the CAPS mandate.

5.2.2 The ATP and Pacesetter

As indicated earlier, the ATP and the Pacesetter for Natural Sciences senior phase curriculum indicate concepts that should be covered per term, topics to be covered each week, and the time allocation for each topic. But these documents do not explicitly state what the Natural Sciences CAPS 2011 document mandates in terms of including IK in the teaching of Natural Sciences. In addition, my analysis of these documents for my study reveals that there is no inclusion or mention of IK in the ATP and the Pacesetter, nor examples on specific topics or detailed guidance on the inclusion of IK or even time allocation for the teacher to include IK. Furthermore, considering that generally, teachers have limited time to cover a broad area of content, and crucially they are expected to follow the Pacesetter and the ATP as the subject advisor uses these documents to evaluate the teaching process, it is plausible that teachers do not reflect on the mandate to include IK in teaching, I examined this assertion in the following section in this chapter. Moreover, it is required by the DBE for schools to send their curriculum coverage every term to track the school's progress in terms of curriculum coverage progress, so it is possible that teachers therefore tend to follow the Pacesetter closely and not use contact time to expand on or provide examples which could include IK.

Based on the document analysis explained above and in relation to research question one, there is misalignment between the mandate to include IK as indicated by the Natural Sciences CAPS 2011 document and the lack of inclusion in this area on the Pacesetter and ATP. The Pacesetter and the ATP, specifically for the senior phase Natural Sciences curriculum, do not show or give any examples of IK. These are the two core documents that teachers are assigned to work with by their

Head of Departments. There is no indication of the inclusion of IK on these documents, as a result, this study will show that teachers may not be aware of what the Natural Sciences CAPS document mandates, and as such, the extent to which they include IK in their science teaching is minimal. The following section in this study investigates teacher awareness and practice concerning the Natural Sciences CAPS mandate for the inclusion of IK in teaching.

One of the recommendations that emerges from the document analysis section of my study is that guidance is required to illustrate how curriculum developers and policy makers intend for teachers to include IK in their teaching practice, i.e., a few examples, representative of different demographics in South Africa of how IK can be included in teaching needs to be provided by the DBE and curriculum developers. This level of guidance could enable teachers to adhere to what the Natural Sciences CAPS document mandates about the inclusion of IK into the teaching of science. The examples will provide teachers with an indication on how they can include IK in their classroom teaching practice. In addition, to further encourage the inclusion of IK in the science classroom amongst teachers, the DBE, curriculum developers, and all the stakeholders could include questions in the formative and/or summative assessments which focus on IK.

5.3 The Teachers' Definitions of IK, Their Views on What the Natural Sciences CAPS 2011 Document Mandates, and How IK Concepts Could be Used in Teaching Natural Sciences

This section provides a discussion of the research questions as follows: The second research question was "what are the teachers' views on what IK is?". For this question I began by exploring the teachers' definition of IK. Two themes were developed concerning the teachers' definitions for IK: the first is how knowledge is acquired, and the second theme was how (this) knowledge evolves. The third research question was "what are the teachers' views of what the Natural

Sciences CAPS document mandates?" and lastly the fourth research question was "what are the teachers' views on how IK concepts could be integrated to teach Natural Sciences?" For this last research question, two themes emerged from the analysis, namely: 1) Teachers' reasons for including IK in their classroom teaching practice and 2) ways of including IK into their classroom teaching practice and content discussion with the learners. The chapter concludes with an integrated discussion of results and a summary of the research findings.

5.3.1 The Teacher Definitions For IK in relation to research question 2

5.3.1.1 Theme 1: How Knowledge Is Acquired. The theory of social constructivism, as described in chapter 3, was used to analyse this theme. Therefore, for this theme, I used Vygotsky's theories on cognitive development and specifically his notion of the MKO for my analysis in this section. Considering the various definitions for IK that have been reported in publications, as shown in my literature review section, it is necessary to start this section by probing the teachers' definition of the concept of IK in their everyday life.

5.3.1.2 How Teachers Define IK. Findings from this research indicate that teachers reported on the link between their current understanding of the world and their environment in their definition of IK. For instance, a teacher, Teboho, said that "IK is the knowledge you acquire at home or in the community you come from." Another teacher provided a similar definition; Koketso explained that "IK is the knowledge that we gather in our lives, through experiences."

Thus, in their definition for IK, the teachers referred to their early childhood memories and the knowledge and experiences as they grew up within their communities. Taking into consideration Vygotsky's theory of the MKO when examining the teachers' comments on their knowledge, they

made links between their understandings and experiences as coming from knowledgeable others within their communities. Koketso further elaborated, "…we learned how to use fire and so on, and we saw different cycles in the world … but we did not fully understand them, but we gathered this knowledge, and it was passed on to the younger generation".

Teachers learned the values and customs of the community since they reported that their knowledge emanates from their homes or the communities in which they grew up. Vygotsky explains that for learning to take place social interaction between the MKO and the learner is critical (Vygotsky, 1977). Hence teachers in this study interacted with the elders in the communities they grew up in and were able to learn from them because of those interactions. When comparing Matsika's (2012) definition of IK to how the teachers in my study define IK, there are some parallels in that they both stated that IK is the knowledge they gain through experience.

It is the knowledge that exists within the community that one comes from. Some of the knowledge that the teachers in my study learned from the grandparents and parents included how to cure ailments using indigenous knowledge (interview: Koketso and Tebogo), which is the focus of the next section. This knowledge that teachers have about curing ailments have been learned from interactions with the MKOs. In learning about the different plants that could cure different ailments, they reported on some of the things that they could now do on their own such as preparation of the medicinal plants, they learned this with assistance from an elderly person. This situation where a learner receives assistance from a teacher, or an adult is what Vygotsky refers to as the ZPD. It is of utmost importance to understand teachers' definition of IK in this study, the reason being, the Natural Sciences CAPS document mandates teachers to include IK in their teaching and as such, first understanding what teachers think IK is, is important.

5.3.1.3 ***Teachers' Views on How their IK is Learned From Their Communities***. As evidenced below, the teachers learned from their communities' old concoctions to cure ailments and linked these experiences to a general understanding of how the world works. In relation to this, Teboho conveyed,

> "There are some remedies, you take it from a perspective where you are sick [and] do not have the necessary westernized medicine to treat a particular ailment or illness and that which you learned from the parents and the grandparents and has been passed down from generation to generation."

The teacher implied that in his experience traditional medicine could be used in the event where Western medicine was unavailable. The teacher in this study faced border-crossing. Moving from the use of Western medicine to the use of traditional medicine that on its own is border-crossing. The reason is it could be that the teacher is now used to Western medicine and now having to make use of traditional medicine that could come with a lot of uncertainty even though as the teacher was growing up, traditional medicine was what was used at home. The teacher indicated that he made use of traditional medicine as a second option and in cases where western medicine is not available, or it seems not to be working to cure the aliment.

Teachers remarked that their parents and grandparents taught them about traditional medicine and how to treat illnesses in the absence of western medicine. What the above entail is that, teachers in this study turn to traditional medicine approaches if western medicine was an option but it is not available at the time they needed it. In this instance the teachers' grandparents and the parents are seen as the MKO as they are the ones providing education about traditional medicine to the growing generation and guiding them towards making use of traditional medicine approaches. The knowledge that they learned about has been part of their tradition as they were growing up, and as

such, they had internalized the traditional or indigenous knowledge and practice. They also shared some of the knowledge that was imparted to them, in relation to this Teboho said that

> "a sty in your eye, there is no cure, the parents would tell you to take a gold ring and rub it in there. A finger you have, a, what is the word? Basically, when you take sunlight soap and sugar, if you have what the word is, I do not know what the word is, but we call it *feitvinger* in Afrikaans (A jammed finger in English). Still, it is like an infection a boil but not a boil, but like a boil, also in treating a boil, instead of using western medicine, you will use a bottle of brandy and pour hot water in it and use it as a suction tool to draw out the pus and things. It is important because it works, in many instances it works."

Teboho gave a narrative of day-to-day treatments that his parents and grandparents used to teach him as he was growing up. A study conducted by Dahlberg & Trygger (2009) similarly showed that villagers in Kwa-Zulu Natal (KZN), a province in South Africa, used household remedies made of locally available medicinal plants to cure ailments. These results build on existing evidence of grandparents and parents using household remedies to cure ailments as opposed to using pharmaceutical medicine. This provides evidence that communities have the belief that traditional medicine works, and people are using IK from their communities to cure ailments.

In addition, Koketso mentioned that

"Many times, I will quote what my grandmother said to me if I had a toothache, then they used to give us certain things not necessarily bought in the chemist. They grew it in the backyard and used herbs for stomachaches and so on."

Koketso reported that growing up, his family did not necessarily use medication from the pharmacy, and instead, they grew medicinal plants in their backyard. This participant explained

that his grandparents and parents knew medicinal plants which were passed down to him. He elaborated that it could be that even though he did not know the scientific name of the plants, if shown the plants he could tell what some of the plants can cure. Dahlberg & Trygger (2009) further stated that villagers frequently used medicinal plants which contributed to their ability to cope with health problems. The research conducted by Dahlberg & Trygger (2009) confirms the narrative given by Koketso about medicinal plants. The findings that the study participants used traditional medicines as an alternative to pharmaceutical medicine is indicative of the environment from which the teacher came, this teacher was from a rural area as that is where you will find more plants planted in their backyards because of the space they have.

