

Integrating Indigenous Knowledge in the teaching of structures in the grade 4 Natural Sciences and Technology classroom

A dissertation presented by

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DECLARATION

I, Malibongwe Percival Gambushe, hereby declare that "*Integrating Indigenous Knowledge in the teaching of structures in the grade 4 Natural Sciences and Technology classroom,*" is my own work and that all the sources I have used or quoted have been indicated and acknowledged by means of complete references.

This research has not been previously submitted for any degree to any university.

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ABSTRACT

Since 1994, the curriculum terrain in South Africa has evolved. The National Curriculum Statement embraces the principle of integrating Indigenous Knowledge Systems (IKS) into the teaching of all learning areas. However, there has been a lack of understanding regarding the integration of IKS in teaching and learning.

For this reason, this study focuses on the grade 4 Natural Sciences and Technology (NS-Tech) teachers' understanding and integration of Indigenous Knowledge (IK) in their teaching of structures in the Pinetown district. The primary purpose of this study was to explore the integration of indigenous knowledge in the teaching of structures in the grade 4 NS-Tech classroom in five different schools in the Pinetown district. This study employed the interpretive paradigm and a qualitative approach to acquire comprehensive data regarding the grade 4 NS-Tech teachers' integration of IK. Purposive and convenience sampling was adopted in five grade 4 NS-Tech teachers in the Pinetown district, currently teaching in the intermediate phase. Semi-structured questionnaires, structured lesson observations and semi-structured post-observation interviews were conducted with the teachers in their respective schools, and all sessions were audio-recorded. Thematic analysis was utilised to analyse the collected data, and themes were created.

The findings of the study revealed that the grade 4 NS-Tech teachers attach some meanings and understanding to themselves regarding IK and its integration in the teaching of structures. On the one hand, the teachers expressed that they perceive IK as informal knowledge, intergenerational learning, lost knowledge, knowledge of traditions and practices, as the meanings by which they attach to IK as well as the amalgamation of indigenous knowledge and Western science, and as the use of skills as their understanding of integrating IK in NS-Tech/Structures. On the other hand, the study revealed that the teachers encountered various issues towards the integration of IK in the teaching of structures. Such challenges include knowledge of indigenous and Western practices, language barriers to learning IK and Western science, and relevant teaching documents for NS-Tech/Structures. These issues were connected to the challenges that restrict the effectiveness of integrating indigenous knowledge in the grade 4 NS-Tech/Structures, which is what the planned curriculum expects of the NS-Tech teachers to integrate IK in their teaching, according to one of the seven principles of the grade 4 NS-Tech CAPS document.

Consequently, this study made some recommendations based on the findings above. The findings are made to the teachers, curriculum designers and for further studies. The NS-Tech teachers, as creative teachers, ought to work collaboratively in their respective schools to approach local people, particularly the elderly, for more knowledge with respect to IK information and how it can be integrated into their classrooms together with contemporary science. Also, the teachers, with relevant stakeholders, need to approach local businesses for possible support of teaching materials, such as technology-related materials, which could be integrated into their teaching. Additionally, teachers need to acquire enough professional development with respect to integrating IK in the classroom, which the Department of Education should provide. The curriculum designers also need to develop precise ideas and have someone administer those ideas to make it simpler for the teachers to comprehend. In addition, studies on IK integration ought to emphasise how teachers act as cultural brokers of knowledge and how they can effectively assist learners in crossing borders from one culture to the next.

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DEDICATION

I dedicate this study to my dearest family, the Gambushe and Maphumulo family.

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LIST OF ACRONYMS

C2005	Curriculum 2005
CAPS	Curriculum and Assessment Policy Statement
DBE	Department of Basic Education
DoE	Department of Education
NCS	National Curriculum Statement
NGO	Non-Governmental Organisation
NRF	National Research Foundation
RNCS	Revised National Curriculum Statement
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNICEF	United Nations International Children's Emergency Fund
WHO	World Health Organisation

CHAPTER 1: INTRODUCTION TO THE STUDY

1.1 Introduction

This study sought to explore the integration of indigenous knowledge in the teaching of structures in the grade 4 Natural Sciences and Technology (NS-Tech) classroom. This introductory chapter provides the background which motivated the study. Scholars such as Ogunniyi and Ogawa (2008), Hoopers (2004) and Mapara (2017) asserted that within the African context, due to colonisation, there is a disjuncture between the Science and Technology curriculum and the indigenous learners' social and cultural background. This disjuncture arises from the disconnect between what learners learn in schools and what they learn or encounter at home.

Each culture generates a unique body of knowledge based on their observations, experiences, cultural customs, and interactions with the environment. This knowledge is passed down through storytelling, dancing and drawings within the community. Often, this knowledge is not documented. This knowledge is unique to a specific group of people or culture living in a specific sociocultural environment and is referred to as Indigenous Knowledge (IK) (Shizha, 2013). Sometimes, IK refers to local, traditional, technical indigenous, peasant, and folk environmental knowledge (Sillitoe, 1998).

According to Mapara (2017), Indigenous knowledge (IK) is a term that refers to the intellectual activities of indigenous societies scattered throughout the world. IK has survived for thousands of years regardless of colonialism (Khupe, 2014; Mapara, 2009). IK meets the core needs of a particular community. Through their indigenous wisdom, people from all cultures have contributed to the scientific and technological transition, particularly to the environment, as a means of survival (Chikaire et al., 2012; Lennert, 2016; Mawere, 2015; Shizha, 2010;).

The knowledge produced by indigenous people generally takes on different meanings according to different academic disciplines. Despite the diversity and complexity of indigenous knowledge, it is often neglected in knowledge production environments and generally described with words such as 'primitive,' 'backwards,' 'savage,' 'rural,' and 'unscientific' (Ezeanya-Esiobu, 2019). However, IK brings affordances for the conceptual improvement of Indigenous learners in science and technology as this cultural knowledge frequently supports the formal curriculum idea adequately (Cronje et al., 2015).

Moreover, the chapter aims to outline the purpose followed by the objectives of this study, the research questions and a detailed explanation of the rationale, which is informed by my personal experience. The significance of the study, clarification of important terms and an overview of the chapters is provided.

1.2 Background

Learners carry their socio-cultural backgrounds into the NS-Tech classroom that could be used to scaffold learning, particularly among indigenous learners (Singh-Pillay, 2023). Therefore, the learners' indigenous knowledge could be used as a platform to draw on to promote conceptual understanding and participation in learning science. Schools are thus places where learners and teachers can see how science, technology, and other forms of knowledge can connect and benefit each other, enhancing learning, their interest in the subject, and their progression in the subject at higher levels. Learners should be encouraged to draw on their socio-cultural background to make sense of abstract concepts in NS-Tech (Aikenhead, 2006; Meyer & Crawford, 2011; Regmi & Fleming, 2012; Zinyeka, 2013; Zinyeka et al., 2016).

Integrating IK into the NS-Tech curriculum will not only improve learners' knowledge and understanding of NS-Tech but will also allow them to have a better understanding of their surroundings, allowing them to address contextual problems with a scientific and technological approach (Chikaire et al., 2012; Mawere, 2015; Shizha, 2010). Therefore, the South African education terrain, post-1994, was re-designed and has undergone several reviews of the curriculum, which culminated in the current National Curriculum and Assessment Policy Statement (CAPS) document. The NS-Tech CAPS policy integrates IK into teaching and learning as one of the seven principles (DoE, 2012). Integrating IK into one of the seven principles is construed as a means to ensure that the previously disadvantaged groups are no longer disadvantaged or marginalised.

However, scholars such as Jacobs (2015), Keane et al. (2017), Mkosi (2019) and Moyo (2011) claimed that the integration of indigenous knowledge into the South African education curriculum is still in its early stages and hence has to be monitored and assessed. In accordance with Regmi and Fleming (2012), successful and effective integration of indigenous knowledge in science and technology learning can only be achieved if teachers understand what integration of indigenous knowledge means and can properly integrate indigenous knowledge in their teaching.

Additionally, teachers need to shift away from the perception of indigenous knowledge not being proven as scientific knowledge (Botha, 2012, p. 320).

Within the CAPS NS-Tech policy document, Specific Aim 2 in particular, states that through studying NS-Tech, learners can carry out investigations, enabling them to address problems practically and understand how the natural world works (DoE, 2012). Specific Aim 3 indicates that learners should be made knowledgeable about the history of science and technology, as well as Indigenous Knowledge Systems (IKSs) from earlier generations and cultures, while also developing learners' scientific and technological cognition and comprehension. When these specific aims are implemented, learners will be able to be curious and critical thinkers, immersing themselves in discoveries in the process of wanting to know, using indigenous and Western knowledge. It is hoped that the envisaged ideas of the NS-Tech CAPS would encourage NS-Tech teachers to enhance IK in their teaching to help their learners draw on IK to promote conceptual understanding and improve their academic performances. Therefore, the NS-Tech curriculum places the NS-Tech teachers as gatekeepers of knowledge in the science classroom (Moichela, 2017). They have a huge role to play in integrating IK concepts with classroom science and helping learners make sense of their lived experiences.

Learners from varied backgrounds should all play an active part and participate in what is taught in the NS-Tech classroom. Furthermore, learners should not be denied the opportunity to learn about their ancestors' contributions to science. With the integration of IK in the classroom, all learners will have a sense that their forefathers contributed significantly to the advancement of science, and they will be aware of the relevance of their culture and respect it. Similarly, De Beer and Petersen (2016) mentioned that school scientific curricula are frequently inappropriate to local indigenous conditions, and as a result, learners are unmotivated by the curricula, become bored and underperform. Because many teachers were trained to value western science and western epistemologies rather than the philosophy in the National Curriculum Statement, most of them lack the expertise of indigenous knowledge required to teach learners. Those who were fortunate enough to have the necessary understanding of indigenous knowledge (IK) typically lack the pedagogies and materials needed to teach.

There have been studies that focused on the integration of IK into the teaching of life sciences (Naidoo, 2010; Seehawar, 2018) and the integration of IK into the teaching of science (Madlela,

2023; Nwokocha, 2014), but there is a paucity of studies on the integration of IK into the teaching of NS-Tech. This study aims to explore grade 4 Natural Sciences and Technology teachers' understanding of the integration of indigenous knowledge in the teaching of structures, as well as how they mediate and reconcile indigenous knowledge in the teaching of structures.

1.3 Purpose of the study

The purpose of this study is to explore the integration of Indigenous Knowledge in the teaching of structures in the grade 4 Natural Sciences and Technology classroom in accordance with the Curriculum and Assessment Policy Statement (CAPS).

1.4 Objectives

The objectives of this study are:

1. To establish grade 4 Natural Sciences and Technology teachers' understanding of the integration of Indigenous Knowledge Systems in the teaching of structures.
2. To establish whether grade 4 Natural Sciences and Technology teachers integrate Indigenous Knowledge in their teaching of structures; if so, how and if not, why.

1.5 Research questions

1. What are grade 4 Natural Sciences and Technology teachers' understanding of integrating Indigenous Knowledge in the teaching of structures?
2. Do grade 4 NS-Tech teachers integrate IK in the teaching of structures? If so, how? And if not, why?

1.6 Rationale for the study

As a former undergraduate student, there was a task given to interrogate the Curriculum and Assessment Policy Statement (CAPS) in our method modules. It became evident that the policy espouses teachers to embrace IKS in their teaching of Science and Technology education to promote learners' understanding of the various cultural contexts in which Indigenous Knowledge Systems were developed (DoE, 2012). However, the observations as a pre-service teacher during teaching practice were precisely the opposite. As pre-service teachers, there was a requirement to attend a four-week teaching practice period at any school of our choice to gain teaching experience. It was during this time that it became clear that there was no mention or integration of indigenous knowledge in the Natural Sciences and Technology CAPS intermediate phase policy in the teaching

of structures. In the area where the teaching practice was undertaken, it was conspicuous that indigenous groups residing there had constructed their homes applying indigenous knowledge and locally sourced materials and that learners were aware of traditional buildings, their design, and reinforcement procedures. Nevertheless, practicing teachers of NS-Tech did not include this invaluable resource in their teaching of structures.

Secondly, an interest developed due to the greater debates on the place and space of IK in the curriculum among scholars, there was also an awareness from within. Jacobs (2015), Keane et al. (2017), Mkosi (2019) and Moyo (2011) noted that the integration of indigenous knowledge in South African school curricula is still in its infancy, even though the curriculum accommodatesthe integration of IK.

In India, Mahatma Gandhi opposed a global curriculum that emphasised '*universal'* disciplines like physics, chemistry, and mathematics while completely ignoring India's most important industry, '*spinning and weaving*' (Gandhi, 1956, p. 23). While he was not advocating for India's education system to be reduced to a spinning and weaving institution, he insisted that indigenous knowledge and industry be intertwined with the universal course in order to produce creative, innovative, and well-rounded individuals who are still in touch with their environment and the larger society (Ezeanya, 2019, p. 17). Furthermore, Gandhi (1956) dismissed the notion of the British education system, which contended that it altered India's traditional educational system, which pushed the concept of pride and service. To be deemed sound, education must assure continuity from one generation to the next. Gandhi also ignored the lack of prominence given to indigenous knowledge in developing the curriculum of learning in Indian universities. Instead, the British ignored Indian literature as plainly baseless and its growth as demonic (Gandhi, 1962, p. 28).

Taking the preceding into account and the value that indigenous knowledge may play in addressing critical challenges South Africa faces, such as unemployment, climate change, and loss of biodiversity, scholars such as De Beer and Mothwa (2014) and Van Wyk and De Beer (2012) proposed that integration of indigenous knowledge.

1.7 Significance of the study

The findings of this study will highlight the importance of integrating Indigenous Knowledge into the teaching of structures in Natural Sciences and Technology Education in grade 4. This study will contribute to a better understanding of teachers' perceptions of Indigenous Knowledge integration in Natural Sciences and Technology (NS-Tech) Education, as well as how it transfers into classroom practice. Plus, it is going to clarify the grounds behind their knowledge and actions. As a result, the findings of this study will benefit school administration as well as subject advisers of the type of support Natural Sciences and Technology teachers require to teach effectively. Finally, the purpose of this study is to contribute to research in Natural Sciences and Technology Education (NS-Tech).

1.7 Definition of key concepts

1.7.1 Natural Sciences and Technology (NS-Tech)

Natural Sciences is concerned with the four knowledge domains of Life and Living, Matter and Materials. Energy and Change, and Earth and Beyond, while Technology focuses on three knowledge domains, namely, Structures, Processing, and Systems and Control. Natural Sciences and Technology, as a result, have distinct aims, focus, developmental techniques, and processes (DoE, 2012). The subjects, Natural Sciences and Technology were integrated because of their relationship and how they complement each other. Science is a way of acquiring knowledge through observing and experimenting, whereas Technology is the practical application of science in order to design products; thus NS-Tech CAPS was introduced in 2012.

1.7.2 Indigenous Knowledge (IK)

Indigenous knowledge is closely related to a society's technology, socioeconomic and philosophical systems, learning, and governance systems (e.g., Alessa et al.,2016; Chikaire et al., 2012).

1.7.3 Indigenous Knowledge Systems (IKS)

Indigenous Knowledge Systems are the understandings, abilities, and philosophies that have been established and implemented by a specific civilisation with a long history that has enabled people to interact with their environment (Tharakan, 2015).

1.7.4 African Indigenous Knowledge Systems (AIKS)

African Indigenous Knowledge Systems is concerned with the testing of information derived from the elderly in the past and based on an ideology and culture (Owusu-Ansah & Gubela, 2013).

1.7.5 Non-Governmental Organisation (NGO)

A non-governmental organisation is a group that works independently, and the government does not fund it. As such, it is not looking to make a profit from its work. They are established on community, national, and international levels for social or political objectives (Folger, 2023).

1.8 Conceptual framework

A conceptual framework is an interconnection or relationship of variables that are expected to be seen or characteristics that are being studied (Scribbr, 2022). Thus, the conceptual framework of this study is drawn from the constructs of the following concepts: collateral learning, cultural border crossing and teachers as cultural brokers of knowledge. These concepts will be used during data analysis when reading the data in order to see how the grade 4 NS-Tech teachers promote collateral learning, cultural border crossing and how they act as cultural brokers of knowledge.

1.9 Methodology

A research methodology is an explication of the type of research that is being performed and shows the methods that were chosen for the study and how they support the study and link them back to the literature review. It also expounds on the data generation methods and the process of data analysis (Natalie, 2022). This is a qualitative study that uses an interpretive paradigm. The phenomenon that is being studied is the grade 4 NS-Tech teachers concerning the integration of indigenous knowledge.

1.10 Limitations of the study

The predicted challenges or limitations for this study are the case study approach and the sample size, which is five schools and five NS-Tech teachers, as well as the fact that all schools are distinct and thus cannot be generalised. However, it is worth noting that a case study design can offer an in-depth understanding of how various aspects of the case interrelate. The potential transferability of these findings to similar contexts can only be partly suggested by the author but ultimately is the responsibility of the reader, who can compare the case to another context. In this sense, then, it has been argued that the case study is associated with its particular forms of generalisability (Yin, 2017).

1.11 Overview of chapters

Chapter 1 which is the introduction chapter, brought to light the background of the study, purpose, and significance, as well as the rationale that motivated the study. In addition, this chapter discussed the aims of the study, research questions, and limitations.