Now that the teacher has moved to Gauteng another province in South Africa, the teacher experienced cultural border-crossing, as some of the traditional medicine that he is familiar with in the city it is not easy to find and as such the teacher could be subjected to using pharmaceutical medication in the event where he is sick and could not get the traditional medication that he is used to. In addition, the teacher faced the difference in terms of lifestyle, values and norms.

There was a lot that the teacher had to learn which was different from what he was accustomed to. With regards to traditional medicine, one could say the teacher continued to use traditional medicine as it is the knowledge he learned as he was growing up and it is the knowledge, he grew up understanding. Now having to start to use something new, which was unfamiliar to him would cause a state of disequilibrium in his minds. Piaget relates that the learner must alter their thinking to reach an equilibrium state. To do that the learners need to make sense of the new knowledge by assimilating it to what they already know. This assimilation comes about when the teacher makes sense of Western medication, perhaps reading the contents of the new medication that they need to take to cure the ailment they might have.

5.3.1.4 Advantages and Disadvantages of the Practice of Traditional Medicine. The practice and the knowledge about traditional medicine that the teachers acquired during their youth have some advantages and disadvantages in today's context. One of the benefits of the acquired knowledge is that it could still be applicable even in today's context. A study conducted by de Wet et al., (2010) showed that all participants preferred using medicinal plants instead of western medicine. They did so for a variety of reasons, including cultural considerations, availability, and the idea that there were no adverse effects and that medicinal herbs were more successful than western treatment. For these reasons, people in today's contexts are still making use of the knowledge they have about medicinal plants to cure ailments. In addition, the study conducted by de Wet et al., (2010) was conducted in Kwa-Zulu Natal and my study is conducted in Gauteng it is two different locations with different situations. As such people in Gauteng seek traditional medicine as a second option in cases where western medicine is not available or seems not to be working.

One of the challenges that could interfere with the ability to use and implement IK in the current context is the ability to practice using traditional medicine in urban areas. Urban areas could hinder using traditional medicine as people living in urban areas have little to no space in their backyards (Hand et al., 2019). In addition, specific plants require specific temperature, soil texture, to mention a few things. For instance, *indungulo,isiphephetho* (isiZulu), is an African ginger and a herbaceous perennial plant on the forest floor. It grows best in well-drained, red, and yellowish-brown soil rich in organic matter (Department: Agriculture, Forestry and Fisheries, 2013, p.2), which is something you will not easily find in urban areas because of all the paving that is there.

Another challenge that teachers in this study indicated is that the knowledge passed to them as they were growing up did not all make sense as they were still young to comprehend the complexity of the information. Interestingly, they went on to state that there were some gaps in

understanding how some of the knowledge would be useful in a practical sense within their lives, as shown in the following quote "…but we did not understand it fully we just knew that there was fire, we learned to use fire and so on and we saw different cycles in the world and so on, but we did not fully understand them." Even though the knowledge was passed down from generation to generation, it was not always wholly articulated why the information was passed down or why the practice was the way it was in the context of that community or family. The knowledge which was passed down to the teacher in this instance is from a MKO and at this point the teacher was in a stage where he learned with an aid of an adult how to use fire and learned the different cycles in the world. Vygotsky refers to the above as ZPD, the range of abilities an individual can perform with the guidance of an expert, but cannot yet perform on their own (Vygotsky, 1977)

The teachers in this study made links between the environment and their communities in their definition of IK. They see IK as knowledge that is gained through experience and knowledge that exist in the community that one grows in. Within their communities they gained knowledge about traditional medicine to cure ailments. To date they make use of traditional medicine as a second option when western medicine is not available or seems not to be working in curing the aliment. The success of ZPD involves social interactions that allow the learners to work on their skills and abilities (Eun, 2017). Growing up some of the knowledge which was passed down to the teachers by their grandparents did not make sense, however, they continued using the knowledge until it made sense to them. For teachers in this study IK is an important part of their family, home and community backgrounds.

5.3.1.5 Importance of IK to the Teachers in this Study. As shown in the quotes in the above section, it is possible that the elders anticipated that the children would learn the indigenous knowledge by observation or practice within the community. The act of learning IK by observation or practice within the community enabled the teachers to accomplish the new task or skill they were learning and in this case it could be the knowledge of how to use/the use of traditional medicine. Scaffolding refers to the assistance that adults provide to children to assist them in accomplishing a new task or skill, this is related to the ZPD. However, this assumption that children will understand the knowledge from experience within the community could also explain why there is sometimes a loss of practice in the process. Maluleka (2017) alluded that

> "IK is in danger of being obliterated due to several factors, such as the lack of interest from younger generations, low life expectancy where people die before transferring it to the next generation, and not being documented. This is because IK, by its very nature, is generally known to have been passed from generation to generation through oral traditions" (p. 1).

Thus, Maluleka (2017) highlights that part of the problem the "the lack of interest from younger generations" (p.1). This lack of interest indicates that IK is not being conveyed to make it relevant to the individuals in today's world. This could also mean that because the younger generation does not see the relevance of the information, they do not see the need to learn it, as mentioned in the last quote under section 5.3.1.3. When one understands the knowledge that is being passed to them and why there is the relevance of the knowledge to the community and way of life of an individual, it can then be valued as it will be of importance to that individual or community.

One of the participants in this study, Koketso, stated that the younger generation only began to comprehend the knowledge passed down to them as they grew older. As shown in the following

quote, teachers can link indigenous practices passed down within the communities and the content provided within the formal classroom context.

> "… we took that knowledge [that was passed down, and which] we did not understand before, and now it is formulated in books, and we took it to the classrooms, and now we can say at least let the learners understand, teach to the learners understandably as opposed to have all this knowledge and not know the origin of it and how to use it and now we can acquire the knowledge and pass it on to the next generation."

In essence, the teacher had reflected that even if the younger generation did not understand how this knowledge would be helpful in their everyday lives, it could begin to make sense to them as they recognized the connection between the information that they received from the school environment and their lived experiences. Using the MKO and cognitive theoretical framework, it is possible to see here that the teachers' grandparents are the more knowledgeable other as they had information about medicinal plants, and they passed that knowledge to the teachers in this study. As mentioned in chapter 3, the MKO refers to someone who has a better understanding or higher ability level than the learner concerning a particular task. Teachers discussed their definitions of what they understood from what IK is, and they further explained what they had learned from the communities they came from. In addition, they indicated that at first, they did not understand what they were being taught by their grandparents and parents, but as they were growing up, they started to make sense of what they were taught.

Cognitive constructivism is an approach to probe for children's levels of understanding and to show that their knowledge can increase and change to higher-order levels of thinking (Amineh & Asi, 2015). As teachers in this study were growing up, not all of what they were taught initially made sense to them, and as such, they had reached a point in their minds that Piaget terms

"cognitive disequilibrium". Disequilibrium according to Piaget (1972) is when a child comes across a situation s/he does not understand. And to try and fix that, they need to make sense of the new knowledge by assimilating it with what they know, that is, by attempting to incorporate it into what they already know. This assimilation and accommodation of new knowledge, from the point of view of the teachers, took place later in life when they were able to make connections to the knowledge they gained as youngsters within their communities. In addition, as they were moving from one province to another, they had to accommodate the new knowledge that they learned which was different from what they already knew. As the teachers were moving from province to province they experienced border-crossing as values and norms were different from what they knew and in addition the medication itself was new to them. Some teachers were used to traditional medicine but because of moving away from their places of birth and where they grew up, they changed their practice from taking medicines prepared according to indigenous methods to taking pharmaceutical medicine, they now seek traditional medicine as a second option in the absence of Western medicine.

5.3.2 Theme 2: Evolution of Knowledge

Teachers in this study indicated that current western knowledge was built on previous knowledge (i.e. Indigenous Knowledge), accessible through the communities within which people grew up. Koketso indicated,

> "As I said, it was taken -all that knowledge - studied further made some sense and in most cases its theories, you cannot say its absolute truth, but it was made a little bit clearer, and it was put in books and recorded and given to us."

> Here, this teacher indicated that, like traditional healers, the other elders in the community had expertise in plants that could cure specific ailments. He claimed that researchers came into those communities and learned from what the community's people knew about traditional medicinal plants.

Then they went back and analyzed it further to try to understand what is in that plant species that cured a particular ailment, and once they found an answer, the same knowledge was then documented and brought back in the form of a report or a book. The view from this teacher can be corroborated by a study on *Agathosma betulina*, also known as ibuchu in Xhosa and long-leaf buchu in English. This is a shrub used in cold and flu remedies, stomach ailments, and healing bruises, to mention a few (Street & Prinsloo, 2013). Traditional healers and villagers in Xhosa villages boil the plant and drink the water to treat some of the ailments mentioned, while scientists investigate the plants to learn more about the physiology behind the therapy. This can be seen in a study conducted by Street &Prinsloo (2013). Here the authors studied the composition of buchu and identified numerous compounds. They found it included "limonene, menthone, diosphenol, l-pulegone [17] with isomenthone, and diosphenol as the major volatile compounds [18, 19] responsible for the distinctive flavour but probably also for antispasmodic, antiseptic, and diuretic activities [12–14, 20]" (Street & Prinsloo, 2013, p.2).

The study conducted by Street &Prinsloo (2013) confirms the claims made by the teacher in this study. Based on the quote from the teacher, the perception is that the parents and grandparents of the teacher had cultural, medicinal knowledge on the indigenous plants, scientists extended on this knowledge by showing what biochemical properties could be linked to the medicinal properties. Indigenous knowledge holders did not know the chemical composition of the plant or how the biochemical processes in the body were influenced by the biochemical components of the plant,

western science explained these links. The knowledge which is used in traditional medicine comes from trial-and-error practice across generations, and this process is what enabled traditional medicine to be used successfully.

In addition, Koketso reported on how the knowledge about herbs as traditional medicines used in his household as he was growing up is similarly used as the foundation to make pharmaceutical medicine sold in pharmacies. Although the type of knowledge is different (i.e. western medicine looks at biomedical and physiological processes, while traditional medicine looks at the use through observation and trial and error) and how the knowledge is understood is different, how the knowledge is used for healing is similar. He shows this in the following quote.

> "Many times, I will quote what my grandmother said to me if I had a toothache, then they used to give us certain things not necessarily bought in the chemist, but they grew it in the backyard and used herbs for stomachaches and so on. So, they came with the role of scientific knowledge, and it was always there. As I said, it was always there and these grannies and bigger people, they used to know exactly what to use and that is as an individual."

Koketso implied that the knowledge we have today about medicine in the pharmacy is similar to the knowledge that their grandparents had used when practising traditional medicine. Perhaps growing up as a child, the practice did not make sense as to why they would take leaves of a tree, boil them, and give them to someone to drink. It could be that the practice is only making sense now as they read the contents of the medicine bought in the pharmacy or as they see a picture of a tree on the container of the medication they purchased from the pharmacy. It reminded Koketso of the tree they had at home as he grew up, which triggered him to remember the practice. Hence, Koketso reiterated that the knowledge has always been there, "It was always there, that is what our elder people taught us." Here we can see Koketso going through cognitive constructivism, he is

making links between what he understood as an adult and what he observed growing up when it came to traditional medicine and pharmaceutical medicine. We see this when he gets triggered but what he sees on the container of the medication bought in the pharmacy and it is at this point when he assimilates what he already knows with what he sees on the container and as such this then enables him to accommodate the new knowledge that he is faced with in order to reach a state of mental equilibrium.

5.3.2.1 Importance of Documenting IK. One of the key concerns that emerge from this study is that as much as knowledge is passed from one generation to the next, it is done verbally and by practice only rather than in written, documented form, and therefore some of the content may be lost over time. Therefore, to maintain the culture and the knowledge base, it is necessary to start documenting the African knowledge. Teachers in my study reported on this matter by saying that our African knowledge or Indigenous knowledge is not recorded, "I start with the premise that all knowledge is Indigenous, it was not recorded that was the mistake that African people as a whole did."

As Adeyemo & Adebayo (2018) and Moahi (2006) show, when IK is not documented then the custodians of the knowledge are usually not given recognition for their traditional knowledge. It is the knowledge that is passed from generation to generation either verbally, through observation, or observation and practice. In a study conducted by Baloyi & Khumalo (2017), they alluded to IK not being documented and stated that "Indigenous knowledge is transmitted orally, experientially, and is not written but is learned through hands-on experience and not taught in an abstract context and its parameters are holistic, non-linear and reflect a qualitative and intuitive mode of thinking" (p.7).

Due to the knowledge not being recorded by the African people, the teachers in my study indicated that the same knowledge is being used by others who see the importance of this knowledge, as shown in the following quote,

> "what the people [colonizers] did they appropriated it, and they just categorized it, and they put terms and terminology, and now it sounded very sophisticated and but it was the existing knowledge that was already there that they just put in another format and obviously recorded it and put it in books and gave it back to us."

The teacher explained that researchers are coming into local communities and are conducting studies of the knowledge that is present here. As such, they take that knowledge and interpret it as their own without necessarily acknowledging the source. A study conducted by Adebayo & Adeyemo (2017) supports this notion:

> "Documentation of Indigenous Knowledge facilitates fixation of information for broad scrutiny and ownership by the writer. A piece of traditional knowledge may be lost forever if it is not properly documented, analysed, and disseminated. The knowledge gained but unavailable to others is wasted" (p.5).

In addition, Labelle (1997), as cited by Baloyi & Khumalo (2017), stated that "The importance of documenting Indigenous Knowledge is to ensure that communities are not left impoverished as a result as the world needs genetic diversity of species; it needs the diversity of knowledge systems" (p.9). Sithole (2007) stated that the documentation of Indigenous Knowledge is essential and an acceptable way to validate it and grant it protection from bio-piracy and other forms of abuse. It is important to document African IK not only from all the forms of abuse but also for preservation for future generations. The studies conducted by these authors, similar to findings from my data,

highlight the importance of documenting IK, even though results from my study did not indicate how one could go about documenting IK specifically.

Although teachers in this study did not indicate how IK can be documented, studies conducted by Adebayo & Adeyemo (2017), Balogun & Kalusopa (2021) gave the importance of documenting IK and what to use to document IK. In a study conducted by Balogun & Kalusopa (2021), they indicated that IK is being documented as much as they have not covered all the aspects of IK

> "Indigenous Knowledge related to traditional medicine, traditional plants and food are currently being digitized at the Indigenous Knowledge Systems Documentation Centers by IK recorders in institutions that are part of the National Recordal Systems initiative across four provinces in South Africa" (p.176)

What is important to note here is that IK is now starting to be recorded. Adebayo & Adeyemo (2017), in their study, indicated information and communication technology (ICT) as tools that could be used to start documenting IK, "with the emerging ICT tools and indigenous ICT expertise, much of the invaluable traditional knowledge can be saved, documented, improved upon, digitized and transmitted for the use of communities within and outside a particular country" (p.8).

In a study conducted by Musaka & Kamusiime (2012), they report that digital preservation of IK as necessary "It is important to consider digital preservation (a set of processes, activities, and management of electronic information over time to ensure its ongoing accessibility) as a method to ensure the long-term availability of the digitized IKS" (p. 75).

One of the benefits of documenting IK is the preservation of knowledge. Over and above that, it could aid in repackaging IK to ensure local sustainability and relevance. In other words, as Adebayo & Adeyemo (2017) put it in their study,

> "For ICT to be an empowerment tool and a conveyor of the locally relevant messages and information, it has to provide opportunities for local people to interact and communicate with each other and with the outside world, expressing their ideas, knowledge, and culture in their own languages" (p.8).

IK was being lost, in part to, not being documented and the current generation not seeing relevance in it. Using technology to document IK is beneficial as it is something that is relevant in today's context.

5.4 Teachers' Views on The Natural Sciences CAPS Mandate in relation to research question 3

In this research question, to start off I first wanted to understand if the teachers thought IK is a Science, and if so, I wanted to know can it be integrated into Natural Sciences, given that it is indeed a Science. Therefore, I proceeded to ask what they think the Natural Science CAPS mandates them to do in terms of integration of IK into Natural Sciences as per pages 5 and 8 of the CAPS 2011 document.

As part of the questionnaire, teachers in this study were asked what they understood by the policy statement mentioned on pages 5 and 8 of CAPS 2011. In relation to this, Koketso indicated, "science and technology combined with IK must be used to show our responsibility towards the environment and that we do not exist in a vacuum."

The teacher here is looking at how IK and the content in the syllabus are possibly linked to pro-environmental behaviours. IK is about the knowledge that one gathers from the environment and community they are coming from. So from the perspective of the teacher, there is a close connection between IK, cultural practices, and the environment, and therefore, the environment

must be protected because of the nature of the lifestyle of the people who have a close relationship with the environment, especially in terms of their cultural practices and in terms of their everyday life. In a study conducted by Thaman et al., (2013) they alluded that "across the globe, people are in constant interaction with the biological components of the environment, and through this interaction they nurture sophisticated sets of knowledge and practice, which include both science and indigenous and local knowledge" (p.10).

When asked the question " What do you understand about Indigenous Knowledge as a science teacher?", the teacher Teboho indicated that, he will value the history by making the learners aware of the pre-established practices that existed before colonisation, such as mining and the discovery of minerals. This teacher highlighted that integrating IK into teaching was necessary "to make learners aware that certain practices were already established in Africa before colonisation, but it was not recognized …. Such as mining and the discovery of minerals" (Interview: Teboho).

Teboho is indicating how it is important to acknowledge what has been, the teacher has referred to the terms "before colonisation", he asserted that African people had their knowledge and their cultural practices that enabled them to live their lives. For instance, in a study conducted by Hammel et al., (2000) evidence is provided which indicates that before colonization in South Africa they were indigenous mining methods used to collect metal ores. However, as Hammel et al., (2000) claims,

> "The perceived value of many 'ancient' mines, however, has been predominantly that they indicate the location of deposits and thus they (and the evidence they contain) have often been destroyed by colonial prospecting and mining. Compounding this problem of destroyed evidence is the fact that the southern African region lacks an indigenous written historical

record and much of the knowledge conveyed through the oral tradition was truncated with the coming of colonialism" (p.49).