Chapter 2 is the literature review of the study. It explores the literature on the definitions of Indigenous Knowledge Systems and Indigenous Knowledge, the integration of indigenous knowledge and its value in the curriculum, indigenous knowledge systems and the curriculum, the challenges of integrating indigenous knowledge in the teaching and learning of NS-Tech, the benefits/value of integrating IK in the teaching and learning of NS-Tech.

Chapter 3 is the conceptual framework underpinning this study, all of which are collateral learning, cultural border crossing and teachers as cultural brokers of knowledge. This chapter explains the previously described conceptual framework that supports the NS-Tech investigation.

Chapter 4 outlines the research design and methodology that was used to conduct this study. It contains the research paradigm, type of research, data collection methods, sampling and sample size, study location, validity of research data analysis, ethical issues, and the limitations of the study.

Chapter 5 focuses on the data analysis and presentation of data for Research Question 1, for which the data was collected in Stage One by using open-ended semi-structured questionnaires.

Chapter 6 focuses on the data analysis and presentation of data for Research Question 2, for which the data was collected in Stage Two using structured lesson observations and semi-structured post-observation interviews.

Chapter 7 is the discussion of findings, summary, recommendations for the teachers of NS-Tech, curriculum designers, and further studies are presented and the conclusion of the study.

1.13 Summary of the chapter

This chapter introduced the study as well as the background of the study. The chapter also highlighted the goal of integrating Natural Sciences and Technology (NS-Tech) education in the intermediate phase (IP), the purpose and objectives of the study, the research questions, the rationale, and the significance of the study. This chapter also explained terminologies, discussed

the limitations of the study, and provided an overview of the chapters. The following chapter will focus on the literature review of the study.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The preceding chapter presented a comprehensive introduction and background to the study, setting the stage for ensuing exploration. The chapter laid the foundation for exploring the important critical aspects of the study. This chapter embarks on a thorough review of pertinent literature. The review offers insights into established key research areas. Firstly, the scholarly debates on IK are discussed briefly. Secondly, this chapter will discuss literature on the following areas: Indigenous Knowledge Systems (IKS), Indigenous Knowledge (IK), integration and its value, IK and the curriculum worldwide, IK and classroom NS-Tech integration, challenges of integrating IK in NS-Tech, and the benefits/value of integrating IK in teaching and learning NS-Tech.

Over the last few decades, Indigenous Knowledge (IK) has sparked public debate and scholarly study (Khupe, 2014). Some IK researchers argued for social justice and human rights (e.g., Govender, 2012; Hewson & Ogunniyi, 2011), while others argued for pedagogical reasons (e.g., Lamb & Godlewska, 2020). One of the tenets of the South African National Curriculum Statements (NCS) is the value of indigenous knowledge systems, which is reinforced by pedagogy and social justice (DoE, 2012).

2.2 Indigenous Knowledge Systems (IKSs)

Different scholars have used the term ‘indigenous knowledge systems’ (IKS) to refer to various aspects of the knowledge and practices of indigenous people. Some scholars have defined IKS as the characteristics and applications of indigenous knowledge (Muyambo & Maposa, 2014), while others have viewed it as the local knowledge that integrates communities and serves as a survival tool (Chiwanza et al., 2013; Sithole, 2014). However, there is no consensus on a single definition of IKS, and the term is highly controversial (Mawere, 2014; Mapara, 2009).

One of the challenges in defining IKS is the complexity and diversity of the knowledge that it encompasses. Zinyeke (2013) cited Onwu and Mosimege’s (2004) work as an example of this complexity. The scholar above argued that it is difficult to agree on a legal and scientific definition of indigenous knowledge because it involves different people and levels of knowledge. Some definitions of IKS have focused on the socio-economic, linguistic, philosophical, political, and

religious dimensions of indigenous knowledge (Ogunniyi, 2007), while others have emphasised the innate or inherited nature of indigenous knowledge that includes technical, traditional, and local knowledge (Hoppers, 2001a; 2001b; 2002; Ogunniyi, 2009b; Semali & Kincheloe, 1999; Silitoe, 1998).

These types of knowledge are generated and transmitted from generation to generation and are adapted to specific conditions by indigenous societies (National Research Foundation [NRF], 2002). Nnadozie (2010) and Mawere (2014) noted that the terms 'indigenous knowledge' and 'indigenous knowledge systems' are often used interchangeably. They explained that IKS consists of various forms of indigenous knowledge that can be scientific, technological, medical, or otherwise. Moreover, IKS is closely linked to the environment and the people who possess it (Kimmerer, 2013). For this study, IKS is defined as knowledge that relies on various types of complex technologies for daily survival, and that is passed down from generation to generation (NRF, 2002).

A review of the literature shows that despite the different definitions of IKS, they all share a common theme: they refer to any knowledge that relates to the activities (knowledge and skills) that are relevant to a particular group of people and reflect their worldviews.

Taking the preceding into account, it is apparent that IKS and IK are similar and hence used interchangeably. However, IKS is the knowledge, skills and practices that were developed by indigenous people that indigenous people hold. In contrast, IK is the knowledge that people in a particular culture have acquired from the elderly over time and which is transferred and expanded from one generation to generation.

2.3 Indigenous knowledge (IK)

The term 'indigenous' is derived from the French word 'indigène' and the Latin word 'indigena.' Both of which in their vernacular and culture imply that it is something that comes from the environment and is in-born; therefore, it can be consolidated that IK is the knowledge (Amaro & Watson, 2016) and implementations of the consequent knowledge that is linked to a specific population in their local region (Sithole, 2020). Indigenous knowledge is a crucial part of Indigenous people's lives, and as such, their survival depends on applying their knowledge and competence (Mawere, 2012).

Indigenous knowledge is essential for the survival of Indigenous people because the understanding is specific to a particular culture and is learned via active practice (Govender & Mutendera, 2020). The practices are important and sacred to the indigenous people, and as such, they necessitate a better understanding of the environment (Chikaire et al., 2012; Mawere, 2015; Shizha, 2010), with acquired knowledge being used as skills for daily survival and problem-solving (Pedzisai, 2013, p. 245; Zinyeka et al., 2016). However, indigenous knowledge has also been defined as knowledge of the inhabitants of a certain place that has survived for the longest amount of time (Mawere, 2015; UNESCO, 2017). Hornby (2010) explained that 'indigenous' refers to something or things that belong to a specific culture or people in a particular place instead of coming to it from elsewhere. Meanwhile, Nnadozie (2013b) explained IK as information and knowledge that is attained through practice and continuous experience.

On the one hand, Mapara (2022) argued that indigenous knowledge is also known as traditional knowledge, communal knowledge, or native knowledge and the skills used for survival purposes within nature in a particular setting. The assumption is justifiable in that such knowledge is passed down from generation to generation by the elders of a given group. In the past, such knowledge may also be obtained from a neighbour. On the other hand, indigenous knowledge is a regional-based understanding that exists due to its distinction in a given culture and thus progresses over time. Thus, this knowledge is a true study of the conventions and merits of that particular community, as well as the relationships among the individuals of that community and environment (Hart, 2010; Zazu, 2008).

Indigenous knowledge is also examined in terms of what Indigenous people know, understand, and practice, as well as what they have become accustomed to over time, which are methods that have grown over time via numerous implementations through trial and error but have proven reliable (Mawere, 2015). Local people carry out such practices, and their understanding is based on knowledge of the environment, culture, language, and geographical location; thus, the approaches are embedded in them, and what they know and understand is passed down to the next generation (Adewopo et al., 2014; Eze & Ike Nnia, 2013). In agreement with the preceding, Hart (2010) stated that indigenous knowledge is the contents, approaches, and practices that are known within communities, their cognitive understanding of them, processes that have not changed, and

connected practices that occur on a daily but also experimenting with nature whilst harmoniously living with it (Chandra, 2014).

It is pertinent to note that numerous researchers have pointed out similarities in how indigenous knowledge is characterised, such as the indigenous essence of indigenous knowledge. Likewise, they agreed that indigenous knowledge is passed down from generation to generation and that indigenous people live via the application of their knowledge (Adewopo et al., 2014; Eze & Ike Nnia, 2013). These concepts are applicable to the study given that they highlight the various methods that different groups employ in their cultural traditions.

Therefore, it can be concluded from these definitions that IK is generated and developed by a community of people in a specific region, and so does not exist in a vacuum. It can only be accessed through the community in which it is active, learned, and verbally passed down from one generation to the next by those who hold it, such as community elders. The implicit fact is that indigenous knowledge has been, and will continue to be, the primary means by which a greater percentage of South Africans survive (Department of Science and Technology, 2004, p. 5).

For this study, IK is defined according to Nnadozie (2013b), who stated that indigenous knowledge is the type of knowledge that indigenous people have, which is attained through practice and repeated experience.

2.4 Integration of IK and its value in the curriculum

Discussions on the acceptance and integration of indigenous knowledge are frequently brought up in academic, political, and community development seminars. The justifications provided for the integration of indigenous knowledge (IK) and science education encompass political rectification and human rights considerations (Kincheloe & Steinberg, 2008; Mushayikwa & Ogunniyi, 2011); conscious mental process and methodological reasons (Ogunniyi, 2011), as well as protecting, using biological biodiversity sustainably, and growing sustainably (Moyo, 2012).

Recognition of the idea that there are numerous cultural societies and many cultural classrooms, as well as how mental frameworks are different from that of science, accounts for the general agreement among science education researchers on the need to consider ways of knowing in addition to Western-situated science in the classroom environment (Richards et al., 2012). In light of those above, scientific education researchers agreed on the importance of demonstrating the

utility of indigenous knowledge (Aikenhead, 2006; Corsiglia & Snively, 2000; El-Hani & Bandeira, 2008; Mathews, 1998; Siegel, 2002).

While considering the relationship between indigenous knowledge (IK) and science is important in the process of classroom integration, it is not sufficient (Khuphe, 2014). What is even more crucial, according to Aikenhead (1996) and Cobern (1998), is the broader perspective of the relationship between science and the socio-cultural world. Furthermore, science education exists inside a sociocultural context since science education must account for cultural issues with knowledge (Khuphe, 2014). As a result, acknowledging culture in science education does not pose a threat to reasoning (Cameron, 2007). Integration of indigenous knowledge has been observed to be successful where there is careful planning and participatory joint efforts with knowledge holders in communities in and around schools (Khuphe, 2014), and such curricula have been modelled and practiced in, for example, Canada (Aikenhead, 2001b) and New Zealand (McKinley, 2005). Considering the preceding, the strategy adopted is one in which school science is illuminated in a way that is consistent with the learners' socio-cultural environment, notably community benefits (Khuphe, 2014).

Gumbo (2015) stated that including indigenous knowledge/technology in the curriculum will help to eliminate misconceptions about indigenous cultures. This is because Western conquerors regarded indigenous knowledge as ancient and undeveloped, not of high standards, not progressive, and inconsequential (Oyeshile, 2021). Furthermore, this is possible through involving both indigenous and non-indigenous learners in collaborative design projects made possible by the use of relevant instruction. As a result, this type of integration can address the disconnect that exists between school and home, as there is less visibility between what is learned in school and what the learner understands from home (see Lipe, 2023). Integrating indigenous knowledge into technology education is a way to counter the action of colonisation and its significance structure (Gumbo, 2015, p. 67). This is because colonisation did not recognise the importance of indigenous knowledge systems and thus suppressed it in all forms, contributing greatly to indigenous communities' low level of educational attainment and thus allowing for many things to go wrong, such as high crime rates, unemployment rates, suicide, and incarceration, to name a few (ACDE, 2010, p. 2).

Gumbo (2015) argued that a '*culturally responsive*' Technology Education curriculum has the potential to assist in assessing the required respect of indigenous cultures by Western people, hence providing indigenous learners with self-confidence (p. 67). Furthermore, integrating indigenous technology into the Technology Education curriculum will aid in ensuring that students' knowledge, comprehension, and consciousness are strengthened in relation to various types of technology that exist (Gumbo, 2015). Another motivation for the integration of indigenous knowledge is the present-day schooling system, which permits learners to attend schools far from home, resulting in them frequently ending up in multi-racial institutions and having to live in school boarding. As a result, the learners engage in and absorb Western ways of teaching and doing things, allowing them to lose their indigenous ways of existence (Saynes-Vásquez et al., 2013; Simons & Lewis, 2013). For greater and more effective integration of indigenous knowledge, there must be an embracement of 'culturally sensitive' teaching and learning practices that do not reject indigenous ideas (Gaudrey & Lorenz, 2018; OCUFA, 2019; Palmater, 2019). Technology teachers should make their teaching and subject matter relevant to the learners' backgrounds, which requires an inclusive and fair educational environment (Gumbo, 2015).

As previously stated, this integration will enable a shift in research in Technology Education by directing scholars toward the field of indigenous technology. Additionally, Technology Education teachers will be transformed into co-researchers with the learners, thereby involving indigenous communities. Teachers will pay close attention to how knowledge is built and legalised in this manner, as epistemologists assume (Gumbo, 2015). Furthermore, Carvallo (2000) argued that another reason for integrating indigenous technology/knowledge in the Technology Education curriculum is that it will enable a way to deal with the issues of the widening gap between rich and poor in the knowledge-based universal economy. Also, the reason for the increasing disparity has to do with the looting of indigenous technology/knowledge, citing some pharmaceutical companies that, when needing to identify medicinal plants and extract the ingredients, thus exploiting them economically, look to indigenous knowledge, and they do not return the knowledge to the owners (Kumar, 2019). In this aspect, indigenous people's psychological property rights have thus been violated (Marinova et al., 2010).

According to UNESCO (2010), indigenous knowledge was viewed as insignificant, not in agreement with scientific ideas or techniques, and therefore outmoded. However, a few methods

were used to make indigenous knowledge more prominent in formal education, independent of its potential value in tackling modern problems. As a result, education became confined to classrooms, and learners were disconnected from their culture and surroundings. Abah et al. (2015) suggested that, for an African child to acquire knowledge with meaningful empirical applications within the learners' communities, science teaching in the African continent must be extended beyond the present method of "*transmission and indoctrination*" in terms of assessing subject matter learning. This can be achieved through the integration of the learner's indigenous knowledge systems to have the possibility of modifying the subject matter knowledge (Abah et al., p. 669).

Furthermore, due to the repeated failure of existing pedagogical models, the curriculum is frequently revisited and reviewed. For example, the Namibian Ministry of Education announced a dramatic review of Namibia's Basic education curriculum in which the new curriculum of the senior primary phase, which consists of grades 5 to 7, will now integrate the mother tongue (Namibia Sun, 2014). This is an important and bold step taken by the current government in recognition of the possibility of integrating indigenous knowledge systems to improve teaching and learning outcomes. Undoubtedly, when some scientific features are interpreted in indigenous knowledge commonly used as a medium of instruction, learners may better understand them, and the meanings can be easily conceived within the learning environment (Abah et al., 2015).

Mawere (2015) desired the integration of indigenous knowledge into the school curriculum since the application of prior information acquired by students stimulates "*innovative thinking and constructivism*" (p. 61). As a result, learners can refine fresh ideas and provide alternative solutions to problems they experience. Dennis (2010) argued that in Kenya, students are more likely to demonstrate pragmatic performances when learning is related to their own everyday experiences. Ndlovu (2019) observed that students understand new concepts better when teaching and learning takes learners' indigenous conditions into account. On the contrary, Brayboy and Maaka (2015) stated that non-compliance with integrating indigenous learners' cultures in schools impedes indigenous learners' growth in institutions.

Indigenous knowledge integration in the classroom is being created as a means of decolonising knowledge and encouraging a sense of national heritage (Aikenhead & Michell, 2011; Le Grange & Ontong, 2018; Mawere, 2015; Seehawer, 2018). Furthermore, Mawere (2015) viewed the

teaching of native language and history in the classroom as a means of promoting a country's recognition. Scholars such as Iseke and Desmoulins (2015) proposed that integrating indigenous knowledge into the school curriculum was a method of emancipating educational stakeholders in the education system because integrating indigenous knowledge into the education system enables teachers to connect with communities (Govender et al., 2016; Iseke & Desmoulins, 2015; McLeod, 2014). Furthermore, the integration of indigenous knowledge into the school curriculum is emancipatory since it enables learners to make their own decisions and choose their future (Mawere, 2015).

2.5 Indigenous Knowledge and the curriculum worldwide

Indigenous Knowledge (IK), a recent topic of discussion, is a major priority for many countries, and hence, there is no general definition of IK. Due to the fact that different cultures from different environments have different principles and practices, it is contradictory to consider a definition of one as a definition of another. This causes problems for teachers in integrating indigenous knowledge into their classroom practice, given that teachers were taught and teach modern science. Taking the previous into consideration, this is a national and worldwide concern.

Africa has traditionally been a great source of information for knowledge generation. The driving force behind indigenous education is to locate knowledge within the context of the user (Blignaut, 2017; Escrigas,2016; Lumonya, 2020). During the colonial era in Kenya, ethnic cultures were directed by worldviews and value systems in which spirituality functioned as a compass for all human activities and advancement (Lumonyo, 2020). This is further proven by community proverbs, which serve as the cornerstone of indigenous and traditional knowledge and allow people to learn about or reinforce essential truths such as peace, harmony, love of life, respect for others, and the environment, to name a few.

According to Kelly and Atbach (1984); Ngugi (1981); Ominde (1964), and Woolman (2001), missionaries and then the colonial government brought the Western concept of conventional education to Kenya. The drive for education at the time was primarily for religious reform, commercial exploitation, and the assimilation of Africans into Western cultures, values, and enactments. However, this undermined the indigenous learning patterns of Kenyan ethnic communities, depriving them of their cultural identities and sense of the past. Furthermore, after independence, it became a barrier for the Kenyan government in rebuilding the country's formal

curricula to allow the integration of many indigenous ways of knowing into formal school structures to assist learners in developing a sense of self-worth that is grounded in their indigenous heritage.

Also, as indicated by Kelly and Atbach (1984); Ngugi (1981) and Ominde (1964) curriculum re-modelling in post-colonial Kenya became an aspect of the process of restoring cultural recognition with deeper roots in validating African customs. The fundamental concern of the government has been the accreditation of citizens through social, economic, and national re-modelling (Republic of Kenya, 2005). As a result of the preceding, Kenya's education system isanticipated to serve as a bridge between varied cultures, national culture, and the nation's universalrequirements (Kenyatta, 1965; Lillis, 1985; Ominde, 1964; Republic of Kenya, 2005; Semali, 1999).

Kenyan ethnic communities' indigenous education practices are comprehensive since they contain all rituals and skills required to support cultural enactments, family life, and society as a whole (Mungazi, 1996; Semali, 1999). The goal is to develop individuals capable of developing interpersonal relationships and accepting civic duty, both of which are essential components of the learning process. As a result, having specialised skills and helpful attributes has been viewed as one of the benefits of being a well-educated and integrated member of society (Mungazi, 1996; Semali, 1999).

It ought to be worth mentioning that the exclusion of Indigenous Knowledge is a global issue, with Taiwan being one example. Cultural disparities persist between East and West for Taiwanese learners, and the cultural discontinuity is higher for Indigenous Taiwanese learners, owing to the fact that they must learn science in Chinese rather than their mother tongue (Caster, 2016; Vinding & Mikkelsen, 2016). For Taiwanese learners, learning Western science is considered a dual 'trans-cultural learning' experience, which is one of the reasons that Indigenous learners' school scientific advancement is decreasing (Human Rights Council, 2013). It is essential to consider thatindigenous learners understand life and nature by means of their own indigenous experiences. Asstated by Aikenhead (2001), a smaller number of learners are able to integrate their indigenous ideologies with Western scientific ideologies, and as a result, school science resonates with them. Additionally, their cultural acceptance of Western science is not an issue.

Scholars such as Aikenhead (2006) and Cobern (2000) argued that modern science education overemphasises a scientific approach to understanding nature by disregarding learners' beliefs. Consequently, such education will eventually cause Indigenous learners to take issue with their teachers' attempts. As a result, in conventional society, there is a progressive divide between Indigenous and Western learners (McKinley, 2007). Hence, Cobern (2000) argued that a 'worldview' relates to the mind's culturally dependent, inferred, basic structure. As such, this inferred structure is often composed of assumptions that influence one's feelings, thoughts, and behaviour in predictable patterns.

According to Kamwangamalu (2016) and Li (2004), there are numerous differences between Indigenous Taiwanese and Chinese grammar. Learners frequently face challenges when learning a second language and in a classroom that promotes an ideology that differs from their own. Aikenhead (2001), Chinn (2007), and McKinley (2007) stated that science teachers have proposed looking into the issue from the perspective of a learners' Indigenous culture and how that culture of Western science can understand and work together in learners' day-to-day experiences.

As mentioned by Aikenhead and Michell (2011), in order to encourage an equitable approach to learning Western science, a balance must be met in Indigenous learners' science classrooms where their Indigenous way of understanding nature is both respected and directly accepted as classroom content, by its integration with the Western science content that is detected in Taiwan's Indigenous classrooms.

Hays (2016) stated that formal education and indigenous knowledge systems are inherently mismatched in some manner. Hays goes on to indicate that one place where indigenous knowledge might be integrated is in informal or vocational education programs. As a result, government entities in Botswana responsible for non-formal education and vocational training have moved quickly in that direction (Hays, 2016). Furthermore, the Botswana Training Authority (BOTA) has implemented levels at which indigenous skills in various areas are officially recognised, regardless of whether they were obtained through formal training. Additionally, levels that have been implemented for indigenous knowledge so far have primarily dealt with crafts, music/dance, and tourism (Hays, 2016).

In addition, concerted efforts have been underway in Botswana since 2004 to build and implement an educational strategy that will provide indigenous populations, the majority of which are the San

people, with educational options that are appropriate for their language, culture, and needs. Extensive discussions with the Ministry of Education, the Department of Non-Formal Education (DNFE), and BOTA, led by the local NGO Letloa and the University of Botswana, have been an important component of describing the plan (Hays, 2016). Furthermore, a major focus of the initiative is how to integrate and involve the San people and communities in their children's education. However, the activities have experienced hurdles in terms of money and political reinforcements, but they are still ongoing (Hays, 2016).

Scholars such as Awofala et al. (2012); Ezeanya-Esiobu (2019) and Ezeudu et al. (2013) have advocated for an educational revolution at the primary and secondary school levels in Nigeria for more than 10 years. As a result, the Nigerian National Council of Education approved a Basic-9 Education approach, which is a revised Basic Education curriculum, in 2005. The agreed curriculum was made necessary by the community's ongoing and expanding transitions, such as the fast-paced technological breakthroughs and their impact on the environment, particularly in the field of Science and Technology (Danmole, 2011).

The following is a statement portraying how Western colonisers cared less about the development of the African people to the point where they provided them with schooling that produced nothing but servants for them; as Ndimande (2016) argued, "*These educational inequalities had a huge impact on the economic and social lives of these children, including the lingering poverty they endured during their adulthood*" (p. 37).

Many years ago, colonialism in South Africa encouraged Western cultural ways of knowing while repressing IK, resulting in cultural inequities not just in education but also in many other institutions and disciplines (Garuba, 2012; Nyamnjoh, 2012). As a result of the transition, IK has been embraced in the curriculum since 1997 and in the national Indigenous Knowledge Systems strategy since 2004.

According to the Curriculum 2005 policy statement, the integration of IK in the Natural Sciences policy document is advocated. Furthermore, indigenous technologies are depicted as more than just ways for indigenous people to work. They represent how indigenous people lived many years ago (DoE, 2002). Similarly, the Curriculum and Assessment Policy Statement (2012) advocated in favour of including IK in the curriculum. It said that its goal is to provide students with the ability to appreciate indigenous knowledge so that learners recognise South Africa's rich history

and tradition as having largely contributed to the values stated in the Constitution (DoE, 2012). Furthermore, IK is mentioned as one of the seven principles in the Curriculum and Assessment Policy Statement.

Considering the above, these curricula seldom mentioned indigenous knowledge, nor did they explicitly explain how it can be integrated, particularly CAPS in the intermediate phase of teaching structures, in particular. According to the CAPS document, the teaching and learning of science and technology should promote an understanding of the history of science and the relationship between NS-Tech and other subjects. In addition, teaching and learning of NS-Tech should promote learners' understanding of the different cultural contexts in which indigenous knowledge systems were developed (DoE, 2012).

However, the expectation was that teachers should integrate indigenous knowledge to reflect different South African cultural groupings that link to the specific content in natural sciences and technology, particularly structures. Whereas the Curriculum and Assessment Policy Statement (CAPS) lists IKS as one of the seven principles, the expectation demonstrates a disjuncture in planned curriculum and curriculum as practice.

According to the Assembly of First Nations (2012), internationally, many teachers are anticipated to acclimatise to changes that occur. Such transitions include curriculum policy alterations to accommodate indigenous learners, which is the case in the South African education system that transitions due to social, economic and political factors due to the coming of liberty for all, specifically Africans/Blacks who were previously marginalised. Naidoo (2010) further argued that the curriculum changes that were implemented with respect to Natural Sciences that are integrated with Technology, referred to as Natural Sciences and Technology (NS-Tech), were based on the idea of 'Science for all.' Thus, conforming to the transitioning socio-political environment took a humanistic strategy.

In addition, the majority of practicing South African teachers lack confidence and thus are not in favour of the curriculum reforms as much is anticipated of them (Cronje et al., 2015; Matike, 2012; Mapara, 2017; Mushayikwa & Ogunniyi, 2011). Moreover, there is no form of support in regardto content knowledge and strategies teachers can utilise in the teaching of indigenous knowledge systems (IKS) in the curriculum. Furthermore, Doll (1986) *"…was one of the first education*

scholars to explore the theoretical and practical implications of reconceiving curriculum, teaching and learning by reference to concepts associated with chaos and complexity theorising in the natural sciences" (p.129). Taking the preceding into consideration, it is suggested that there be analteration in the way teaching and learning take place such that he perceives the strengths of post-modernism.

Furthermore, the value and impact of classroom and community teaching and learning of indigenous knowledge systems are critical for meaningful education and relevant community development (Briedlid & Krovel, 2020). Also, by integrating indigenous knowledge systems in the curricula, the gap between indigenous learning approaches at home and Western education canbe narrowed, and thus, this strategy may well declare its merits and traditional knowledge as imperative to the academy.

The integration of indigenous knowledge, specifically African Indigenous Knowledge Systems, into the education system will enable African learners and teachers to reconsider the intrinsic socialorder of knowledge systems, as AIKS has been unfairly criticised in the past (Emeagwali & Shizha,2016). As a result, integration into the formal education system requires acknowledgement that AIKS exists in various forms of knowledge (Kaya, 2013).

2.6 IK and classroom NS-Tech integration

In the prevalent educational reasoning, many teachers are losing track of the notion that IK should play a pivotal role in bridging the gap between what learners know, their everyday lived experiences, and what they learn in school science (De Beer, 2019). In recent years, there has beenan increase in the effort in several nations, including South Africa, to integrate some componentsof indigenous knowledge into traditional Natural Sciences curricula. For example, the Revised National Curriculum Statement acknowledges empirical science's great contribution to human progress throughout the centuries but also asserts that there are other ideologies (DoE, 2002).

For example, many people in South Africa believe that people are not separate from the earth andits living things. They believe that everything comes from God or a constructive spirit and thus has a devotional meaning and that events occur for both devotional and physical reasons. People frequently use different modes of thinking for different situations, and even scientists may have religious frameworks or other ways of attributing merits to life and making choices in their own lives. It is thus reasonable to assume that students in the Natural Sciences Learning Area think in

terms of more than one ideology. Several times a week, they cross the border from their home culture into the culture of research and then reverse (DoE, 2002).

To achieve effective teaching and learning of the NS-Tech subject, the gap between Western Knowledge and IK must be overcome, as Naidoo (2010) reported numerous examples of teachers who believed that IK and classroom science contradicted one another (Nnadozie, 2009). Education attempts to provide students with the required information and competence for the world, as well as the ability to face society in a variety of ways through the usage of varied skill sets obtained through education (DoE, 1997). Tema (2002, p.18) observed a learning gap among African pupils as a result of the learners' differing knowledge, which some gained at home and others at school.

According to Ezeanya-Esiobu (2019), "A country that invests in creating an enabling environment for its human capital to operate at optimum usually receives yields by way of highly innovative products and services" (p. 4). It is critical to introduce and teach indigenous knowledge to learners since the knowledge can bring about positive change not just in the learners' lives but also in the world at large. IK is only partially apparent in the South African curriculum due to a lack of investment.

Research has shown that South Africa and New Zealand have a large number of indigenous people, so a deeper look into the integration of IKS into the schooling curriculum is required. However, fewer manifestations of indigenous technologies that can be used to solve technological/environmental issues in school teachings have been reported (Gumbo, 2015), and teachers have demonstrated a lack of understanding of the indigenous concept, which has resulted in an emphasis on teaching Western science (Williams & Gumbo, 2011).

According to Semali and Kincheloe (1999), the integration of indigenous knowledge into the school curriculum should be treated in the same way as Western science rather than as a separate body of knowledge. A learner has a better chance of looking at and dealing with issues if they have multiple ways of interpreting and understanding them. For example, if a learner has both IK and Western Science, he/she has a good chance of solving an issue scientifically and/or indigenously (Jegede & Aikenhead, 1999).

Indigenous knowledge is very significant in the built environment in Australia, as evidenced by the government providing funding to support the integration of indigenous knowledge in higher

education since it considers it an essential aspect that should be integrated (Australian Government Office for Learning and Teaching, 2012). Another program to be funded in Australia was the Learning and Teaching Academic Standards Statement (LTAS): Architecture, Building and Construction, according to Savage et al. (2011). This demonstrates the need to integrate IK into the curriculum because it is fundamental to the lives of the learners. This will enable them to utilise their skills in many different ways.

2.7 Challenges of integrating indigenous knowledge in NS-Tech

Integrating IK into NS-Tech teaching has proven to be difficult for teachers in South Africa and abroad. Efforts to integrate IK into the curriculum have occurred globally, for example, in New Zealand, Australia, and the United States of America, to name a few (Kurt et al., 2018). Similar attempts have been made in African nations such as Kenya and Zimbabwe, among others (Ng'asike, 2019), where IKS has been integrated into teaching and learning at various levels. These efforts have been hampered by issues such as language, pedagogy, resources, and lack of motivation. These are discussed below:

2.7.1 Language

Sebola (2015) argued that communication is crucial in ensuring that IK integration occurs properly since everything must be explained to the learners for the activities to be carried out effectively. Language can also be a barrier to understanding and expression. Therefore, it must be addressed appropriately.

Papp (2016) examined the education level of the indigenous people in Australia, the USA and Canada, which is due to the marginalisation by European people through colonisation. The issues identified across these countries concern lower education levels compared to non-Indigenous people, which promotes misconceptions (Papp, 2016).

Within African countries such as Kenya, Malawi and South Africa, vernaculars have long faced issues and miseries due to being degraded and undervalued in education in both colonial and post-colonial Africa (Hardman et al., 2011; Human et al., 2015; Taylor & Coetzee, 2013). It was discovered that when the English language is used in a classroom where the teacher gives out instructions, learners frequently do not understand and apply what they have been taught to practical situations at home, indicating the subtractive nature of English (Hardman et al., 2011; Human et al., 2015; Taylor & Coetzee, 2013). Furthermore, the common justification for using

foreign languages, such as English, in science education in Zimbabwe is that native languages lack scientific terminologies (Sebola, 2015). Moreover, studies on cultural beliefs and science in Africa confirm that science education is ineffective because the subject is disconnected from everyday life experiences, and the language of learning and teaching isolates learners (Jacob, 2015; Mahlangu & Garutsa, 2019; Mapara,2017).

2.7.2 Pedagogy

According to Nkopodi and Mosimenge (2009), integrating IK into the Science, Technology, Engineering, and Mathematics classrooms is difficult because both subjects are widely perceivedas 'Western' and unrelated to African culture and are presented poorly in the teaching and learning process (Sulisworo et al., 2017). Furthermore, Mathematics is regarded as a subject requiring a more hands-on approach, such as '*observing*', '*representing*', and '*investigating*', all of which arehuman activities. However, there is no clear guideline from the curriculum as to how and what tointegrate in an attempt to teach Mathematics in correlation with indigenous knowledge (Chahine et al., 2013, p. 40). This problem is attributed to teachers who were not effectively prepared for IKand culturally relevant pedagogy (Dziva et al., 2010; Jacobs, 2015; Luyckx et al., 2005; Mkosi, 2019; Moyo, 2011).

According to Moyo (2011), while implementing IK into the curriculum, scientific teachers confront a hurdle since they must consider numerous IKS components and select how to integratethem into the school science curriculum. Diwu and Ogunniyi (2011), in a study regarding the integration of indigenous knowledge in a science classroom, argued that teachers were critical of the integration of IK into the curriculum. A large number of teachers maintained that there are fewclear examples of IK in the curriculum as opposed to contemporary science. Also, much of the time, very little about IK is evaluated in the final assessments, which demoralises them from attempting to integrate IK into their science lessons. As previously stated, teachers do not integrateIK into their instruction since the curriculum does not explicitly describe how the integration should take place, resulting in varied understandings and implementation attempts (Jacobs, 2015).Kaya and Seleti (2013) postulated that one of the most pressing issues in the integration of IK is that education systems inherited from colonial control are founded on cultural merits that differ from those found in most African indigenous tribes.

In a class with varied learners, integrating IK into the school curriculum is problematic (Cronje et al., 2015; Mapara, 2017; Matike, 2012). It is difficult for a teacher who lacks a comprehensive knowledge base on indigenous practices to meet the demands of students from varied backgrounds. At best, they are comfortable teaching what they know and understand, and the lack of a uniform indigenous knowledge curriculum increases the possibility of the education system disintegrating. Gumbo (2015) argued that teachers should adapt their perspective and begin to exhibit a desire in various forms of knowledge to create a space for all pupils, regardless of their cultural circumstances.

According to Naidoo and Vithal (2014), integrating indigenous knowledge into teaching and learning is difficult since teachers continue to follow multiple methods that favour Western science while potentially alienating indigenous knowledge. Ogunniyi (2000) also noted that teachers' endeavours tend to favour Western concepts, especially when indigenous learners subjugate their classrooms. Furthermore, the superiority of Western conceptions over indigenous ideologies tarnishes learners' notion of recognition as traditional Science and Technology learners (Ogunniyi, 2000).

It must be realised that little has been done to integrate indigenous knowledge into contemporary school curricula. Many recent science textbooks acknowledge the prevalence of indigenous knowledge among learners and that science should be placed in the context of the learners' actual lives (Mkosi, 2019). It is, however, clear from the preceding that there has been little to no attention to the methods of inquiry available within indigenous knowledge or the contexts in which the learners live. Therefore, it is evidently visible that regular science teachers at higher educational institutions have been thoroughly educated in the scientific system of inquiry and that they are nothing more than just reporters of scientific findings.