To make learners aware of the value of their cultural practices the teacher indirectly says he will use the knowledge that has been there before colonization to help learners understand that their knowledge is worthwhile, valuable, and it needs to be recognized. So, the importance of the mandate here according to the teacher, is to acknowledge the knowledge and understanding that, the community had before colonization.

Another teacher Neo, when asked the same question he indicated that, there is science in IK because our forefathers understood nature even though they could not relate it to scientific principles found in the science classroom today. For example, they understood how seasons functioned regarding food preservation.

> "Food preservation was done by our forefathers, for them they did not know that it relates to science, they only know it as seasons, knowledge was done with little explanation and reasoning, this is where science takes over to provide the hypothesis and reach to the conclusion to get the result."

The teacher said that their grandparents and parents had knowledge about their environment, some of the knowledge passed down to them was not understood in terms of theoretical knowledge, but they continued practicing it since the practical knowledge was understood. For instance, how food is preserved in recent times is different from how food was stored previously. Considering the rich history and heritage of the country and keeping in mind the different cultural groups that we find in a classroom, the teacher mentioned the "how" part by explaining to the class. He showed how he could bring that in the classroom which is in-line with what the Natural Sciences CAPS 2011

document mandates, i.e. “acknowledging the rich history and heritage of this country as important contributors”. Integrating different cultural ways of preserving food in the classroom affords every individual in the classroom an opportunity to bring knowledge from their community and cultural background into the teaching and learning space.

Lastly, Neo explained that the methods used in the past by forefathers to conserve water have been expanded scientifically and turned into irrigation systems used today.

> “The rainfall was studied by our forefathers in a way that they were able to preserve water through their seasons. Nowadays we are making irrigation systems to supply crops with water. What has been valued in the past is still being valued, but with more advancement”.

What the teacher indicated here was how he intended to demonstrate and acknowledge what the policy mandates as part of his teaching practice within the science classroom. The teacher was linking the importance of valuing IK and the curriculum that they are teaching because he saw how IK was linked to the environment. He made links to what was done in the past to show how it is still used in current days with scientific advancement.

5.5 Theme 1: Teachers’ Reasons For Including IK in Their Classroom Teaching Practice in relation to research question 4

In this section I explore the different reasons why teachers in this study integrate IK in their classroom teaching and topic discussion with the learners.

5.5.1 Integration of IK with Natural Sciences

Teachers believe that incorporating IK into the classroom is essential. Koketso mentioned that “It is important and interesting because you get to marry the two.” In addition, Teboho said that “As a science teacher, it is imperative that you use IK to drive on certain concepts.” In a study

conducted by Mawere (2015), he alludes to the importance of integrating IK in the school curriculum, and he proposed that,

> "Since indigenous knowledge is the knowledge that arises directly out of the children's real-life experiences, its incorporation into the school curriculum can motivate and bolster the intellectual fortunes and interests of the learners as students realize that recognition is given to what they already do, know, and say in their own communities" (p.63).

Integrating IK into the teaching of Natural Sciences is not only in line with what the Natural Sciences CAPS document mandates, but it also allows for learners to understand the topic better by applying it in their daily lives.

Teachers include IK in their teaching of science as they believe that it helps learners understand science better. This is what some of the teachers in my study said, "I think NS and IKS should be combined because it affords learners a better understanding of the different culture in our country and how each knowledge can be used in the science classroom" (Interview: Koketso) and also "it is a powerful concept to introduce current knowledge to learners, but also to explain the origin of the knowledge to make it more meaningful" (Interview: Neo). The teachers are saying here that they used IK in their teaching of Natural Sciences and making use of IK in their teaching helps learners understand the science concepts better. The findings from this study show that teachers are making use of IK during their teaching and topic discussion with their learners during their teaching practices, this is aligned with what the Natural Sciences CAPS document mandates, which is to integrate IK in science concepts (CAPS, 2011).

5.5.2 Theme 2: Ways of Including IK in Their Classroom Teaching Practice and Content Discussion with the Learners

In this section I explore the different ways teachers included IK during their teaching practice while they discussed content with the learners.

Teachers use personal experiences from their youth to demonstrate how knowledge has evolved over time and to provide an alternative way of explaining the same idea, as shown in the following statement.

> "When you are in class, you can look at the information in the textbooks or the internet wherever you get your sources from, but you can also bring in your experiences to the learners and say my grannie used to use this leaf for stomachaches, she used to cook this, and we used to drink this if we needed to get well and so on. Now this plant was taken now, and now we have this medicine, which is a remedy for a tummy, so we can tell them about the latest medicine you can get from the chemist, but we can also bring in knowledge as we grew up from our parents that our parents taught us and bring it in so that they can see."

The teacher is showing how an individual can bring IK concepts to the classroom to help learners connect the dots between what they learn in their everyday lives and at school and how both worldviews are related and relevant in their current context.

As shown above, the teachers in my study indicated that they use IK as a tool to help them teach science concepts to learners. In a study conducted by Nnadozie (2009), she mentioned that "the educators understand the integration of indigenous knowledge in Life Science as an addition to the western knowledge that is taught at school" (p.62). She further states that participants in her study used IK to understand, strengthen and explain scientific knowledge (Nnadozie, 2009) Based on

the data from my study and literature readings, teachers view IK as a critical component to use to help them explain science concepts to learners differently and in doing so learners seems to grasp the science concepts better. Using IK as a tool to teach Natural Sciences concepts seems to be helpful not only for teachers to adhere to what the Natural Sciences CAPS document mandates but it also has benefits for learners, as they understand science concepts better when they are explained using IK.

Teachers in this study affirmed that when teaching, one should include IK in the teaching of science. Teachers in my study were asked how they could put the mandate from the Natural Sciences CAPS document into practice. Teboho stated that he "use[s] IK to explain scientific phenomena,". Koketso said, "make the subject come alive, bring in artefacts, researches, electronic media and organize science excursions to enable learners to appreciate the science through a variety of sources." The teachers are indicating here that one should include IK in their teaching of science, and based on the question that they were asked, they have given an indication of what to do to adhere to the policy mandates. The use of artefacts, for instance, is one way of helping learners make links between what is being taught in the classroom, and it is one of the many ways in which teachers could include IK in their teaching of Natural Sciences as they can bring artefacts from home which learners are familiar with or learners could bring artefacts to school and the teacher can use them in explaining the science topic at hand. In a study conducted by Allender & Manke (2008), they indicated that using artefacts brings strong images, memories and feelings to mind. This is why teachers should "use support materials such as physical objects and artefacts to introduce and reinforce concepts" (Kortjass, 2020, p.75). Based on these studies and the findings based on my data, the use of artefacts can be beneficial to learners as it will aid them in

understanding science concepts and also make learning fun and exciting. It is another strategy that other teachers could adapt in integrating IK in their teaching of Natural Sciences.

In addition, teachers also mentioned that they used practical examples of IK, which learners were familiar with from the communities that they come from, in doing so, they made them aware of the science they know from home and introduce science topics in the classroom,

> "fermentation is part of science; cooking at home is part of science because it involves light and heat. The rainbow is part of the colours of the spectrum. Many people see it, but when is it forming, and why do we see it."

The teacher implies that when teaching the topic fermentation, for instance, one could start first by talking about the brewing techniques that learners are familiar with from the community or have seen as an introduction to the topic. In a study conducted by Mawere (2015), he shows how a similar technique is used to explain a scientific concept in a science classroom.

> "In western Mozambique, a traditional method of brewing beer (*tototo*) similar to the distillation system students learn in science at school has been invented. To make the beer they use over-ripe fruits and boil them until the contents' liquid turns into steam and the then the steam is condensed to form a colourless liquid. This liquid is the traditional beer. Thus when students go into learning the science of distillation they go into the classroom understanding the concept of beer-brewing system *tototo* from home" (Mawere, 2015)

Based on the results from this study and literature, the use of IK examples that learners are familiar with helps learners in understanding science concepts better.

Teachers also gave other ways in which they include IK in their teaching of Natural Sciences. They mentioned the teaching approach, that "you work from the principle of known to the unknown and

that can break down the barrier of their phobia from learning science" some teachers believe that science scares learners, so approaching science this way (working from the known to the unknown) would help to ease their science fears. In other words, as a teacher, you start first by what the learners know of the topic, and then you move to what they do not know. In a study conducted by Mawere (2015), he talks about the same teaching approach, and he reports,

> "This resonates well with the adage "From the known to the unknown," which suggests that indigenous knowledge, being knowledge that the learners have before they enter the academy, will no doubt inspire and stimulate their minds to be abstract and even seek solutions to their daily problems using locally generated solutions" (Mawere, 2015, p.63)

Based on the results of this study and what comes from literature, using this strategy to introduce science concepts could be beneficial to learners in that they will be able to make links between science concepts taught in the classroom. If more teachers could start using this strategy, many of the problems they face, such as learners finding it hard to understand concepts could be solved. Like the teacher Teboho said "the word science scares learners" in implementing this strategy most of their problems will be solved.

Some teachers in this study recommended that learners should do research at home, to find out about different medicinal benefits or anything relating to the topic at hand, and that research should be done without the help of a textbook or the internet, in other words, getting the community involved in the learners learning and development.

> "you get learners to bring remedies for ailments from home or DIY [do it yourself] type of thing where you can come to school with the information that they did not get from a textbook but from an adult or a grandparent for that matter (Interview: Koketso)."