Mavuso et al. (2021) conducted a study in the Eastern Cape regarding the integration of IK that revealed that there was a lack of teacher development, which would enhance teachers' knowledge of how to integrate IK and methodological practice. Without clear and effective strategies or methodologies to integrate and teach IK in the NS-Tech classroom, IK will remain behind because of the little investment given to it.

Moreover, in a study conducted by Seehawer (2018) with a team of scholars in Grahamstown, Eastern Cape, regarding how IK could be integrated into teachers' regular classes, teachers

demonstrated that they were interested in integrating indigenous knowledge (pp. 96-97). One of the young participants, who grew up in an urban slum and is in her first year of teaching, mentioned that integrating indigenous knowledge in her classroom is a struggle because there was no indigenous information in her childhood. She also discussed how 'upcoming teachers with inadequate expertise of indigenous knowledge, such as herself, can teach and advocate for indigenous knowledge (Workshop 4, August 12, 2015).

South Africa has a legacy of colonial and apartheid education that marginalised and devalued the indigenous knowledge (IK) of the African people. These systems were considered inferior and incompatible with modern science education. This view is erroneous and detrimental to the development of a diverse and inclusive scientific culture. However, some challenges remain in the integration of IK into the science curriculum. One of them is the perception that IK is exclusive to the African people and not relevant to other groups. This may undermine the pedagogical value of IK as a source of multiple perspectives and alternative solutions (Badugela, 2019).

2.7.3 Resources

Indigenous knowledge is not recorded, making it difficult for teachers to access it. Furthermore, textbooks are a vital contributor to knowledge in teaching and learning, yet they frequently cause problems. Many teachers believe that some textbooks are rarely useful to indigenous learners (Diwu & Ogunniyi, 2011). Some textbooks available in South Africa attempted to integrate IK. However, there were few cultural activities to engage with, and they mostly comprised case studies. Textbooks developed for a national market frequently do not play a role in fitting in with the South African context, leaving teachers with few resources to support their teaching and learning (Lubben, 2011). In addition, it was discovered that, in South Africa, learners underperformed in science because the subject was stereotypically presented in standard textbooks as a rooted body of knowledge and as an absolute truth, and science teaching is thus influenced by English as the language of learning and teaching, thus not yielding the desired outcome from learners and teachers (Abah et al., 2015; Christie, 2010; Keane, 2015; Mkosi, 2019). This further perpetuates the inequalities that already exist in the country (Abah et al., 2015).

South Africa has a diverse culture, and each culture can implement its indigenous knowledge. Hence, indigenous knowledge is "*local knowledge*" by definition. As a result of the differences in cultures from one community to the next, the teaching resources generated will not be appropriate

for the next community, which is why the teaching and learning materials must fit into the cultural context of the local community.

Gumbo and Williams' (2014) comparative study explored the pedagogical content knowledge (PCK) of secondary Technology Education teachers in New Zealand and South Africa. The results of the study revealed a lack of devotion from teachers in terms of integrating indigenous technologies/knowledge into the Technology Education curriculum. In addition, this was also evident in development workshops and implementation, which do not include indigenous technologies/knowledge. There was evidence in this study that indigenous perspectives were essentially non-existent in the teaching and learning process, as well as in teaching and learning materials and assessments.

Furthermore, in a study on the integration of indigenous knowledge in a South African school, Ontong and Le Grange (2018) discovered that there was a lack of teaching resources, such as indigenous knowledge materials, as well as a lack of training in indigenous knowledge by teachers, which was a major impediment to the integration of indigenous knowledge in the Geography curricula.

2.7.4 Lack of motivation

Another challenge with integrating indigenous knowledge is the teachers' lack of motivation. Many science teachers have misgivings about integrating indigenous knowledge into their classroom implementations because they regard science as a more dominant system of knowledge than indigenous knowledge (Keane, 2015). Because of the cultural diversity of their classrooms, the teachers are uninterested in integrating indigenous knowledge into their teaching practice (Keane,2015). At best, they are comfortable teaching what they know and understand, and the lack of standardised indigenous knowledge system curricula raises the likelihood of the education system disintegrating.

2.8 Benefits/value of integrating IK in teaching and learning NS-Tech

Integrating IK within Natural Sciences and Technology (NS-Tech) can benefit the broader public, especially learners. This is due to the idea of IK having the ability to gather new visions and practices in education, particularly in the teaching of NS-Tech (Jacob et al., 2018). Indigenous knowledge, spanning disciplines like mathematics, science, and technology, can greatly enhance learners' learning experiences (Gumbo, 2015, 2020; Nyika, 2017). These studies consistently

affirm that integrating indigenous knowledge enriches learners' understanding of these subjects. Using indigenous knowledge in science classes has the potential to provide real-world context to learning (Anazifa & Hadi, 2017). According to Zengeya-Makuku et al. (2013), teaching from an indigenous perspective bridges the gap between learners' formal education and their culturally rooted knowledge. Moreover, Gumbo (2016) contended that integrating indigenous technologies into the curriculum renders teaching and learning more tangible and meaningful for learners. This approach, supported by research, not only enhances knowledge acquisition for all learners but also brings excitement into the classroom.

Dennis (2010) discovered that indigenous vernacular was used in integrating IK in teaching and learning in Canada. Kaya and Lyana (2014) and Lukong (2016) observed that when learners had the option to use their indigenous vernacular when explaining concepts or aspects, they were more eloquent and coherent. According to Akena (2012), in Uganda, the use of indigenous language in teaching and learning was viewed as a means of liberating the coloniser's subjugating vernacular. Mawere (2015) supported the use of indigenous language as the language of learning and teaching as a strategy for reclaiming cultural identity.

In the Engineering faculty, for example, the integration of IK plays a critical role in meeting the needs of the current generation in terms of sustainable development goals, such as economic growth, without negatively impacting the ability of the next generation to meet their own needs (Bradley et al., 2016; Jeffrey, 2015; United Nations, 2018). Furthermore, the scholars above argued that engineering design is the driving force of advantageous, ongoing development and growth, and sustainable design is linked with sustainable development propositions and includes attention to life-cycle low-impact materials, reuse and renewability, etc.

Expressed, this means that the engineering design, which involves an iterative process to achieve a certain aim or purpose, offers multiple paths to achieving a result that is regularly updated to satisfy sustainability standards. At the same time, the environmentally beneficial materials used are reusable. In this way, the current generation can use the products while ensuring that the following generation has access to them. As a result, the integration of IK will allow the present generation to be acknowledged in the classroom and provide their indigenously sustainable ways of utilising resources in conjunction with the most recent upgrades.

Furthermore, Gumbo (2015, cited in Marchland, 2008), mentioned in a case study that there was a demonstration of how indigenous people in three countries, namely Yemen, Mali, and England, used natural resources for construction. This study illustrated skills exhibited by indigenous elders in communities and thus passed down verbally and through observations and practice from one generation to the next.

The recognition of multicultural societies and multicultural classrooms, as well as how cognitive frameworks differ from those of science, explains why science education researchers agree on the importance of considering ways of knowing in addition to Western-oriented science in the classroom (Gupta & Elby, 2012). School science is intimately related to Western culture, as opposed to indigenous ways of knowing. Integrating Indigenous knowledge into the classroom is a step toward recognising diversity in ways of knowing and valuing Indigenous Knowledge (Khupe, 2014). According to research, indigenous knowledge contributes greatly to global knowledge diversity (Turnbull, 1997). Furthermore, IK represents learners' prior knowledge and may be a useful resource for learning, which could further enhance their surroundings (Waghid, 2018; Doudin, 2016).

According to Khuphe (2014), there are numerous advantages to using socio-cultural techniques for indigenous knowledge and science integration. Such advantages include integrating values that will help learners cross borders into and out of school science. It is possible that this would encourage and further grow their identities, preparing them for a competent life in an indigenous and scientific environment. As a result, cross-cultural scientific education gives space for communities to make decisions about what and how to learn (Khuphe, 2014). It is worth noting that teachers frequently have the opportunity to discover indigenous knowledge alongside their students. In this way, they can foster lifelong learning (Nadelson & Seifert, 2019).

Indigenous Knowledge Systems are considered to have been used by communities in traditional Africa to safeguard natural resources from unsustainable exploitation, preventing harms that occurred previously due to the misuse of natural resources. These ideas demonstrate the importance of IK, indicating that it should be introduced into the curriculum (Segage, 2010, pp. 66-76). Learners can be taught to value life and defend our planet by introducing these ideals into the classroom. If taught in inclusive pedagogy, IK can help encourage equitable resource management by teaching students to be responsible and economical with our natural resources and

to take care to reduce our ecological imprint. As a result, teaching learners about sustainability, resource conservation, and how to pass on that knowledge to future generations is essential.

In light of the preceding, there is an indication of a link in that the integration of IK in contemporary Africa could prove to be crucial, just as it has proven to be pivotal to the survival of the indigenous people. This relationship manifests itself in the form of teaching and learning both within and outside of the classroom, as well as how both Western and indigenous people can benefit from it. When compared to how indigenous people used the resources, which included a method of preserving them, the way they are being used is a true sign that they are being overused and/or abused and will soon run out. Consequently, IK teachings could considerably aid in learning how preservation occurred and other elements involved while blending both Western and Indigenous ways of life.

Learning African Indigenous Knowledge Systems (AIKS) will enable learners to readily express their gratitude for their ancestors' language, cultural identity, intelligence, and contribution to knowledge technology advancement (Mawere, 2014). Re-examining indigenous education can be viewed as part of a process of reclaiming cultural identity with deep roots in true African traditions. By sharing their experience, integrating indigenous knowledge into school curricula will help different cultures and/or communities (Bereketeab, 2011; Lerch, 2016). This is related to the idea that people from other cultures can share and interact with indigenous knowledge from other civilisations in order to demonstrate value and mimic them where necessary (Mawere, 2014). A good example is one of Tanzania's 'Washambaa' people, who established a land-use system that mimicked the peak vegetation of the ephemeral natural forest through multi-story cropping, integrating annuals and perennials on the same plot (Mawere, 2014).

2.9 Summary of the chapter

This chapter defined and discussed the definitions of indigenous knowledge systems (IKS) and indigenous knowledge (IK). It also discussed how indigenous knowledge systems are included in various policy documents, both nationally and internationally, the relevance of integrating IK in teaching and learning, as well as the benefits and challenges associated with integrating IK, wherein the challenges included language, pedagogy, resources, and lack of motivation. The next chapter discusses the conceptual framework that underpins this study.

CHAPTER 3: CONCEPTUAL FRAMEWORK

3.1 Introduction

The previous chapter thoroughly discussed the literature that was reviewed for this study. This chapter will explain in detail the conceptual framework that underpins this study. The purpose of this study is to explore the integration of indigenous knowledge into the teaching of structures in the grade 4 NS-Tech classroom in the Pinetown district.

This study draws on Jegede's (1995; 1999) theory of collateral learning, the concept of cultural border crossing (Aikenhead, 1996; 1997), and teachers as cultural brokers (Michie, 2004). The application of this conceptual framework will enable the researcher to make sense of the integration of indigenous knowledge into the teaching of structures in the grade 4 NS-Tech classroom in the Pinetown district. In addition, the conceptual framework is vital as it places teachers in a liminal space as brokers of IK and NS-Tech knowledge. Consequently, this chapter will explore "collateral learning," "cultural border crossing," and "teachers as cultural brokers" of knowledge (Figure 3.1).

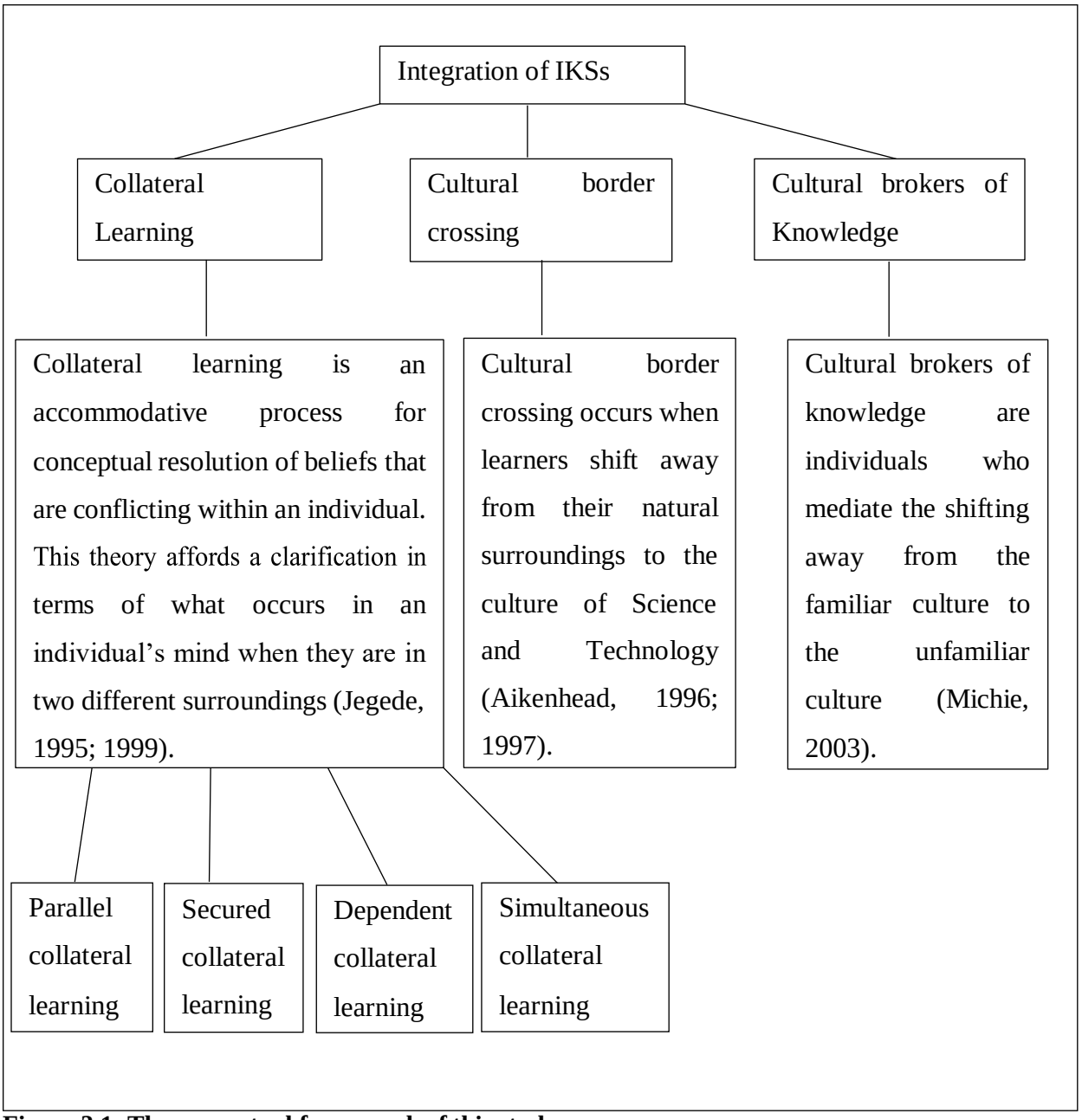


Figure 3.1: The conceptual framework of this study

3.2 Collateral learning

In 1995, Jegede proposed a "collateral learning" model of learning as an alternative to the conceptual (ex)change model for describing the learning outcomes when learners, particularly those from non-western societies, are exposed to science culture in the formal classroom. In the words of Jegede (1995), collateral learning is "*an accommodating mechanism for the conceptual*

resolution of potentially conflicting tenets within a person's cognitive structure" (p. 117). Collateral learning is a cognitive process in which learners reconcile or accept competing knowledge or beliefs within their existing mental frameworks. It is the use of an adaptive process to resolve potentially conflicting beliefs or principles within someone's psychological framework. It thus underpins the process by which a learner in a non-Western classroom creates, alongside and with limited intervention and interaction, Western and indigenous explanations of a simple idea that this type of learner keeps in his/her mind with the possibility of using it in the future foreither Western or indigenous settings (Jegede & Aikenhead, 1999).

This theory explains what happens in the minds of a learner when they traverse borders from one culture to another (Nnadozie, 2009, p.35). For some time, learners may understand what they have in mind that they have gathered from their culture as well as the differing ideas that they have accumulated from another culture (Nnadozie, 2009). Collateral learning explains what learners experience when they bring their indigenous knowledge to science class and engage in science learning. As learners traverse borders, collateral learning assists teachers in understanding how learners experience science knowledge in addition to indigenous knowledge. This assists teachers in developing more effective strategies for their classrooms as cultural brokers.

Aikenhead and Jegede (1999) defined four types of collateral learning that take place on a continuum: parallel, secured, dependent, and simultaneous collateral learning.

3.2.1 Parallel collateral learning

Parallel collateral learning takes place when a learner has two opposing viewpoints at the same time. This indicates that the learner has both indigenous and Western scientific knowledge in their minds at the same time, but with limited interaction, as seen in learners learning for the first time (Jegede, 1999).

3.2.2 Secured collateral learning

Secured collateral learning is considered to take place over a longer period, during which the learner must resolve a conflict between two opposing "knowledge frameworks" (Jegede, 1995). This means that the child must attempt to resolve what Jegede (1995) refers to as 'cognitive dissonance' in the understanding basis of the encapsulated long-term memory. Thus, this 'cognitive dissonance' displays contradictory ideologies that are expressed indirectly in the

Western science with which the child is confronted in the science classroom, as well as in the indigenous knowledge that the child takes to the classroom (Koopman, 2018, p. 107).