The teacher meant here that learners should do research without the help of the internet and that their research should be conducted by asking elders at home and around the community about the topic that would have been given to the learners. This way, learners would bring the rich IK that the community has, and that information could be used in the science classroom.

Lastly, one of the teachers mentioned the importance of lesson preparation and stated that "I would say there is a way, but you have to make an effort. I would say when you prepare your lesson, always get alternatives to tell the learners" (Interview: Koketso). In a study conducted by Seehawer (2018), one of her participants indicated that,

> "She would integrate IK on water purification but did not determine specific indigenous water purification methods. This strategy gave learners the chance to contribute with all practices they gathered from their families rather than limiting their participation. At the same time, it enabled her to integrate IK without being aware of all indigenous water purification methods. She just needed to assume that IK about water purification existed" (p.101).

Making an effort to include IK in teaching and learning science is significant in that as a teacher, you will be carrying out the mandate of the CAPS policy document, and also you would be helping learners make sense of what they are learning in the science classroom and how what is being learned relates to their everyday life.

What emerged in this chapter which is of importance is the document analysis. The documents that are provided to teachers to use namely the CAPS, ATP and, pacesetter are all linked to each other, however, when it comes to the inclusion of IK there is a misalignment amongst the document. Teachers defined IK making links between their current understanding of the world and the environment. They also made links on how their IK is linked with the environment which

they grew up in. Lastly teachers are adhering to what the CAPS documents mandates them to do, which is to include IK is int heir teaching and learning of the subject Natural Sciences.

Chapter Six

Conclusion, Recommendations and Further Studies

6.1 Conclusion

In the introduction the focus was on Natural Sciences teachers' views on IK and how to use it in their teaching and learning. I first introduced the study and provided a brief overview of the study and then disccused the problem statement, purpose of the study, significance of the study, and provided research questions. Following that in Chapter two I have provided a historical overview of the study and then disccused the concepts of IK and IKS and thereafter, provided the problems that teachers encountered when integrating IK and also their reasons for integrating IK into their teaching and learning. In chapter three I have disccused theoretical frameworks that grounded my and provided guidance interms of the discussion of results. Lastly in chapter four I then provided the research methods that I have used to collect and analyse data.

This chapter provides a summary of the results and discussion of this study. To do so, I have outlined the theoretical frameworks that guided the study, followed by a description of the findings for the major themes that emerged from the study. After that, I provided an overview of the issues that Natural Sciences teachers experience when integrating IK into their teaching practices as well as a conclusion is presented. This study aimed to investigate Natural Sciences teachers views on IK and it could be used in South African classrooms. Theoretical frameworks such as

constructivism were used. Under constructivism theories two theorist were used when applying frameworks for this study, namely Vygotsky and Piaget. Vygotsky's sociocultural theory the ZPD and MKO were used and Piaget's cognitive development. Followed by Aikenhead and Jegede cultural border-crossing.

The first research question analysed the curriculum document that the teachers are provided with, namely the CAPS document, ATP, and the Pacesetter. These documents were analysed with regards to the extent in which IK is included in all of them. Specifically, the documents which were analysed are for Natural Sciences grades 8 and 9. The CAPS documents mandates teachers to include IK in their teaching of science and there is no mention anywhere in the ATP and the pace setter of the inclusion of IK and how that could be done. The ATP and the Pacesetter are the two most important documents that teachers refer to and these documents are provided to them by their head of departments to use. Teachers' made use of these documents as subject's advisor comes around the schools every term to check if teachers are on par with what the ATP and pace setter stipulates. Moreover, the schools are required to send in their subject curriculum statistics to the district to also check if the school is on par with curriculum coverage.

As such, considering that IK is not mentioned in the ATP nor the Pacesetter the chances of teachers including it in their teaching practice are very limited. When looking at these documents one can see that there is a misalignment amongst the curricular documents with regards to IK.

The other research questions in this study analysed teachers' views of what IK is, what the Natural Sciences document mandates and how these views could be integrated into the teaching and learning of Science. From these research questions, 3 themes emerged together with the sub-themes. The themes are as follows, 1) knowledge acquisition, 2) evolution of knowledge and 3)

teachers' reasons for including IK into the teaching of science and content discussion with their learners.

Teachers reported on their understanding of what IK meant to them, and they further discussed what they had learned from the communities they were coming from. In addition, they indicated that at first, they did not understand what they were being taught by their grandparents and parents, but as they were growing up, they started to make sense of what they were being taught as they grew up. This notion is what Piaget cognitive theory terms as cognitive disequilibrium. And to reach equilibrium the learner must make adjustment in their cognitive state to assimilate and accommodate the new knowledge to their current knowledge structure.

The teachers in this study also provided information on how knowledge evolved over the years. They mentioned that the current Western knowledge is built on previous knowledge which is the IK from the indigenous communities within South Africa. From here they hinted that the IK that we as African people have is not being documented and as such it is important to start documenting this knowledge so that the coming generation can know about our history. Although they did not give indications of how IK could be documented this study with the aid of literature provides the importance of documenting IK and mentioned ways in which this could be done.

Lastly teachers provided reasons for including IK in their teaching of Natural Sciences and they also indicated some of the ways they integrated IK into their discussion in classrooms with the learners and while teaching science concepts. Some of the ways which teachers used to integrate IK in their classroom discussion with the learners, it enabled the learners to cross borders successfully with the help of the teacher and it allowed the teacher to be a culture-broker who played a role of being a tour guide in learners education (Aikenhead, 1997).

These reasons included making learners understand science better and most importantly it is what the CAPS document mandates. One of the ways in which the teachers in this study included IK in their teaching practices and classroom discussion with the learners is through their personal experiences from their youth days to demonstrate how knowledge evolved and to explain Science concepts in a different way.

In South Africa there are curriculum documents which are provided to teachers to use i.e the CAPS document, ATP and Pacesetter. The CAPS document mandates the teachers to include IK in their teaching of science. My study showed that teachers are doing what is mandated by the CAPS document. My study has extended on existing literature in that many authors indicated that the CAPS document mandates teachers to include IK in their teaching and learning and yet not many authors have spoken about the other curricular documents which are provided to the teachers by the head of departments to make use of. While conducting document analysis on the documents selected for this study it emerged that there is misalignment between the documents based on reference to IK inclusion in the curriculum. It was important to analyse these documents as teachers make use of them regularly and it is in these documents where the mandate to integrate IK during the teaching of Science was given.

6.2 Recommendations

This section provides recommendations for curriculum developers in trying to develop strategies which can help teachers in the successful integration of IK into their teaching practices of science.

6.2.1 Recommendations For Curriculum Developers

Tertiary institutions are the ones responsible for training pre-service teachers and getting them ready to become lifetime teachers. The challenge is that tertiary institutions seems not to be training pre-service teachers to come with ways of integrating IK in the Science classrooms and coming

with different strategies to engage every learner in the classroom with their different cultural backgrounds. One of the recommendations that emerged based on my study data is that higher learning institution which are training pre-service teachers should play a role in filling in this gap and start changing their teaching methodologies to include IK integration in teaching and learning of science.

Curriculum developers should look into the curriculum documents which are provided to the teachers i.e., the CAPS, ATP and, Pacesetter. These documents do not seem to align well when it comes to the inclusion of IK into the teaching and learning of science. Furthermore, the curriculum developers, in their creation of these curriculum documents, should provide teachers with some examples of IK and ways to include them while teaching certain concepts in the Natural Sciences subject. In this way teachers would have an idea of what to include and may be further encouraged to come up with IK ideas that are suitable for the community in which they teach.

6.3 Further Studies

The document analysis done in this study showed that there is a misalignment when it comes to curriculum documents and the inclusion of IK into the teaching and learning of Science. As such, these are important documents which teachers make use of on a regular basis. Seeing that there is a misalignment, further studies into how these documents could align and provide guidance to teachers into successfully integrating IK into the teaching of Science would be important. In addition exploring possibilities for professional development to develop teachers' skills, knowledge and practices to integrate IK in their classroom.

Reference List

Adeyemo, A. A., & Adebayo, J. O. (2018). Documentation And Dissemination Of Indigenous Knowledge By Library Personnel In Selected Research Institutes In Nigeria. *Library Philosophy & Practice*.

Algozzine, B., & Hancock, D. (2017). *Doing case study research: A practical guide for beginning researchers*. Teachers College Press.

Allender, J., & Manke, M. P. (2008). Evoking self in self-study: The analysis of artifacts. *Journeys of hope: Risking self-study in a diverse world*, 14(6), 20-23.

Amineh, R.J., & Asi, H.D. (2015). Review of Constructivism and Social Constructivism. *Journal of Social Sciences, Literature and Languages*, 1:1, 9-16.

Ankiewicz, P. (2015). 'n Teoretiese besinning oor die implikasies van die filosofie van tegnologie vir kriteria vir vakkurrikulumontwikkeling en-evaluering: oorspronklike navorsing. *Suid-Afrikaanse Tydskrif vir Natuurwetenskap en Tegnologie*, *34*(1), 1-7.

Balogun, T., & Kalusopa, T. (2021). Web archiving of indigenous knowledge systems in South Africa. *Information Development*, 02666669211005522.

Botha, R. J. (2002). Outcomes-based education and educational reform in South Africa. *International journal of leadership in education*, *5*(4), 361-371.