3.2.3 Dependent collateral learning

The third type is dependent collateral learning. This happens when the '*schema*' from the Western scientific ideology confronts the child's indigenous ideology, which thus enables a child to reorganise his/her existing '*schemata*' (Koopman, 2018, p. 107). The change to the new '*schemata*' occurs due to what the child already knows. Therefore, this implies that the child can make a transition in approval of, or in opposition to, the cultural ideology, however, depending on what is already there in his or her brain. Additionally, if this does not occur, the child will be required to alter his or her existing understanding to understand the new idea (Koopman, 2018).

3.2.4 Simultaneous collateral learning

Jegede (1995) defined simultaneous collateral learning as the fourth type of collateral learning. When a learner attempts to learn about phenomena from two cultures at the same time, they evaluate the phenomena and have accessible problem-solving skills from both cultures and similarities and differences between the two ideas (Jegede, 1995). This is referred to as simultaneous collateral learning. According to Fakudze (2004), simultaneous collateral learning happens when occurrences in one culture allow the learning of the opposing culture. It is located between parallel and dependent learning. Teachers acquainted with the collateral learning theory become better collateral brokers because successful border-crossing into the classroom by both learners and teachers is important to good collateral learning (Aikenhead & Jegede, 1999; Nnadozie, 2009). Further, to reduce conceptual conflicts, teachers' classroom approaches should consider learners' past knowledge as well as the underlying foundations of that knowledge (Muza, 2014). As stated by Koopman (2018), the way a child finds answers to the tension between two opposing views, indigenous and Western, is solely dependent on the 'fruitfulness' and 'plausibility' of the understanding for the child, which results in the third type of collateral learning (p. 107).

Pyenson (1993) pointed out that 'collateral learning' originated in two key historical evolutions, the first of which was the use of science to defend Western arguments and provide support for Western progress. There is some support in the literature for the 'collateral learning' concept. Goodman (1984) emphasised the relevance of acknowledging the multiplicity of cultures that

exist, each with its ideology and existence. Furthermore, while reporting the direct connection between the reasoning patterns and motivations of Western and African cultural viewpoints, Horton (1971) consolidated that both cultures, Western and African, share the use of theory to go beyond the restricted understanding of natural causes provided by sensibleness. The preceding argument is more concrete given that Ogunniyi (1987) endorsed it by contending that both structures, scientific theories, and myths, provide strategies developed from modelled experiences, wherein he contended that scientific theories rely on a neutral model and myths rely on a humanlike model.

A typical example is shown; in which they use the 'rainbow creating' technique. Western science teaches learners that a rainbow exists due to the reflection of light by droplets of water. However, indigenous reasoning described the appearance of a rainbow as a result of a python crossing from one river to another or the death of somebody very important, such as a chief. (It needs to be highlighted that there are many other indigenous explanations for the appearance of a rainbow (Jegede & Aikenhead, 1999)). Furthermore, such an indigenous explanation is going to be impossible to believe because physical proof does not exist in comparison to the Western notion. Nonetheless, learners continue to maintain this indigenous belief (Jegede & Aikenhead, 1999).

Collateral learning recognises learners' prior knowledge and provides them with an alternative to access concepts or aspects (Herbert, 2008). It is worth emphasising that learners arrive in class with some or many preconceived ideas that they learned from their parents and that they are influenced by their viewpoints, religious leaders, media, and indigenous knowledge, to name a few (Cavallo & McCall, 2008; Demastes et al., 1995). These preexisting beliefs, together with the learners' religious positioning, form a conceptual ecology that teachers must consider when developing assessment instructions (Cavallo & McCall, 2008; Mathews, 2001; Sinatra et al., 2008; Smith, 1994). Cavallo and McCall (2008) and Lawson and Warsnop (1992) demonstrated that the type and quality of teaching and learning carried out in the classroom will undoubtedly influence learners' and teachers' attitudes. Collateral learning has thus been demonstrated to be beneficial for explaining patterns of learning in cultures with strong religious beliefs, as is the case in South Africa (Aikenhead & Jegede, 1999). Some beneficial recommendations were made regarding collateral learning as a teaching approach that enhances learning and expands the course content that is taught without significant loss of class time (Shull, 2013). It also helps learners in having

significant comprehension of the concepts that are taught. As a result, learners in a science class will generate scientific aspects alongside one another, and the method will be effective and exploratory.

3.3 Cultural border crossing

Cultural border crossing refers to a learner moving from one culture to another, from one of science and technology to another, for example (Jegede & Aikenhead, 1999, p. 45; Nnadozie, 2009;). The mind of a learner is divided into distinct cultures (Jegede & Aikenhead, 1999). These cultures have varying effects on the lives of learners and include, but are not limited to, school culture, science/technology culture, family culture, and so on. A lot is expected of a learner from the teacher when they enter a different culture, and when they enter, they bring all of their other cultures with them while having to blend into the new culture. In doing so, the learners must shiftaway from the known to the unknown (Jegede & Aikenhead, 1999).

Science teaching and learning must be culturally sensitive, with an emphasis on what happens in minds and hearts (Hewson, 1998). Additionally, educational researchers discovered that, in most cases, learners from racial and linguistic minority backgrounds are frequently challenged by specific disagreements with the 'ways of life' that have to do with school achievement and, as a result, face far more difficulties navigating within schooling institutions (Hanrahan, 2002, p. 332). Furthermore, McIntyre et al. (2001) stated that for the few and working-class learners, school might be a contradictory and occasionally unbearable place. As a result, in this situation, learners' transition into school science might be a strange and confusing process (Piliouras & Evangelou, 2012).

Giroux (1992) proposed 'border pedagogy', which emphasises the need to confront and challenge current borders of knowing while also constructing new ones as a pedagogical enactment. It is vital in the context of 'border pedagogy' to create new classroom conditions to evaluate the capacity of learners to communicate, write, and listen in a "multi-perspectival language" (Giroux,1997, p. 332). As a consequence, it is critical to understand that learners are not excluded from this discussion. Rather, they are engaged as border-crossers who take on, cross, change, and rework borders as they encounter 'counter-discourse' with inaugurated boundaries of white and class-specific understanding, primarily with concerns about autonomy, equity, and fairness (Piliouras & Evangelou, 2012, p. 332). Similarly, teachers become border-crossers under the condition of

border pedagogy when they affirm marginalised communal narratives, lived experiences, and voices, allowing them to be present in the classroom environment (Piliouras & Evangelou, 2012).

Reveles et al. (2008) employed another metaphor, "contextual shifting", to draw attention to the reality that, as individuals move from condition to condition, they are frequently expected to change their ways of conversing, doing, and socialising with others in order to be recognised and benefit from cultural membership (p. 332). As a result, Piliouras and Evangelou (2012) agreed with Reveles et al. (2008), who argued that many racial and linguistic minority learners are not explicitly taught "contextual shifting" (i.e., transitioning their ways of conversing, doing, and socialising) in ways that may lead to academic achievement.

Cross-cultural science education is viewed as a pattern of research and implementation that has guided investigations into curriculum, directions, and evaluation for learners who encounter school science as an unfamiliar culture (Aikenhead et al., 1999; Atwater & Riley, 1993; Jegede & Okebukola, 1991). Furthermore, Aikenhead (1996) contended that science is new to most learners in school science, whether they live in Western or non-Western civilisations. Moreover, Costa (1995) and Jegede (1995) maintained that the unfamiliarity arises as a result of the difference between the learners' life-world cultures and the culture generally accepted by the scientific society, the distinctions between the learners' ideology and the ideology frequently displayed by Western science (Cobern, 1996) and the distinctions between the communal conditions of learning science knowledge and the conditions of using that knowledge.

Aikenhead and Jegede (1999) proposed that teachers should: 1) acknowledge Western science as a cultural body by its very nature; 2) recognise the cultural border crossings that the majority of learners encounter to differing standards when moving from their life worlds into the worlds of school science, and as a result, recognise that studying science is a cross-cultural occurrence for majority of the learners; 3) consider the various ways learners deal with psychological conflicts that arise from cultural clashes and use collateral learning theory to enable sense out of these disputes; and 4) assist learners in working out their border crossings and finding a solution to any cultural disputes.

According to Aikenhead (1999), teachers ought to include "*smooth, adventurous, managed, hazardous, or impossible border crossings*" in their courses (p. 186). He proceeded to point out that when teachers pay close attention to their learners, the instructions are obliged to change

accordingly. However, achievable border crossings could become smooth when learners recognise the course content as being applicable to their world. As a result, a considerate teacher would link the course content to the learner's educational attentiveness by addressing the divide between the culture of Western science out of technical and communal matters and out of former times, knowledge, and sociology of science (Solomon & Aikenhead, 1994, p. 187).

Smooth, regulated, dangerous, and impossible border crossings have all been classified as different types of border crossings (Costa, 1995; Jegede & Aikenhead, 1999), which correspond with the stage of difficulty learners encounter when transitioning from their familiar culture to the school science culture. Smooth border-crossing occurs when the learner's culture and knowledge are consistent with the sciences taught in the classroom. Managed border-crossing occurs when the learner's everyday culture and knowledge diverge from the sciences taught in the classroom, and hazardous border-crossing happens when both cultures are widely dispersed (Fakudze, 2004). Finally, impassable border crossing happens when both cultures are at odds, making it difficult to cross from the learner's native culture to the science subculture at that time (Fakudze, 2004).

3.4 Teachers as cultural brokers of knowledge

Cultural brokers, according to Michie (2003), are those who facilitate the transition of a person or a group of people from one culture to another. In other terms, a cultural broker is someone who assists in negotiating between one culture and another. In relation to science/technology education, a cultural broker is someone who helps learners transition from their communities' culture to the scientific/technology culture. Jegede and Aikenhead (1999) use the term "teachers as cultural brokers" to describe the function of teachers in assisting learners' cultural border crossing during the learning of scientific-technology knowledge at school. The teachers' role in the Science/technology classroom, in which learners have brought their indigenous knowledge from their local communities, is to act as cultural brokers, acting as a bridge between the learners' indigenous knowledge and the scientific/technology knowledge.

Cultural brokers are thought to be especially effective in situations where diverse groups come into touch with the prospect of anxiety and conflict, such as during colonisation (Wolf, 1956, p. 94) and political disagreements (Yohani, 2013, p. 94). Furthermore, Sleeter (2001) noted that research on cultural brokering in education has focused on teachers' roles in bridging the gap

between learners' cultures and those of the school in an attempt to close the cultural divide that exists between the two worlds.

Considering the preceding, teachers who play the role of "cultural brokers" are imperative in the education field and have a pivotal role when they utilise "culturally relevant, or culture-based, pedagogy" as they make the links between new academic course content and the background lived experiences of learners which they bring to the classrooms (Delpit, 1995; Gay, 2000; Kana'iaupuni et al., 2010; Ladson-Billings, 1994, p. 96). These practices, it is believed, place a premium on developing relationships between learners and teachers. Furthermore, they frequently assist teachers in identifying and addressing potentially hidden prejudice within themselves, the policy document, and classroom interconnections (Howard, 2007; Nieto, 2000).

Furthermore, Sleeter and Cornbleth (2011) maintained that culturally relevant methodology and competence are more evenly distributed across the classroom, resulting in the teacher being perceived as a co-constructor of understanding and the policy document being adjusted to assist in enabling connections to learners' backgrounds and initiating relevancy. These models have been considered to be better suited for culturally diverse learners. As stated by Howard (2007), teachers with cultural competency or knowledge, as well as the use of learners' diverse cultures, have a positive effect on their academic achievement. Additionally, studies have shown that teachers who use culture-based education have more engaged learners, a greater sense of self-worth, and higher results on mathematics and literacy assessments than teachers who do not use culture-based education (Kana'iaupuni et al., 2010).

3.5 Summary of the chapter

This chapter detailed the conceptual framework that was relevant and used for this study, which was collateral learning, cultural border crossing, and teachers as cultural brokers of knowledge in relation to the integration of indigenous knowledge in the teaching of structures in the grade 4 Natural Sciences and Technology classroom. The next chapter focuses on the research methodology.

CHAPTER 4: RESEARCH METHODOLOGY

4.1 Introduction

The previous chapter reviewed the relevant literature on the integration of indigenous knowledge, notably in the grade 4 NS-Tech classroom in Pinetown District schools. The purpose of this chapter is to present the research methodology used in the study to explore the integration of IK in the teaching of structures in the grade 4 NS-Tech classroom. The chapter provides full definitions and explanations of the paradigm, research type, and research design choices. In addition, the chapter discusses the instruments and methods implemented in this study for collecting data and analysis. Furthermore, the chapter explains why the sample methods that were used were chosen. Also, the methods used to assure validity and credibility are detailed in the study.

4.2 Structure of the methodology

The methodological structure of the study and methods of data generation are depicted in Figure 4.1. After that, each methodological choice is explained.

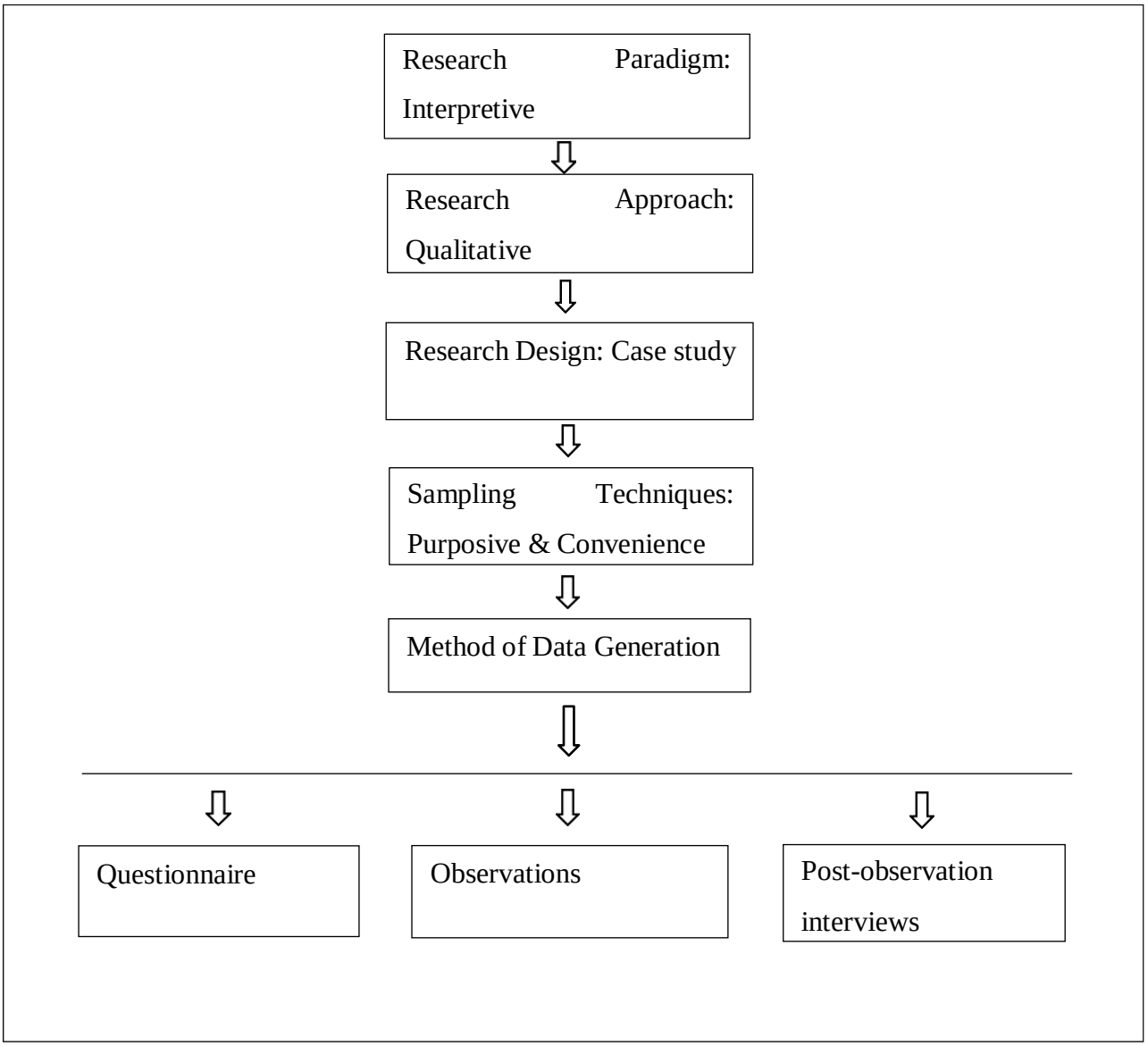


Figure 4.1: The Methodological Structure of the Study

4.3 Paradigm: Interpretive

A paradigm is defined as the lens through which we view the world. According to Creswell (2017), "*paradigms are patterns of beliefs and practices that guide the way we do things or more formally establish a set of practices*" (p. 57). The interpretive research paradigm is concerned with comprehending the world through the subjective experiences of humans (Cohen et al., 2018). This study adopted the interpretive paradigm because the researcher wants to understand the integration of indigenous knowledge in the teaching of structures in grade 4 from the perspective of grade 4

NS-Tech teachers. Furthermore, the interpretive paradigm seeks to improve our knowledge of how people make meaning of the contexts in which they live, work, and learn.

The interpretive paradigm is similarly concerned with human activities that are said to have meanings that can be determined by a researcher (Denzin & Lincoln, 2018). Dewi (2021) and Maree (2013) suggested that an interpretive researcher works on the premise that entry into reality occurs only through social creations such as language, sensitivity, and shared meanings; therefore, interpretive learning attempts to understand phenomena through the perceptions that individuals designate to them. With the previous in consideration, it is further explained that the interpretive paradigm's main point is in the concept that people's lives can only be understood from within, and hence the interpretive paradigm focuses on people's experiences and their perspectives (Dewi, 2021; Maree, 2013).

As such, by using the interpretative paradigm, the researcher gained a significant amount of perception of people's experiences, which is the initial step of qualitative research. Consequently, the researcher was able to effectively perceive and interpret the insights, views, and/or rationales of participants from within and outside of the social environment (Denzin & Lincoln, 2018). The interpretive paradigm holds significance for the study because indigenous knowledge is constructed socially (Pham, 2018).

4.4 Research approach: Qualitative

Guided by the interpretive paradigm, this study adopted a qualitative approach. Widely acknowledged and valuable, this research approach contributes to the development of a knowledge of the social world in which we live and answers questions such as 'why things happen the way they do' (Hays et al., 2016). This suggested that qualitative researchers are more concerned with developing explanations for social occurrences. Qualitative researchers are frequently invested in making sense of what they observe and hear in a given environment. Additionally, Hays et al. (2016) claimed that their major goal is always to explicate rather than outline, so they respond more to the interpretive approach in building understanding (Kalu & Bwalya, 2017). Also, qualitative research is humanistic, based on two perspectives: the first, that it is based on personal, subjective, and experiential meaning, and the second, that it seeks to attach meanings that relate to particular behaviours and how things are done in each context (Holloway & Galvin, 2016; Kalu & Bwalya, 2017).

This decision was motivated by the interpretive paradigm's ontological perspective, which includes the concept of constructing various social realities (Creswell, 2013). Qualitative research is defined as research that attempts to collect rich descriptive data about a specific real-life phenomenon—in this case, how NS-Tech teachers integrate IK in the teaching of structures—or context in order to develop an understanding of what is being observed or studied (Yin, 2014).

In a qualitative study, a researcher must ensure that he/she visits the participants, the location, the field, and the institutions to acquire a true depiction of the behavioural patterns in their natural context (Mohajan, 2018). This enables the researcher to become the primary instrument for data collection and analysis. That is, the researcher can identify factors which influence the participants' experiences. Moreover, Mohajan (2018) stated that the findings in a qualitative study are regularly provided in the following formats: themes, categories, concepts, or tentative hypotheses or theories.

4.4.1 Advantages of qualitative research

There are benefits associated with the usage of qualitative design in the realm of research. Because qualitative data is frequently concerned with human experiences and observations, it is more authentic and reliable. This suggested that the closer the researcher is to the field and the more involved he/she is, the greater the possibility of gaining an understanding viewpoint on it. As a result, using positivistic investigations allows the researcher to find concerns that are not scientifically located (Mohajan, 2018). Further, qualitative research design allows for the use of numerous data collection instruments, one or more data analysis methodologies, and disparate theoretical frameworks that are organised in accordance with the qualitative research study (Gopaldas, 2016). Qualitative approaches allow the researcher to be as reflexive as possible, actively listening to participants and engaging in dialogue in accordance with their personalities and styles (Mohajan, 2018).

4.4.2 Disadvantages of qualitative research

There are two major opponents of this type of research. The findings of qualitative studies cannot be generalised to a larger population because (1) the sample group in a qualitative study is comparatively small because it requires a limited number of respondents, and (2) participants are frequently not chosen at random (Mohajan, 2018). Also, Mohajan (2018) suggested that qualitative research is criticised based on data analysis. Since qualitative research frequently gives non-

numerical data, which happens to be texts, good analysis of textual data requires much time and is costly since it does not only comprise the method of transcribing, categorising, and interpreting data. This implies that there should be enough time for collecting data, analysing it and interpreting it. Given that qualitative researchers are more concerned with meanings and experiences; they tend to ignore contextual sensitivity. The engagement of a researcher in collecting data might also influence participant replies.

4.5 Research design

The research design is the plan for how the researcher will collect and analyse data to provide valid solutions to research questions. As a result, this study used a case study design. According to Yin (2014), case study research is an empirical method of inquiry that analyses a current phenomenon inside its real-life setting using a range of data collection methods. Furthermore, the case study method aims to answer the essential questions of 'what,' 'how,' and 'why' of the phenomenon being examined and provides a detailed interpretation of the phenomenon by focusing on individual examples (Sauro, 2015). Drawing on the preceding, Cohen et al. (2018) argued that a case study enables the provision of detailed descriptions of participants' lived and daily experiences, thoughts about various conditions, and feelings about a condition using a wide range of data sources or lenses.

4.5.1 Case study

Creswell (2013) suggested that the qualitative case study research approach focuses on exploring a phenomenon in order to appreciate it fully. A qualitative case study research approach provides a different example of real individuals in real settings, as well as expounds on causes and effects, and deep understanding is essential for justice to be served in a situation (Cohen et al., 2018, p. 54). As conditions vary and change, case studies record the real-life, complex, dynamic, and evolving interactions of occurrences, human relationships, and other concerns in a specific instance (Cohen et al., 2018). A case study entails a more in-depth investigation from numerous perspectives of thecomplexity and difference of a given circumstance, institution, or genuine life-life context (Cohen et al., 2018).

Therefore, a case study is an in-depth exploration of a single case, which could be a person or a group of people, as, in this example, Grade 4-NS-Tech teachers are the case. Furthermore, Bertram and Christiansen (2014) contended that case studies attempt to determine what it is like to be in a

specific situation. The research design used in this study provides an in-depth understanding of the reality of indigenous knowledge integration in Natural Sciences and Technology Education in grade 4, as well as the potential obstacles associated with integrating indigenous knowledge (Creswell, 2013).

In addition, the case can arise to be specific aspects of an individual's or a group of people's social existence or a phenomenon that can frequently take the shape of words (Lapan et al., 2012). Therefore, it can be claimed that a case study is an effective approach that a researcher can use when attempting to comprehend peculiar occurrences involving a person or persons in a given location or situation. As a result of the preceding, it is clear that conditions are an important factor in case study research methodology because it enables the researcher the opportunity to engage with the participants of the study in their surroundings, resulting in greater understanding and explication of the case being investigated.

Cohen et al. (2013) suggested that the case study strategy is explicitly acceptable when the person conducting the study, the researcher, has limited influence in terms of occurrences, such as when people's behaviours cannot be controlled or influenced. This emphasises the idea that the effect of a case study approach is focused on obtaining abundant and direct descriptions of occurrences that are applicable to the case being studied, in this case, the grade 4 Natural Sciences-Technology teachers, in an attempt to seek deeper insight and an understanding of the perspectives of events, and consequently, the researcher is thoroughly drawn in the case as the study may be related to the researcher.

A researcher can select and use a variety of case study methodologies (Creswell, 2013; Cohen et al., 2013, p. 291). The scope of the bounded case distinguishes these approaches to case studies, that is, whether the case study consists of one person, a group of people, a procedure, an institution, or a task. Furthermore, Creswell (2013) stated that the intent of the study and motive distinguishes these categories. Keeping this in mind, Lapan et al. (2012) and Creswell (2013) identified the following types of case studies.

4.5.1.1 Intrinsic case study

According to Lapan et al. (2012), an intrinsic case study focuses on the case being researched, replying to queries about the entity or object in order to emit the explained activities to the participants and stakeholders. The goal is not to comprehend some abstract generic phenomenon

but instead to try to have a complete comprehension of the situation under consideration. In simple terms, an intrinsic case study seeks to improve understanding of a specific instance. Cohen et al. (2013) claimed that this form of case study is one that a researcher employs to gain knowledge of a specific issue at hand.

4.5.1.2 Instrumental case study

This form of case study examines a single example in order to develop new theories to compare findings to new ones for confirmation or to call their reasonableness into question (Lapan et al., 2012).

4.5.1.3 Collective case study

According to Creswell (2013), this type examines a succession of case studies together in order to establish a case. This strategy is supposed to provide insight into the case being investigated.

In another classification of case study methodologies, Cohen et al. (2011) mentioned three types of case studies based on their results (p. 291). Case studies of this type include:

4.5.1.4 Exploratory case study

This type of case study is useful for displaying facts in order to get fresh insights and shed light on a person's understanding of a process or issue. This type also serves as a trial for other studies. This signifies that the case study provides new and comprehensive data or understanding of a topic or phenomenon through the research findings, which can serve as a foundation for future research.

4.5.1.5 Descriptive case study

This type of case study focuses on providing narrative accounts of a specific case or phenomenon.

4.5.1.6 Explanatory case study

This type of case study method is concerned with hypothesis testing.

This study employed an exploratory case study research approach. This is because the exploratory case study method is based on the purpose of the study, which is to explore the integration of IK in the teaching of structures in the grade 4 NS-Tech classroom. This also implies that the study looks to shed light on other NS-Tech teachers in their integration of IK in the teaching of structures. This is because it is a major concern because the literature revealed that the integration of IK is an issue; however, it ought to be integrated. Moreover, this type of case study rigorously corresponds

with the data collection methods used for this research study, which includes ten questionnaires for the five teachers, ten lesson observations, and five post-observation interviews with the grade 4 NS-Tech teachers.

4.6 Location of the study

The study was conducted in the Kwa-Zulu-Natal province in the city of Durban. The research was conducted in five schools in the Pinetown District, with two in Kwa-Mashu township and three in Ntuzuma township, where many indigenous communities reside. All the schools are public schools, and as such, they rely on the government for financial support to run effectively. Moreover, all these schools embrace a number of rich and disadvantaged learners each year to develop them to become the people they want to be in the future. During lunch, learners are given food if they do not have any. Teachers from various locations work at the schools to improve the lives of the learners.

4.7 Gaining access and ethical consideration

As Mertens (2015) pointed out, it is essential to gain access to participants and develop a productive relationship with them. As someone who grew up in the Kwa-Mashu and Ntuzuma communities, I was familiar with some of the schools and had undergone teaching practice as a pre-service teacher during my undergraduate studies, which made things a lot easier and more comfortable for the participants—the teachers. This simplified access to lesson observations and post-observation interviews.

Gaining access is a critical and difficult stage that researchers face while attempting to do a study in a specific area. As a result, formal permission to conduct research was received from the research office at the University of KwaZulu-Natal (see Appendix A). Furthermore, permission was obtained from the KwaZulu-Natal Department of Education to conduct research at the five schools (see Appendix B), as well as consent forms from the principals, teachers, learners, and parents (see Appendix C).

It is to be noted that only four teachers ended up participating in the rest of the study. The following are the reasons why one teacher did not participate: Due to the teacher's hectic schedule, the teacher did not appear to want to participate in the study any longer. For a longer period, the teacher did not respond to communications. The teacher would answer late and agree on a date to visit the school but subsequently encountered problems and had to cancel.

In addition, the participants were informed that they were participating in the study voluntarily and thus have the right to withdraw at any time, that there is no financial gain for participating in the study, and that their identities are strictly classified using pseudonyms (see Appendix C). Also, the participants were asked to permit the lesson observations and interviews to be recorded and were reassured that the recordings and transcripts would only be accessible to the researcher and the supervisor (see Appendix G). The recordings and transcripts were also kept safe in a password-protected folder on the researcher's computer and would be deleted after five years.

4.8 Data generation plan

According to Bryman (2016), data generation and data collection are often used interchangeably, but Goldkuhl (2019) argued that the term 'collection' is somewhat problematic due to the idea of the term meaning that the data is out there and ready for collection, particularly, second-hand data. According to Bless et al. (2013), not all data collection instruments are suited for both qualitative and quantitative research studies, but Bryman (2016) mentioned that both qualitative and quantitative research studies share similar concerns whilst differing in other aspects. Because most qualitative studies generate textual data, the appropriate instruments to collect data from participants in their natural context include interviews, questionnaires, observations, focus groups, and visual analysis, such as from movies or books (Kalu & Bwalya, 2017). Goldkuhl (2019) argued that for data collection for qualitative research, scholars often base their attempts on specific research intentions.

Data collection is a series of interconnected activities that a researcher engages in to gather relevant and significant information useful to answer research questions about the phenomenon under study (Creswell, 2016). This study is structured in accordance with the interpretive paradigm and hence employed qualitative data collection methodologies. Patton (2015) postulated that "*open-ended questions and probes yield in-depth responses about people's experiences, perceptions, feelings, and knowledge"* (p. 14). The qualitative instruments used in this study, questionnaires, lesson observations, and post-observation interviews, allowed teachers to openly express their thoughts on the integration of IK in the NS-Tech curriculum on the teaching of structures.

In addition, the study audio-recorded the teachers with their agreement in order to collect comprehensive data on indigenous knowledge. This was consistent with Patton (2015), who stated that the interpretive paradigm employs detailed representations in the investigation of a given

occurrence. Further, audio recordings of the lesson observations and post-observation interviews were made to ensure that the participants' voices were captured. Audio recording allows researchers to follow up on what they have researched (Merriam & Tisdell, 2015). Therefore, indigenous knowledge and what could be integrated was collected in this study through questionnaires, lesson observations, and post-observation interviews with teachers from five schools in the Pinetown District of the province of KwaZulu-Natal.

The data generation strategy is outlined in Table 4.1. Data generation for this study was divided into two stages. As reflected in Table 4.1. The first stage of the study responded to Research Question One:

1. *What are grade 4 Natural Sciences and Technology teachers' understanding of integrating Indigenous Knowledge in the teaching of structures?*

The data collection method utilised to respond to the first research question was an open-ended semi-structured questionnaire (see Appendix F). The data gathered was analysed.

Table 4.1: Data generation method

Research question(s)	Stage(s)	Data source(s)	Instrument(s)
What are grade 4 Natural Sciences and Technology teachers' understanding of integrating Indigenous Knowledge in the teaching of structures?	1	Grade 4 NS-Tech teachers	Questionnaire
Do grade 4 NS-Tech teachers integrate IKS in the teaching of structures? If so, how? And if not, why?	2	Grade 4 NS-Tech teachers	Lesson observations Interviews

The second stage of the study responded to Research Question Two:

2. *Do grade 4 NS-Tech teachers integrate IK in the teaching of structures? If so, how? And if not, why?*

The data was collected via lesson observations and semi-structured post-observation interviews (see Appendix G and H), and the data was analysed.

The instruments used during data generation are discussed in the section below.

4.8.1 Questionnaire: Semi-structured questionnaire

A questionnaire is a data collection instrument that consists of either closed-ended or open-ended questions in which interviewees complete written responses on the phenomenon under investigation (Cohen et al., 2018). According to McGuirk and O'Niell (2016), qualitative research seeks to understand how different people experience events, places, and processes as part of a fluid reality constructed through multiple interpretations. Thus, questionnaires become a useful instrument for gathering original data about people's behaviour, attitudes, attributes, experiences, social interactions, opinions, and even consciousness. This study sought to explore grade 4 NS-Tech teachers' integration of IK into the teaching of structures. Questionnaires have proven to be one of the most successful data collection instruments.

First, the rationale for employing a questionnaire is founded on the understanding that questionnaires provide respondents with the privacy and time they require to consider and formulate responses to sensitive problems. Second, the administering of the instrument is both time- and cost-effective. It decreases both the physical distance and the burden of travelling to multiple research sites. Open-ended and closed-ended questions can be included in questionnaires. Closed-ended questions force respondents to select answers from a list of alternatives, whereas open-ended questions allow respondents to respond and express their opinions in their own words or provide free-form comments (McGuirk & O'Niell, 2016).

A semi-structured questionnaire (Appendix D) with open-ended questions was used to collect data on the integration of indigenous knowledge in the teaching of structures in the grade 4 NS-Tech classroom. The questionnaire was designed to collect data about the teachers' general teaching experience and experience in teaching grade 4 NS-Tech. With the assistance of university researchers, the open-ended questionnaire was developed and piloted with Pinetown district Grade 4 NS-Tech teachers. The questionnaire was piloted to ensure that the items were clear and that no ambiguities or difficult language existed. The findings of the piloting revealed that the questionnaire items had good construct validity. According to Cohen et al. (2018, p. 54), pilot research improves the questionnaire's reliability, validity, and practicability.

The use of an open-ended questionnaire to collect data for this study was deemed appropriate given that open-ended questions reflect the peculiarity of a particular circumstance, which in this study is how grade 4 NS-Tech teachers integrate IK in the teaching of structures (Cohen et al., 2018). Open-ended questionnaires allow participants to express themselves freely in all of their responses, which record all of their experiences. It is essential for a researcher using the interpretive research paradigm to ask open-ended questions in order to get comprehensive data from participants. The questions will contain biographical information, perspectives on IK, the importance of IK in scaffolding learning and enhancing teaching, and perspectives on the integration of IK in the NS-Tech curriculum. The semi-structured questionnaires used for the study consisted of ten questions, including the type of qualification the teachers hold, their understanding of what integration is in the NS-Tech subject, and whether the term IK means anything to them, to name a few (see Appendix D). The questionnaires for the study were distributed to teachers in mid-February, with a week to complete them whenever they were able to. However, because the teachers were so busy, it took them two weeks to complete the questionnaires.