Botha, R. J. (2002). The Introduction of a System of OBE in South Africa: Transforming and Empowering a Marginalized and Disenfranchised Society.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How people learn* (Vol. 11). Washington, DC: National academy press.

Breidlid, A. (2003). Ideology, cultural values and education: The case of Curriculum 2005. *Perspectives in education*, *21*(2), 83-102.

Brits, S., de Beer, J., & Mabotja, S. (2016). Through the eyes of a puppet: A pedagogy of play for the incorporation of indigenous knowledge in the life-and natural sciences curriculum.

Bruchac, M. (2014). Indigenous Knowledge and Traditional Knowledge. *In Smith, C. (Ed.), Encyclopedia of Global Archaeology*, 3814-3824. New York: Springer.

Chaiklin, S. (2003). Analysis of Learning and Instruction. *Vygotsky's educational theory in cultural context*, *39*.

Chilisa, B. (2019). *Indigenous research methodologies*. London: Sage Publications.

Chisholm, L. (2003). The politics of curriculum review and revision in South Africa.

Choy, L. T. (2014). The strengths and weaknesses of research methodology: Comparison and complimentary between qualitative and quantitative approaches. *IOSR journal of humanities and social science*, *19*(4), 99-104.

Cobern, W. W. (1991). Introducing teachers to the philosophy of science: The card exchange. *Journal of Science Teacher Education*, *2*(2), 45-46.

Cohen, L., Manion, L., & Morrison, K. (2017). *Research methods in education*. Routledge.

Creswell, J. W. (2009). *Mapping the field of mixed methods research.* In: SAGE publications Sage CA: Los Angeles, CA.

Creswell, J. W. (2015). *A concise introduction to mixed methods research*. SAGE.

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.

Cronje, A., De Beer, J., & Ankiewicz, P. (2015). The development and use of an instrument to investigate science teachers' views on indigenous knowledge. *African Journal of Research in Mathematics, Science and Technology Education*, *19*(3), 319-332.

Cropley, A. (2015). *Introduction to qualitative research methods*. Hamburg, Germany.

Cropley, A. (2015). Introduction to qualitative research methods. *Hamburg, Germany*.

Cross, M., R. Mungadi, and S. Rouhani. 2002. From policy to practice: Curriculum reform in South African education. *Comparative Education 38, no. 2: 171–87*.

Dahlberg, A. C., & Trygger, S. B. (2009). Indigenous medicine and primary health care: The importance of lay knowledge and use of medicinal plants in rural South Africa. *Human Ecology*, *37*(1), 79-94.

Daniels, H. (2016). Vygotsky and dialogic pedagogy. *Dialogic pedagogy: The importance of dialogue in teaching and learning*, 48-64.

De Beer., J. & Mothwa, M., 2013, 'Indigenous knowledge in the science classroom: Science, pseudo-science, or a missing link?' paper presented at the ISTE International Conference on Mathematics, Science and Technology Education, Kruger National Park, 21–24 October.

De Beer, J., & Whitlock, E. (2009). Indigenous knowledge in the Life Sciences classroom: put on your De Bono hats! *The American Biology Teacher*, *71*(4), 209-216

de Wet, H., Nkwanyana, M. N., & van Vuuren, S. F. (2010). Medicinal plants used for the treatment of diarrhoea in northern Maputaland, KwaZulu-Natal Province, South Africa. *Journal of ethnopharmacology*, *130*(2), 284-289.

du Plooy-Cilliers, F., Davis, C., & Bezuidenhout, R. (2014). Research matters. *Cape Town: Juta*, 25-31.

du Plooy-Cilliers, F., Davis, C., & Bezuisenhout, R. M. (2014). *Research Matters.* Cape Town : Juta & Company Ltd.

Eun, B. (2019). The zone of proximal development as an overarching concept: A framework for synthesizing Vygotsky's theories. *Educational Philosophy and Theory*, *51*(1), 18-30.

Fiske, E. B., & Ladd, H. F. (2004). *Elusive equity: Education reform in post-apartheid South Africa*. Brookings Institution Press.

Giroux, H. A. (1992). Language, difference, and curriculum theory: Beyond the politics of clarity. *Theory into practice*, *31*(3), 219-227.

Hagan, T., (2014) Measurements in quantitative research: How to select and report on research instruments. Oncology Nursing Forum, *41*(4),431-433

Hammel, A. White, C, Pfeiffer, S. & Miller, D. (2000). Pre-colonial mining in southern Africa. *Journal of the Southern African Institute of Mining and Metallurgy*, *100*(1), 49-56.

Hancock, B., Ockleford, E., & Windridge, K. (2001). *An introduction to qualitative research*. London: Trent focus group.

Hancock, D. R., & Algozzine, B. (2017). *Doing case study research: A practical guide for beginning researchers*. Teachers College Press.

Hand K, Freeman C, Seddon P, Recio M, Stein A and Van Heezik Y (2019) Are City Kids Missing Out on Nature*?. Front. Young Minds. 7:71.*

Harling, K. (2002). An overview of case study. Paper presented at the learning workshop Case Studies: Their Future Role in Agricultural and Resource Economics. Long Beach, California. July 27

Hewson, M. G., & Ogunniyi, M. B. (2011). Argumentation-teaching as a method to introduce indigenous knowledge into science classrooms: Opportunities and challenges. *Cultural Studies of Science Education*, *6*(3), 679-692.

Janes, J. (2001). *Survey research design.* Library hi tech.

Janes, J. (2001). Survey research design. *Library hi tech*.

Jankowicz, A. D. (2000) Business Research Projects (3rd edition*). London: Thomson Learning*

Jankowicz, D. (2002). *Research methods for business and management*. Einsburg Business School. Watt University.

Jegede, O. J., & Aikenhead, G. S. (1999). Transcending cultural borders: Implications for science teaching. *Research in Science & Technological Education*, *17*(1), 45-66.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational researcher*, *33*(7), 14-26.

Khumalo, B. N., & Baloyi, C. (2018). African Indigenous Knowledge: An Underutilised and Neglected Resource for Development. *Library Philosophy & Practice*.

Kortjass, D. L. P. (2020). *Cultivating an integrated learning approach to early childhood mathematics: a teacher educator's self-study* (Doctoral dissertation).

Kvale, S. (1996). An Introduction to qualitative research interviewing."Interviews". In: Thousand Oaks: Sage Publications.

Kvale, S. (1996). Interview Views: An Introduction to Qualitative Research Interviewing. Thousand Oaks, CA: Sage Publications.

Le Grange, L. (2000). Is qualitative research a meaningful term for describing the cross-fertilisation of ideas which characterises contemporary educational research?. *South African Journal of Education*, *20*(3), 192-194.

Leong, F. T, & Austin, J. T. (2006). *The psychology research handbook: A guide for graduate students and research assistants*. Sage.

Leong, F. T., & Austin, J. T. (2006). *The psychology research handbook: A guide for graduate students and research assistants*. Sage.

Mack, N. (2005). Qualitative research methods: A data collector's field guide.

Maila, M. W. (2001). *The assessment of learning programmes for the Senior Phase at Environmental Education Centres in Mpumalanga* (Doctoral dissertation).

Maluleka, J. R. (2017). *Acquisition, transfer and preservation of indigenous knowledge by traditional healers in the Limpopo province of South Africa* (Doctoral dissertation).

Mathers, N. J., Fox, N. J., & Hunn, A. (1998). *Surveys and questionnaires*. NHS Executive, Trent.

Mathers, N., Fox, N., & Hunn, A. (2007). Surveys and questionnaires, the NIHR research design service for Yorkshire and the Humber. *National Institute for Health Research, East*

Midlands, available at: wwwrdsyhnihracuk/wp content/uploads/2013/05/12_Surveys_and_Questionnaires_Revision_2009pdf (accessed May 2017)[Google Scholar].

Matsika, Chrispen. 2012. Traditional African Education: Its Significance to Current Education Practices with Special Reference to Zimbabwe, *Mambo Press, Gweru*

Mawere, M. (2015). Indigenous knowledge and public education in sub-Saharan Africa. *Africa Spectrum*, *50*(2), 57-71.

McLeod, S. A. (2012). What is the zone of proximal development?.

Moll, L.C. (2001). Through the mediation of others: Vygotskian research on teaching. In V. Richardson, Handbook of Research on Teaching (4th edition) *Washington, DC, American Education Research Association.*

Moodley, V. (2013). In-service teacher education: Asking questions for higher order thinking in visual literacy. *South African Journal of Education*, *33*(2).

Msila, V. (2007). From apartheid education to the Revised National Curriculum Statement: Pedagogy for identity formation and nation building in South Africa. *Nordic Journal of African Studies*, *16*(2).

Muza, B. 2014. *South African Grade 9 teachers ' and learners' knowledge about medicinal plants and their attitudes towards its integration into the science curriculum.* Unpublished MSc dissertation. University of the Witwatersrand, Johannesburg.

Mvududu, N., & Thiel-Burgess, J. (2012). Constructivism in practice: The case for English language learners. *International Journal of Education*, *4*(3), 108-118.

Naidoo, P 2010. *Teachers' Interpretation and Implementation of the Policy on Indigenous Knowledge in the Science National Curriculum Statement*. Unpublished PhD thesis, KwaZulu-Natal, Durban.