4.8.2 Lesson observations: Structured observation schedule

Being present in a situation and recording impressions of what happens, followed by interpreting the meaning of the observed behaviour, is what observations entail (Bertram & Christiansen, 2014). Observations take place in real-world contexts where programs can change and be redirected. Fieldwork observations put researchers in direct contact with the environment and the people they are studying (Bertram & Christiansen, 2014). Bertram and Christiansen (2014) further argued that direct observation provides researchers with first-hand data, allowing them to create precise descriptions of the setting, activities, interactions, and participants' experiences (Bertram & Christiansen, 2014). Observation offers a type of first-hand data (Yin, 2014), given that researchers collect data using their senses rather than depending on what has previously been recorded by someone else.

Similarly, Cohen et al. (2018) stated that observation allows a researcher to collect 'live' data from naturally occurring social situations, specifically by looking directly at what is happening rather than depending on second-hand descriptions. Yin (2014) contended that there are two types of observations: 1) a direct observation, which does not include any intervention by the researcher in the field and 2) participant observation, wherein the researcher engages in the field. The advantage

of observation as a data collection method is that it makes it possible for a researcher to collect data from organically occurring interactions with others in the present moment. Rather than relying on second-hand data, the researcher can see what is going on (Cohen et al., 2018).

A university researcher assisted in the development of an observation schedule. Its purpose was to make data collection easier when watching structured observations in the grade 4 NS-Tech classroom. The goal of the lesson observations was to acquire insight into the teacher's practice of integrating IK into the teaching of structures in the grade 4 NS-Tech classroom. The researcher was able to collect data on the physical, human, interactional, and program settings attributable to the semi-structured observation schedule. The physical environment and its organisation were included in the physical setting. The lesson observations were carried out in early April of 2023, just as the second term of the school year began. This was in accordance with the arrangement that was reached with the five teachers and principals. The lesson observation schedule (Appendix E) included lesson stages, namely the introduction, development, and conclusion stages. The activities of the teachers and students, as well as the teaching materials used during the session, were recorded. In addition, with permission from the teachers, the lesson observations were audio recorded - a total of eight observations, two per school for each teacher. The lessons observed ranged from 35 to 55 minutes for each school. The observations were held when the teachers agreed on a set date for the researcher to come. However, not all observations were held in accordance with the set date. This was due to the structure of the schools' timetables fluctuating; each day was unique, and there was no set grade 4 NS-Tech period (Appendix G).

4.8.3 Interviews: Post-observation interviews

The researcher used post-observation interviews as a data collection instrument. The interviews were designed to elicit more data pertaining to what had been observed during the lesson observations in the grade 4 NS-Tech classroom. Post-observation interviews allow for more flexibility in probing for greater depth than observation notes. Furthermore, the researcher conducted interviews at each of the four schools for the convenience of the teachers. Individual semi-structured interviews, according to Barrett and Twycross (2018), are essential since they allow the interviewer to explore participant replies to the questionnaire and observations. I employed post-observation interviews as a direct engagement with the participants for this study to build an in-depth understanding of their perspectives, experiences, and feelings that shape their

daily experiences of teaching in the NS-Tech classroom. With the participants' permission, these post-observation interviews were audio-recorded for transcription and analysis (see Appendix I).

The post-observation interviews were conducted following the lesson observations, which occurred from late April to early July due to the constraints of the teachers' schedules. Four post-observation interviews were conducted, with each participant being asked a total of nine questions (see Appendix F). The post-observation interviews lasted between 5 to 10 minutes each, and they were conducted during the teachers' free time. These were individual interviews performed by the researcher in each of the four schools. The post-observation interviews were also audio-recorded with the participant's consent.

4.9 Sample and sampling: Purposive and convenience

Cohen et al. (2018) defined sampling as a process of making decisions regarding the population, surroundings, events, or deeds that will be observed. Marshall and Rossman (2014) asserted that sampling is pivotal in that the researcher studies a phenomenon in its natural setting, and it helps to identify a person's or group's rich in data and thus can be investigated in greater depth. Gentles et al. (2015) contended that sampling is concerned with the selection of certain data sources from which data would be collected to respond to the research objectives. It should be highlighted that the step of selecting a study sample is critical in any research endeavour because studying the entire population is rarely possible, efficient, or ethical (Etikan et al., 2016). Gentles et al. (2015) agreed that it is impossible to explore the entire population in research because a group of individuals with unique characteristics should be picked to represent the entire community. Therefore, only a sample should be chosen to represent the entire population (Kalu & Bwalya, 2017).

The research design guided the selection of participants for the study. The study employed both purposive and convenience sampling. The case study design guidelines required that participants be chosen on purpose. Purposive sampling, according to Kumar (2011), is defined as a method in which participants are chosen precisely and systematically because they are most likely to have access to the data relevant to the research. Purposive sampling, according to Crossman (2018), is the most well-known and widely used sampling approach in qualitative research because participants are chosen based on preselected criteria that are relevant to the research questions and the focal point of the study. Purposive sampling also refers to judging, selective, or subjective

sampling (Crossman, 2018). Crossman (2018) also stated that this sampling strategy is most appropriate when the researcher has to reach out to potential participants as soon as possible. This method of sampling is entirely dependent on the researcher's discretion in picking the area of the study to be explored. Similarly, Saunders et al. (2012) stated that in purposive sampling, personal judgment must be used to select cases that help answer research questions or achieve research objectives.

The criteria for selecting participants in this study were NS-Tech grade 4 teachers due to the subject starting from the fourth grade, specifically combined from the fourth grade. Five teachers from five different schools were purposefully chosen to participate in this study. Each of these schools has one Natural Sciences and Technology teacher in the respective grade; thus, five teachers were chosen for this study. The geographical background of the specific schools in the Kwa-Mashu and Ntuzuma area was chosen for practical reasons: these schools are near to whereI live. This therefore enables an ease in collecting data.

4.10 Data analysis

A qualitative approach to data collection was followed in this study, wherein the data was analysed qualitatively. Data analysis is the process of adding structure, order and meaning to the massive amounts of data that have been collected (Cho & Lee, 2014; Connelly & Peltzer, 2016). Additionally, data analysis refers to the act of making sense of what the researcher has generated and evaluated. Sorting and filtering through these resources to uncover comparable phrases, links between variables, structures, themes, distinctions between sub-groups, common sequences, etc. (Lester et al., 2020). This study employed an inductive approach to analysing data, which works with the raw data generated. The data was analysed by using a thematic approach.

Furthermore, the approach is defined as the process or method of classifying, reporting, and investigating themes within data that elucidate various aspects of the research issue (Lester et al., 2020). Further, this type of data analysis allows the researcher to identify patterns of experiences based on participant responses to address the research questions. I will highlight evidence that relates to previously identified themes. As a result, the linked patterns were combined and organised into sub-themes.

Also, the conceptual framework, which comprises the following constructs: collateral learning, cultural border crossing, and teachers as cultural brokers of knowledge, were taken into

consideration when analysing the data. Collateral learning looks into the idea of conflicting beliefs that learners have in their minds and creates a resolution (Jegede, 1997; 1999); cultural border crossing happens when a person moves from one culture to the next, familiar to unfamiliar culture (Aikenhead, 1996; 1997) and teachers as cultural brokers of knowledge happens when they facilitate the movement from one culture to the next (Michie, 2003). Therefore, the constructs mentioned above were carefully considered when identifying the themes during coding. This is because the teachers play a pivotal part in ensuring that the learners transition effectively from one culture to the next in the classroom, as classes are often constructed of different learners.

The recorded data from the structured lesson observations and semi-structured post-observation interviews were first fully transcribed. After that, the data was transcribed, and the audio recordings were thoroughly listened to in order to gain deeper knowledge and understanding of the data (Matheson, 2007). This process began while transcribing the structured lesson observations and semi-structured post-observation interview responses. Thus, the transcripts were read and re-read to understand them better. In doing that, the literature that was reviewed was also taken into thorough consideration because it underpinned what was emerging from the data. The data was familiarised through the lens of the conceptual framework that supports the study.

The data was analysed using the NVivo-Lumivero software program to identify developing themes and sub-themes (Maguire & Delahunt, 2017). This is a computer program for a qualitative study that deals with textual and multimedia data for any amount of data. This enables researchers to store data and both collected data and literature; as a result, the application enables researchers to categorise and classify data based on common patterns that develop.

In accordance with Creswell (2008), a thematic data analysis in a qualitative research study includes six interconnected stages: (i) prepare and organise the data for analysis, (ii) explore and code the data, (iii) code to build a description of and themes (iv) represent and report qualitative findings (v) interpret the findings, and finally (vi) validate the accuracy of the findings.

The first step was collecting data from the field, organising it, and preparing it for analysis using the NVivo-Lumivero software program. At this point, the material had been transcribed in the precise language used by the participants and was ready to be explored. This step entails a thorough reading of the data, including an exploration of each interview transcript. This was done to look for common concepts or ideas held by participants that are applicable to the research questions.

Likewise, where irrelevant information was observed, data reduction occurred, the type of material that does not respond to the research questions but, in certain cases, plays a role in the original ideas. The common themes were coded imperatively using the NVivo-Lumivero software program.

The coded themes were analysed in greater depth while creating descriptions of those themes that answered the research questions. As a result, the themes coded together were linked with the ideas they expressed to build essential themes that symbolise them. Therefore, this step supplied the primary ideas that directly addressed the research questions.

The primary themes offered by coded themes were then symbolised with meanings and outlined as findings of the study.

Prior to the last step, the findings of the study were explained and linked with the objectives of the study. The process of explication of the findings consisted of a thorough review of the initial data to ensure that what was expressed coincided with what had been explained. Moreover, the relationship between the findings and past studies was closely studied during that process to corroborate the inferences.

The final step was to validate the findings and their inferences. This occurred because of the member-checking process. As the respondents strived to be always open and honest, the effective relationship that I had established during the data collection period aided substantially in the process. As a result, the precision validation was uncomplicated.

The NVivo-Lumivero software program is an online program that students, individuals, or groups can use by purchasing a license. The license allows learners to use the program for 12 months with unrestricted access. Anyone can access the program by visiting https://lumivero.com/products/nvivo/.

4.11 Trustworthiness of the study

According to Connelly (2016), the concept of trustworthiness is well-established in research, and different authors have assigned different interpretations. This refers to the level of confidence in the data, interpretation, and methods used to ensure the quality of the study. Cope (2014) pointed out that the utility and honesty of the findings are highly dependent on the trustworthiness or truth of the qualitative research and the transparency of the study's conduct. This comprises four

concepts identified by qualitative researchers and defined by Lincoln and Guba (1985). The four concepts are as follows:

4.11.1 Dependability

To address the issue of dependability more directly, "the processes within the study should be reported in detail, thereby enabling a future researcher to repeat the work, if not necessarily to obtain the same results" (Shenton, 2004, p. 71). Similarly, Polit and Beck (2014) contended that dependability refers to the consistency of the data over time and across the context of the study. In general, dependability assesses the researcher's ability to produce work that can be supported. As a result, the researcher should hold himself entirely accountable to the supervisor and the concept that he has described. Hence, to make this possible, the researcher preserved written records of the research expedition.

The consistency of the findings is defined as dependability (Korstjens & Moser, 2018). Further, dependability needs participants' evaluation of the study's findings, explanations, and suggestions, as these are justified by the data collected from the participants of the study. Additionally, Nieuwenhuis (2016) contended that there is dependability for individuals to see that decisions were made, why they were made, and how explanations were produced.

4.11.2 Credibility

Credibility is one of the most important aspects of research and must be followed for the research to be honest. According to Korstjens and Moser (2018), credibility refers to reliance, which can be seen in the truthfulness of the research findings. Moreover, it determines whether the research findings are plausible information derived from the participants' authentic data and provides an accurate explanation of the participants' authentic opinions. The researcher is expected to devise several ways to ensure that the data provided is reliable. The researcher's aims for this study are to record the interviews with the participants and provide transcripts to the participants to ensure that what they said during the interviews was accurately recorded.

Also, Cohen et al. (2011) asserted that, to secure the study's credibility, the researcher must ensure that the findings accurately define the case under investigation. Consequently, to ensure the reliability of the findings in this study, the researcher ensured that all the lesson observations and post-observation interviews were audio-recorded, saved, and preserved on a personal computer as well as in the NVivo-Lumivero software program. The audio data was transcribed verbatim and

shared with the participants to effectively analyse its accuracy, specifically justifying if what the participants stated corresponded to the transcriptions to ensure consistency of findings.

This is known as member-checking in qualitative research (Birt et al., 2016). Moreover, three data collection procedures were used to increase the degree of credibility: semi-structured questionnaires, structured lesson observations, and post-observation interviews. Bertram and Christiansen (2014) stated that this approach is known as triangulation, and it is used to determine the information gathered from the methodologies.

4.11.3 Transferability

Transferability is defined as the extent to which the findings of qualitative research may be used in different contexts or settings with different respondents (Korstjens & Moser, 2018). In simple terms, transferability is believed to mean that findings in current research will be the same as findings in previous research under the same conditions (Streubert & Carpenter, 2014), and so the research findings will be transferable for future use. According to Lietz and Zayas (2010), the term "transferability" is another name for "fittingness", which is also known as "validity" in quantitative research studies.

The researcher has provided a study that is inclusive of a thorough literature review, conceptual framework, and a logical methodological process. Also, the data was analysed, presented, and discussed, and recommendations were made in response to the research questions.

Also, Connelly (2016) noted that transferability is concerned with the extent to which the findings of the study may be extended to different settings. Therefore, the researcher had no control over the transferability of the study, but the reader was the one who decided. Similarly, the essence of transferability, the extent to which the findings are beneficial to people in various contexts, differs from other parts of research in which the readers determine how relevant the findings are to their circumstances (Connelly, 2016). Also, I supplied a circumstantial and detailed description of the research setting and findings to ensure that whoever would like to transfer the results of this study to a different context can do so in a reasonable manner.

4.11.4 Confirmability

Korstjens and Moser (2018) and Shenton (2004) suggested that the fundamental concern of confirmability is the study's level of neutrality, and knowledge should not be based on your unique

preferences and opinions but must be grounded in data. The researcher in a study must ensure that they present the truth about the participants rather than displaying their injustice and favouritism (Cope, 2014). As such, this can only be applied in stages based on how the findings and interpretations were discovered. Confirmability is also argued to refer to how much others approve of the research findings, which the review methods by the participants, supervisors, and colleagues, the researcher's validity, the outline of the conflicting phenomenon, and actual explication regarding the details are used to improve (Lietz & Zayas, 2010).

In addition, confirmability is defined as the extent to which the conclusions of the research study could be confirmed by other researchers (Korstjens & Moser, 2018). Further, confirmability is focused on determining that the data and explanations for the findings are derived from the data rather than the researcher's imagination. Audio recordings of the interviews were used to make certain that the collected data was not riddled with personal bias. Also, the researcher was as reflexive as possible to ensure that preconceived notions would not have an emotional or physical bearing on the study or interfere with the viewpoints of the participants (Thomas & Magilvy, 2014).

4.14 Summary of the chapter

This chapter explained the research design and methodology that was used to conduct this study. First, the chapter discussed the paradigm that was used, as well as the type of research and the justification for using these methodologies. In addition, the research design, sampling strategies, data generation methods, and analysis were thoroughly explored and presented. Furthermore, this chapter discussed ethical issues and how to overcome them. The next chapter presents data and analysis of the findings.

CHAPTER 5: PRESENTATION OF THE ANALYSIS OF RESEARCH QUESTION ONE

5.1 Introduction

The previous chapter discussed the research design and methods. This chapter presents the analysis and presentation of findings of Research Question One: "*What are grade 4 Natural Sciences and Technology teachers' understanding of the integration of Indigenous Knowledge in the teaching of structures?*" Also, this chapter presents empirical findings and their interpretations from the data analysis performed. The qualitative data obtained through open-ended questionnaires was used to answer this research question. This is consistent with the research methodology structure, which was described and explained in Chapter 4.

Pseudonyms were used to protect the names of the participants at schools A (Teacher A), B (Teacher B), C (Teacher C), and D (Teacher D). During the data presentation in this study, verbatim quotations were used. The primary motivation of the study was to explore grade 4 NS-Tech teachers' integration of indigenous knowledge in the classroom for schools in the Pinetown district of KwaZulu-Natal. The following research questions were developed to achieve this goal:

1. What are grade 4 Natural Sciences and Technology teachers' understanding of the integration of Indigenous Knowledge in the teaching of structures?
2. Do grade 4 NS-Tech teachers integrate IK in the teaching of structures? If so, how? And if not, why?

5.2 Analysis and presentation of data for Research Question One

In this section, it first presents the biographical data of the participants, followed by an analysis of data from the questionnaire and interview in response to research question one. The biographical data provides insight into terms of gender, professional qualifications, general teaching experience, experience of teaching technology, and professional development workshops attended on IKS organised by the Department of education. Four teachers participated in the study, and pseudonyms were used to protect and ensure the confidentiality of the participants (Table 5.1).