Naidoo, P. D., & Vithal, R. (2014). Teacher approaches to introducing indigenous knowledge in school science classrooms. *African Journal of Research in Mathematics, Science and Technology Education*, *18*(3), 253-263.

Ngcobo, L. P., & Mavuru, L. (2020). Natural Sciences Township Teachers' views About the Nature Of Indigenous Knowledge. *Southern African Association for Research in Mathematics, Science and Technology Education*, 314.

Ngxola, N. (2013). *Teaching Evolution in a New Curriculum: Life Sciences Teachers' Concerns and Needs* (Doctoral dissertation, University of the Witwatersrand, Faculty of Science).

Ninnes, P. (2000). Representations of indigenous knowledges in secondary school science textbooks in Australia and Canada. *International Journal of Science Education*, 22(6), 603-617.

Nnadozie, I. J. (2009). *The integration of indigenous knowledge systems (IKS) in the teaching of conservation of biodiversity & natural resources: A critical case study of Grade 10 life sciences educators in the Pinetown district.* Master's Thesis: University of KwaZulu-Natal, Durban.

Ntuli, S. G. (2009). *An investigation into the nature and causal factors of female vs. male criminality in Cato Manor Township, Durban* (Doctoral dissertation).

Odora-Hoppers, C. A. (2004). The cause, the object, the citizen: Rural school learners in the void of intersecting policies and traditions of thought. *Quarterly of Education and Training in South Africa*, *11*(3), 17-22.

Ogunniyi, M. (2007). Teachers' stances and practical arguments regarding a science-indigenous knowledge curriculum: Part 1. *International Journal of Science Education*, *29*(8), 963-986.

Onwu, G., & Mosimege, M. (2004). Indigenous knowledge systems and science and technology education: A dialogue. *African Journal of Research in Mathematics, Science and Technology Education*, *8*(1), 1-12.

Queirós, A., Faria, D., & Almeida, F. (2017). Strengths and limitations of qualitative and quantitative research methods. *European journal of education studies*.

Raymond, E. (2000). Cognitive Characteristics. Learners with Mild Disabilities (pp. 169-201). Needham Heights, MA: Allyn & Bacon, A Pearson Education Company

Regmi, J., & Fleming, M. (2012). Indigenous knowledge and science in a globalized age. *Cultural Studies of Science Education*, *7*(2), 479-484.

Regmi, S., & Regmi, K. (2012). Best practice in the management of venous leg ulcers. *Nursing Standard (through 2013)*, *26*(32), 56.

Ronoh, J. C. (2018). *Indigenous Knowledge in the School Curriculum: Teacher Educator Perceptions of Place and Position* (Doctoral dissertation, Nelson Mandela University).

Sakayombo, R. (2014). *Indigenous Knowledges In Agricultural Science: An Exploration into the Integration of Indigenous Knowledges in the Teaching of Agricultural Science in selected Secondary Schools in Zambia* (Master's thesis, Oslo and Akershus University College).

Seehawer, M. (2018). South African science teachers' strategies for integrating indigenous and Western knowledges in their classes: Practical lessons in decolonisation. *Educational Research for Social Change*, *7*(SPE), 91-110.

Setati, M. (2001). Researching mathematics education and language in multilingual South Africa. *The mathematics educator*, *12*(2).

Shizha, E. (2008). Indigenous? What indigenous knowledge? Beliefs and attitudes of rural primary school teachers towards indigenous knowledge in the science curriculum in Zimbabwe. *The Australian Journal of Indigenous Education*, *37*(1), 80-90.

Sithole, J. (2007). The challenges faced by African libraries and information centres in documenting and preserving indigenous knowledge. *IFLA journal*, *33*(2), 117-123.

Sjøberg, S., & Schreiner, C. (2006). How do students perceive science and technology. *Science in school*, *1*(1), 66-69.

Soudien, C., and J. Baxen. 1997. Transformation and outcomes-based education in South Africa: Opportunities and challenges. Journal of Negro Education 66, no. 4: 449–59.

Teacher Approaches to Introducing Indigenous Knowledge in School Science Classrooms

Thaman, R., Lyver, P., Mpande, R., Perez, E., Cariño, J. and Takeuchi, K. (eds.) 2013. The Contribution of Indigenous and Local Knowledge Systems to IPBES: Building Synergies with Science. IPBES Expert Meeting Report, UNESCO/UNU. Paris, UNESCO. 49 pp

Toma, J. D. (2011). Approaching rigor in applied qualitative. *The SAGE handbook for research in education: Pursuing ideas as the keystone of exemplary inquiry*, 263-281.

Tomlin, H. (2016). Contesting ideologies and the struggle for equality: Reconsidering the politics of education in South Africa. *Policy Futures in Education*, *14*(6), 846-863.

Vhurumuku, E. (2010). The impact of explicit instruction on undergraduate students' understanding of the Nature of Science. *African Journal of Research in Mathematics, Science and Technology Education*, *14*(1), 99-111.

Vygotsky, L. S., & Cole, M. (1978). *Mind in society: Development of higher psychological processes*. Harvard university press.

Webb, P. (2013). Xhosa Indigenous knowledge: Stakeholder awareness, value, and choice. *International Journal of Science and Mathematics Education*, 89-110.

Whiting, L. S. (2008). Semi-structured interviews: Guidance for novice researchers. *Nursing standard*, *22*(23).

Yaroshevsky, M. (1989). *Lev Vygotsky*. Progress Publishers.

Appendix

Appendix A

Annexure C

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

GDE RESEARCH APPROVAL LETTER

Date:	22 July 2020
Validity of Research Approval:	04 February 2020 – 30 September 2020 2019/537
Name of Researcher:	Raphothe N
Address of Researcher:	3463 Thabo Mbeki Street
	EXT 1
	Orange Farm
Telephone Number:	0840780591
Email address:	711966@students.wits.ac.za / paseka325@gmail.com
Research Topic:	Natural Sciences teachers' views on Indigenous Knowledge and how to use it in teaching and learning in classrooms in South Africa
Type of qualification	MSc
Number and type of schools:	1 Secondary School
District/s/HO	Johannesburg Central

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

24/07/2020

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

1. *Letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*

1

Making education a societal priority

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

Appendix B

GAUTENG PROVINCE
REPUBLIC OF SOUTH AFRICA

Enquiries: Gumani Mukatuni
Directorate: ER & KM
Tel: (011) 355 0775/ 082 515 5412
Gumani.Mukatuni@gateng.gov.za

MEMO

TO: **Head of the Department, DDGs, Chief Directors, Directors, Districts, Principals, Universities and Research organisations**
FROM: **Faith Tshabalala**
Acting Director: Education Research and Knowledge Management
SUBJECT: **Regulations on access to schools by Researchers due to COVID 19 pandemic**
DATE: 10/06/2020

Dear Sir/madam

Kindly note that visitors are currently NOT permitted into the GDE school premises because of the pandemic (Covid 19) challenges, as the Department is not certain of the status of the learners or teachers; this includes Researchers.

Researchers may, however collect data online, telephonically or may make arrangements for Zoom with the school Principal. Requests for such arrangements should be submitted to the GDE Education Research and Knowledge Management directorate. The approval letter will then indicate the type of arrangements that have been made with the school.

The Researchers are advised to make arrangements with the schools via Fax, email or telephonically with the Principal.

Yours sincerely

.....

Ms Faith Tshabalala
Acting Director: Education Research and Knowledge Management
Date: 10/06/2020

Appendix C

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

Research Office

HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)
R14/49 Paseka

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER:** H20/04/19
PROJECT TITLE	Natural Sciences teachers' views on Indigenous Knowledge and how to use it in teaching and learning in classrooms in South Africa
INVESTIGATOR(S)	Mr N Paseka
SCHOOL/DEPARTMENT	Animal, Plant and Environmental Sciences
DATE CONSIDERED	24 April 2020
DECISION OF THE COMMITTEE	Approved Risk level: Minimal
EXPIRY DATE	22 September 2023

DATE 23 September 2020 **CHAIRPERSON** _____
(Professor J Knight)

cc: Supervisor : Ololade F Dr

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at; Room 10004, 10th Floor, Senate House, University. Unreported changes to the application may invalidate the clearance given by the HREC (Non-Medical)

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to completion of a yearly progress report.**

_____ _____/_____/_____
Signature **Date**

PLEASE QUOTE **THE PROTOCOL NUMBER ON ALL ENQUIRIES**

Appendix D

University of the Witwatersrand

Private bag 3 wits 2050

Johannesburg sa

Researcher: Nimrod Paseka Raphothe

Phone: 0840780591

e-mail: 711966@students.wits.ac.za

LETTER TO THE PRINCIPAL, SGB Chair, etc.

Dear Sir/Madam

Permission to Conduct Research

My name is Mr. Nimrod Paseka Raphothe. I am a GET and FET phase Natural Sciences teacher at a GED secondary school. I am studying towards a Master's degree in Science Education at the

Faculty of Science, University of the Witwatersrand. My research is titled **Natural Sciences teachers' views on Indigenous Knowledge and how to use it in teaching and learning in classrooms in South Africa**. My focus is on grades 8 and 9 Natural Sciences teachers. The aim of the study is to explore ways in which teachers can integrate indigenous knowledge systems (IKS) in the teaching and learning of Natural Sciences subjects. This letter is seeking your permission and the permission of the Natural Sciences teachers in your school to participate with me in this research study.

I would like to invite grades 8 and 9 Natural Sciences teachers at your school to participate with me in this study. The goal is to gain insight into how these teachers integrate indigenous knowledge into their teaching and learning methods in the classroom.

In this study, participants will be invited to complete a questionnaire. Following the questionnaire, and with 'participants' consent, I will set up an interview where we will discuss their answers to the questionnaire. This interview will be conducted and recorded via the telephone due to the current COVID-19 pandemic. The audio records will be transcribed and shared with the participants. This will be done at 'participants' convenience.

The participants in this study will not be advantaged or disadvantaged in any way, except that they may become aware of their IK and how it can be used in teaching and learning in their classroom settings. Participants are free to withdraw their permission/participation at any time without any prejudice or penalty against them. There are no foreseeable risks in participating in this study. Participants will not be paid for participating in the study.

The names and identities of participants and the school will be kept confidential at all times and in all academic writings about the study as pseudonyms will be used instead of actual names. Individual privacy of participants will be maintained in all publications resulting from this study. All research data collected will be kept in locked cabinets in my supervisor's office and in password-protected computer; and only the researcher and his supervisor will have access to the data, which will be destroyed between 3 - 5 years after the completion of this project.

Should you have any further questions about this study, please contact the Wits University Ethics Committee, Ms. Shaun Schoeman via email at: Shaun.Schoeman@wits.ac.za or by telephone at 011 717 1408 or contact my supervisor, Dr. Femi Otulaja, at 011 717 6075 or via email at Femi.Otulaja@wits.ac.za

_____	_____	_____
Name of Participant	Signature of Participant	Date

Appendix E

University of the Witwatersrand

private bag 3 wits 2050

Johannesburg sa

Participant's Information Sheet

Project Title: Natural Sciences teachers' views on Indigenous Knowledge and how to use it in teaching and learning in classrooms in South Africa

Researcher: Nimrod Paseka Raphothe

Phone: 0840780591

E-mail: 711966@students.wits.ac.za

Invitation to Participate: I am inviting you as a Natural Sciences teacher to participate with me in this study where I am exploring how secondary school Natural Sciences teachers use indigenous knowledge as part of their teaching and learning method. I would engage you in the study to get your views on using Indigenous Knowledge in teaching and learning of Natural Sciences in Senior Phase (GET) sciences classrooms.

Purpose: The purpose of this study is to explore the integration of Indigenous Knowledge in teaching and learning of Natural Sciences concepts in grades 8 and 9 classrooms.

Procedures: During this study, I will invite you to complete a questionnaire as a Natural Sciences teacher. Following the questionnaire, and with your consent, I will set up an interview with you where we will discuss your answers to the questionnaire. This interview will be conducted and recorded via the telephone due to COVID-19 pandemic. The audio records will be transcribed and shared with you.

Risks: There are no foreseeable and/or potential risks involved in participating in this study.

Benefits: There is no direct benefits from participating in this study. However, as a result of participating, your own awareness of indigenous knowledge may increase. This study may provide you, other teachers, learners, researcher(s), your school, the University and the field of Natural Sciences with valuable insights into the teaching and learning of Natural Sciences and

how learners and teacher(s) can interact to enhance individual and collective successes in the Natural Sciences classrooms.

Disclaimer/Withdrawal: Your participation in this study is voluntary and you are free to withdraw from this study at any time without any prejudice or penalty against you. You are free to leave out any questions that you do not wish to answer on the surveys. Withdrawal from participating, or refusal to participate in this study will not in any way affect you.

Alternatives: You may choose not to participate in this study. If you choose not to participate, no references to you will be made in reporting of this study.

Compensation: You will not receive any financial or other compensations for participating in this study.

Confidentiality: All information collected in this study is private and confidential, and you will not be identified by your actual name. The name and location of this study will be kept confidential and anonymous at all times and in all academic writings about the study. Pseudonyms will be used instead of actual names of participants and location of study. All research data will be kept in locked cabinets in my ' 'supervisor's office and in a password-protected computer. Only the researcher and his supervisor will have access to the data. The data will be destroyed between 3 -5 years after the completion of this study**.**

' '**Participant's Rights:** Should you have any further questions about this study, please contact the Wits University Ethics Committee, Ms. Shaun Schoeman via email at: Shaun.Schoeman@wits.ac.za or by telephone at 011 717 1408 or contact my supervisor, Dr. Femi Otulaja, at 011 717 6075 or via email at Femi.Otulaja@wits.ac.za

Appendix F

University of the Witwatersrand

private bag 3 wits 2050

Johannesburg sa

Consent Form

Title of project : Natural Sciences teachers' views on Indigenous Knowledge and how to use it in teaching and learning in classrooms in South Africa

Name of researcher: Nimrod Paseka Raphothe

I, …….., agree to participate in this research project. The research has been explained to me and I understand what my participation will involve. I agree to the following:

(Please circle the relevant options below).

I agree that my participation will remain anonymous	YES	NO
I agree that the researcher may use anonymous quotes in his / her research report	YES	NO
I agree that the interview may be audio recorded	YES	NO
I agree that the information I provide may be used anonymously after this project has ended, for academic purposes by other	YES	NO

researchers, subject to their own ethics

clearance being obtained.

…… (signature)

…… (name of participant)

…… (date)

Appendix G

University of the Witwatersrand

private bag 3 wits 2050

Johannesburg sa

Researcher: Nimrod Paseka Raphothe

Phone: 0840780591

e-mail: 711966@students.wits.ac.za

Natural Sciences ' 'Teacher's View of NCS/CAPS and Indigenous Knowledge Systems (IKS) Questionnaire

Kindly answer the following questions sincerely to the best of your knowledge. Your participation in this survey is gratefully appreciated. Thank you.

Gender: _____ Grade(s): _____ Subject: _____ Years of Teaching: _____

The CAPS document for Natural Sciences states:

On page 5, that teachers should teach in ways that demonstrate the """""""""""Valuing indigenous knowledge systems: acknowledging the rich history and heritage of this country as important contributors to nurturing the values contained in the Constitution""""""" """""

What do you, as a teacher, understand by this policy statement in the CAPS?

_____

_____

_____

How do you think that you, as a teacher, can do this in the Natural Sciences classroom?

_____

_____

_____

_____

On page 8, teachers are given ideas of what science, indigenous knowledge and Natural Sciences are:

What do you understand by the Indigenous knowledge part and its relationships to science or Natural Sciences?

_____

_____

_____

Also on pages 8 and 9, teachers are informed that: “Science as we know it today has roots in African, Arabic, Asian, European and American cultures” and that “Our forebears [foreparents, ancestors] would not have survived if they had not been able to learn about the natural world they depended on. They made careful observations, recognised regular patterns in seasons, the life cycles of plants, and the behavior of animals”. So, teachers are therefore instructed to “use of a variety of approaches to teaching and learning Science, should promote understanding of: the different cultural contexts in which indigenous knowledge systems have developed”

Knowing these,

How could you, as a teacher, engage with and use of indigenous knowledge in teaching Natural Sciences in South African school?

_____

_____

_____

Also on page 10, concerning Specific Aim 3: Understanding the uses of Science, CAPS says, "Learners should understand the uses of Natural Sciences and indigenous knowledge in society and the environment". And that, "Science learned at school should produce learners who understand that school science can be relevant to everyday life". And have "An appreciation of the history of scientific discoveries, and their relationship to indigenous knowledge and different world views, [and] enriches our understanding of the connections between Science and Society".

Can this be achieved? ___ "Yes" or ___ "No"(Check one √)

If Yes, How?

_____

_____

_____

_____

__

If "No", Why not?

_____

_____

_____

_____

_____

Comments:

_____

_____

_____

_____

_____

_____

Appendix H

University of the Witwatersrand

private bag 3 wits 2050

Johannesburg sa

Researcher: Nimrod Paseka Raphothe

Phone: 0840780591

e-mail: 711966@students.wits.ac.za

Sample Interview Questions

Interview Questions

1. The CAPS document speaks about the integration of Indigenous Knowledge with Natural Sciences, can you tell me about your interpretation of what this means to you?
2. When were you aware of this mandate?
3. What is Natural Sciences in your own understanding?

4. What do you understand about Indigenous Knowledge?
    a. As an individual
    b. As s science teacher
5. Is Indigenous Knowledge important in
    a. Your personal life
    b. Your practice in teaching of Natural Sciences
6. I s Indigenous Knowledge science? If yes why do you say so, if not why do you say so?
7. What do you think are the similarities and differences are between Indigenous Knowledge and Science taught in the classroom are?
8. How does Indigenous Knowledge relate to Natural Sciences?
9. Is it necessary to include Indigenous Knowledge into the teaching of Natural Sciences? If no, why not and if yes why and how do you do it?
10. How do you include Indigenous Knowledge into the teaching and learning of Natural Sciences?
11. Can you give 1 or 2 examples of concepts that you use when including Indigenous Knowledge?
12. Is there any other way to include Indigenous Knowledge in the classroom?
    If possible, what are those things that you have actually said to them to show that you have done/included Indigenous Knowledge?
13. If there are concepts that you do not include Indigenous Knowledge, why is it so?