Table 5.1: Participants biographical data

Pseudonym	Gender	Professional qualification	Total teaching experience (years)	Experience in teaching NS-Tech (years)	Professional development on IKS
A	Female	B. Ed Honors (English/IsiZulu)	2	2	None
B	Female	B. Ed (English)	6	2	None
C	Female	B. Ed (Physical science)	14	12	None
D	Female	PGCE (IsiZulu/Creative arts)	14	6	None

Key: B. Ed = Bachelor of Education, PGCE = Post-Graduate Certificate in Education

What is noticeable in Table 5.1 is that the participants were females. This trend of more females teaching at primary schools across many countries has been noted by Carroll et al. (2021). These scholars affirmed that the high number of females teaching in primary school is linked to the position of women in society as nurturers, preservers of culture and cultural beliefs and role models to female learners, particularly in science and math classes. It was also noted that of the four teachers, only one has a specialisation in NS-Tech. Teacher A has other specialisations, such as English and isiZulu. Teacher B has English, Teacher C has Physical Science, whilst Teacher D has isiZulu and Creative Arts. This means that these teachers are teaching out of the field, specifically teaching subjects which the teachers did not major in. It is important to note that none of these teachers have attended any professional development workshop on IKS. However, the NS-Tech curriculum emphasises the need to value indigenous knowledge systems and for it to be integrated into teaching as outlined in specific aim 3 of the NS-Tech CAPS curriculum.

Two themes emerged from the analysis of the data in response to research question one, namely, the meaning of IK and understanding of the integration of IK into the teaching of NS-Tech/Structures. Each theme is presented next.

5.2.1 Meaning of indigenous knowledge

The grade 4 teachers of NS-Tech attached four meanings to IK, as depicted in Table 5.2. The meanings attached to IK, namely, IK as informal knowledge, IK as intergenerational, IK as lost knowledge, and IK as knowledge of past traditions and practice, are presented next.

Table 5.2: Meanings of IK

Meaning of IK	Participants
IK as informal knowledge	A, B, C and D
IK as intergenerational learning	B and D
IK as lost knowledge	C and A
IK as knowledge of past traditions and Practices	A, C and D

5.2.1.1 IK as informal knowledge

All four teachers considered IK as informal knowledge, as is visible in the excerpts below:

> "This is the knowledge you get outside the classroom. There is no curriculum" (Teacher D).

> "There are stories shared by elders about life, nature, farming, building in the evenings. Many of the elders cannot read or write; it is not formal, and there are no tests and exams" (Teacher C).

The excerpts above bring to the fore the "informalness" and lack of structure associated with IK. The "informalness" of IK is linked to where this exchange of knowledge has occurred, i.e. outside the classroom and who is responsible for the knowledge exchange. The subdued message in the above testimonies is that because IK is constructed outside school, it is construed as less important, raising questions about its epistemological validity. The elders, who are the custodians of this

knowledge, have not been schooled formally and cannot read or write, which again raises questions about whose or which knowledge is valued. IK is the body of knowledge held by people who are not regarded as developed as far as modern science and civilisation is concerned (Mposhi et al., 2013). These teachers emphasised the lack of any examination or formal tests regarding IK. The lack of any formal assessment renders IK as having little relevance or importance. The findings that indigenous knowledge is informal resonates with that of Sotero et al. (2020). These scholars noted the pedagogical approach used to impart IK to the younger generation and saw it as leverage to get learners to talk about IK in class.

5.2.1.2 IK as intergenerational learning

In indigenous communities, culture, tradition, and ancestral practices, religion plays a pivotal role in ensuring that the young generation has knowledge and understanding and the values and norms of these practices around them. This knowledge is transmitted by grandparents, parents or any elder in the community. The testimonies below show that teachers link culture, tradition and ancestral practices to IK.

> "It is where culture, norms, values and tradition of ancestral practice religion is emphasised to the youth so that the younger generation can know what was happening a long time ago" (Teacher B).

> "You get this information about rituals, remedies from grandparents, old people in the community. This is a way to remind the younger generation what needs to be done" (teacher D).

> "It can be recognised by making them play indigenous games such as (*magalobha*) and (*amatshe*) and in their creative art, there should be African instruments they make" (Teacher B).

What comes to the fore in the above excerpts is the intertwined relation between culture, tradition, norms, values, ancestral practice, and IK. The role of culture, tradition, and religion is crucial to the development of learners' understanding of a phenomenon or process. This is due to the idea that culture, tradition, and rituals are important contributors to a person's growth and a sense of belonging in a particular locale. Moreover, IK is associated with culture, tradition, and religion, which relates to the assertion brought forth by Onwu and Mosemege (2004), wherein they

explicate IK as the type of knowledge attained through living and operating in a specific region. Furthermore, teachers B and D, see the passing on these cultural, traditional, and/or ancestral processes and knowledge as a way to link the youth, who are the future generation, with the past processes and systems in the local community. In a way, the idea of IK has been knowledge that is transmitted from an older generation to the younger generation. In other words, IK is regarded as being generational. Older people can generate learning experiences for the young, thereby improving the cultural and knowledge capital of the youth. The findings of this study are aligned with that of Stephan (2021), who reiterates that intergenerational learning is a systematic transfer and interaction of knowledge, skills, competencies, wisdom, norms, and values between generations.

5.2.1.3 IK as lost knowledge

The participants, C and A, expressed concerns that IK is lost knowledge as it is transmitted orally.

> "When elders die, this knowledge is lost as they did not write it down" (Teacher C).

> "Many elders cannot read or write, so this knowledge they have about culture, traditions, and technologies is lost; the younger generation cannot read about it or learn. It is lost for future use. Also, as the elders get older, they tend to forget, and the knowledge gets distorted or watered down" (Teacher A).

The teachers recognise the slow loss and extinction of IK in communities due to elders being the holders of IK and the lack of documentation. The oral mode of transmission from generation to generation makes it prone to disappear and become watered down, as elders tend to forget as they age. Thus, IK becomes lost to future generations. These findings are similar to Issa et al. (2018), who noted that Nigerian healers did not document their traditional practices and remedies and that this knowledge remains or is trapped with them when they die, and consequently, it is lost.

5.2.1.4 IK as knowledge of past traditions and practices

The excerpts below reflect that teachers A, C and D regarded IK as having knowledge of past traditions and practices.

> "… because it gives the learners the idea how things were done before" (Teacher A).

> "It is the knowledge about keeping ancestors happy and initiations" (Teacher C).

"My understanding of indigenous knowledge in the subject NS-Tech has to do with the skills and understanding of the histories of the natural world with the interaction of nowadays system of living" (Teacher D).

The teachers believe that a strong relationship exists between IK and the traditions of the people in their community. It is knowledge about ancestral practices and initiations. The elders in the community practice that.

5.3 Understanding of integrating IK in NS-Tech when teaching structures

The study revealed that the grade 4 NS-Tech teachers' understanding of integrating IK in NS-Tech/Structures is based on the idea of incorporating IK and Western science education (Table 5.3) due to the notion that they have a close relationship and could work effectively together. Additionally, the teachers are of the belief that IK has a lot to do with skills which are used in the environment. The following sub-themes will be discussed as contributing factors to this theme: amalgamation of IK and Western Science and IK as the use of skills.

Table 5.3: Understanding of integrating IK in NS-TECH when teaching structures

Understanding of integrating IK in NS-Tech	Participants
Amalgamation of IK and Western Science	A, B and C
IK as the use of skills	C and D

5.3.1 Amalgamation of IK and Western science

The participants mentioned that they believe that indigenous knowledge and Western science (WS) should be infused because it would be beneficial for the learners, as is visible from the following excerpts:

"It is very crucial that we integrate indigenous knowledge in the teaching and learning of NS/T. The subject mostly has topics about nature" (Teacher A).

"I understand that modern and indigenous knowledge are good together because we need to emphasise these two aspects to the younger generation" (Teacher B).

"Using indigenous knowledge in NS-Tech will help/does help learners understand science in a better way since they do relate to what is being taught" (Teacher C).

It is evident from the excerpts above that teachers A, B, and C are of the view that there is a strong connection between indigenous knowledge and Western science. This connection is due to the idea that IK and WS mostly deal with aspects concerning the environment, and as such, the teachers believe that the infusion of these two types of knowledge will enable the learners to easily understand aspects that need to be taught during the teaching and learning process. This is in line with Hlatshwayo and Shawa (2020), wherein asserted that Ubuntu IK values should be integrated with Western scientific knowledge, which could foster effective teaching and learning. This is because the spirit of Ubuntu places a very strong influence on togetherness where the learners are located. This is very much a disputed issue in the South African curriculum owing to the apartheid curriculum, which hindered the infusion of local knowledge due to it being perceived as primitive and not scientific in any way (Mahlangu & Garutsa, 2019; Mapara, 2017) and the kind of education system that was implemented only served the white minority thus increasing inequality (Mkosi et al., 2023).

5.3.2 IK as the use of skills

The participants shared their sentiments that IK had a lot to do with skills in that the indigenous people used the acquired skills for hunting and farming, and the skills were also used to teach the younger generation. Such skills are significant for their survival and can form part of IK in its integration into the NS-Tech/Structures. This is what the teachers said:

> "… linking what they know or what they practice in their cultures to science. It is easier to make science fun or interesting if learners relate" (Teacher C).

> "In the subject, NS-Tech has to do with the skills and understanding of the histories of the natural world with the interaction of nowadays system of living" (Teacher D).

According to the preceding, it is evident from the teachers' sentiments that IK is the use of skills acquired from one generation and passed down to the next. These skills are essential for a variety of purposes, especially concerning the environment. Teachers C and D expressed that there should be a connection between what is learnt at home to what is learnt at school as both cultures could serve a better purpose for the learners. Such would enable a different kind of learning to take place using the learners' skills and their understanding of the environment. This is in connection with the argument brought forth by Rajasekaran et al. (1994), wherein it was asserted that IK is the use

of knowledge that has been acquired through repeated practice and experiments with the environment by local people of a specific culture.

5.4 Summary of Findings of Research Questions One

Research Question One was presented as: "*What are grade 4 Natural Sciences and Technology teachers' understanding of the integration of Indigenous Knowledge in the teaching of structures?*"

The findings regarding the above research question were drawn from the questionnaires that were held with four NS-Tech teachers in the Pinetown District. It is evident from the above findings of Research Question One that teachers have different perceptions that they attach to them. Two themes emerged, namely, the meaning of IK and the understanding of integrating IK in NS-Tech/Structures. From these three themes, six sub-themes emerged, namely, IK as informal knowledge, IK as intergenerational learning, IK as lost knowledge, IK as knowledge of traditions and practices, an amalgamation of IK and Western Science, and IK as the use of skills.

Moreover, regarding Research Question One, it became evident from the teachers' differences in their meaning of IK and understanding of integrating IK in their teaching of structures. However, it can also be noted that these differences stem from their difference in experiences and how they perceive IK, both from home and how it relates to school. These differences in their meaning of IK and understanding of integrating it support the argument brought forth by the literature that there is no global definition of IK. Instead, the definitions are dependent from person to person and culture to culture (Muyambo & Maposa, 2014; Nel, 2005; Semali & Kincheloe, 1999; Onwu & Mosemege, 2004). This is noticeable from the six sub-themes that appear to ground the teachers' meaning of and understanding of integrating IK.

5.5 Summary of the chapter

This chapter presented the analysis and presentation of Research Question One: "*What are grade 4 Natural Sciences and Technology teachers' understanding of the integration of Indigenous Knowledge in the teaching of structures?*" The chapter analysed the data collected using open-ended semi-structured questionnaires. Also, the chapter aimed to establish teachers' understanding of the integration of IK in the teaching of NS-Tech/Structures. The next chapter will present the analysis and presentation of findings of Research Question Two.

CHAPTER 6: PRESENTATION OF THE ANALYSIS OF RESEARCH QUESTION TWO

6.1 Introduction

The previous chapter discussed the data analysis and presentation of findings of Research Question One. This chapter will present an analysis and presentation of the findings of Research Question Two: "*Do grade 4 NS-Tech teachers integrate IK in the teaching of structures? If so, how? And if not, why?"* The qualitative data obtained through structured lesson observations and post-observation interviews was used to answer Research Question Two (see Appendices E and F). This is in line with the structure of the research methodology (see Chapter 4). The lesson observations and post-observation interviews aimed to find out whether the grade 4 NS-Tech teachers integrate IK in their teaching of structures.

Moreover, the data analysis for Research Question Two focused on what grade 4 NS-Tech teachers do in the classroom to integrate Indigenous Knowledge into the teaching and learning of structures. The 'how' referred to the teachers' explanations of how they integrate IK, whereas the 'why' referred to the reasons they did not integrate IK during the observations. The data for this stage was gathered through structured lesson observations and post-observation interviews.

6.2 Analysis and presentation of data for Research Question Two

This section presents the analysis of data from the structured lesson observations and semi-structured post-observation interviews (see Appendices E and F) in response to Research Question Two. Four teachers participated in this section of the study.

The purpose of the structured lesson observations was to determine whether grade 4 NS-Tech teachers integrate IK in the teaching of structures. If they do, how, and if they do not, why not? Therefore, the lesson observations focused on any manifestations of IK in the teachers' or learners' actions, as well as the resources used during the classes and how IK was portrayed in the lessons. As argued by Athanasou et al. (2012), observation is an organised method of data collection that depends on a researcher's capacity to obtain data through his or her senses without communicating with participants. The advantage of observation as a data collection approach is that it allows a researcher to collect data from naturally occurring social settings in real time. As opposed to relying on second-hand data, the researcher can actually see what is going on (Cohen et al., 2018, p. 54).

This section covers two topics, namely; IK teaching and learning activities, and the depiction of IK in the lessons.

6.2.1 Findings from the lesson observations: Integration of IK in the teaching of structures

The lesson observations revealed that all four teachers did not integrate IK in the teaching of structures. Two components, focused upon during the observation of lessons, will be covered in this section: IK teaching and learning activities and depiction of IK in the lessons. These components were the primary objective of the research during the lesson, as the researcher employed a structured lesson observation schedule (see Appendix E).

6.2.1.1 IK teaching and learning activities

Teacher A's lesson was based on matter and material, with a recap and then writing notes, but it is worth noting that there was no integration of IK. This is how the teacher began the lesson:

> "Do you still remember that we are talking about matter and materials, right! The students respond." (Teacher A).

Teacher B began the lesson by recounting with the learners what they had done in the previous lesson, which was centred on an activity about structures. The teacher went on to explain to the learners that there are two types of structures: natural and man-made structures. The teachers' involvement in the session demonstrated that the lesson was student-centred. This is what the teacher said:

> "Let us just remind each other, yesterday or maybe last week, what did we learn about? Or rather, there is an activity that we did in class; what was it about? The students respond. The animal shelter or rather a structure or animal shelter, right? The students respond." (Teacher B).

> "Yes! We have two structures of animal shelter. It is the animal, it is the natural structure and the man-made, right!" (Teacher B).

Even though the lesson was centred on the teaching of structures, there was no integration of IKS in the lesson, and the exercises had nothing to do with structures. The learners studied things around them in **Teacher B's** second lesson, and this is how the lesson began:

> "Yesterday, you wrote down notes, right? The students respond. The notes that we wrote, what were they about? The teacher calls out some students." (Teacher B).

> "We are learning about materials that are around us as we live in this world… matter and material exist in three different forms." (Teacher B).

Teacher C commenced her lesson by asking learners if they had all written their notes for the previous lesson. This is what was said:

> "… have those in front written? Open your book, open, open." (Teacher C).

Most of the lessons, including **Teacher C's**, focused on solids, liquids, and gases; as a result, it was challenging to document anything pertaining to structures, particularly in the lesson on IKS integration in the teaching of structures, which according to the grade 4 NS-Tech CAPS document, structures were supposed to be taught during that week; herein is evidence of Teacher C's lesson:

> "Solid, Liquid and Gas. How can we differentiate it? Between the solid and Liquid. Can anyone tell me the difference?" (Teacher C).

The teacher started her second lesson by asking learners what they understood from the previous lesson. This is how the lesson was initiated:

> "Uh, okay, types of structures, uhm, I mean state of matter." (Teacher C).

The teacher and learners engaged in a question-and-answer session about the learners' last lesson. The learners were engaged in class, as evidenced by their comments on the prior lesson. The teacher then went on to begin the lesson of the day, which was based on structures; the following is how the teacher began the lesson:

> "Let us begin the structures now. Let me see!" (Teacher C).

Teacher C inquired about the learners' awareness of structures before explaining that structures are things that surround us and that structures exist both within and outside of the classroom. The teacher then gave students examples of structures. The class was engaging since the teacher was knowledgeable on the topic of structures, as stated below:

> "Structures can carry and support the load. Structures can carry and support what? The load. Can carry and support the load. This class or this block is a structure." (Teacher C).

"… can you see it? Yes! It is over there, come and see here. That is a pylon." (Teacher C).

The teacher demonstrated a thorough understanding of structures before teaching about the functions of structures, and the learners participated actively in the lesson. Although there was evidence of the teaching of structures in **Teacher C's** lesson, there was no discussion or integration of IK in the lesson and no IK-related learner activities.

Teacher D's first lesson began with the teacher noting that the topic for the day was based on "material properties." This is how it started:

"Okay! Today we are learning about the properties of the material." (Teacher D).

The majority of the lessons for the teacher mentioned above were taught using using 'a textbook method', which may be argued to be an ineffective style of teaching and learning for learners. Furthermore, the learners were not required to do anything to stimulate their thinking other than write notes in their exercise books. The second lesson for **Teacher D** began with the teacher questioning the students about structures, as follows:

"Okay, now we started on Structures, right?" (Teacher D).

Despite being aware that the teacher informed learners that the lesson would focus on structures and asked them questions, the teacher then changed to material properties. There was obvious evidence that it was unclear whether the lesson was on structures or properties of materials because the teacher was teaching about properties of materials. Notwithstanding being apparent that the lesson was about material properties there was no evidence of IK.

6.2.1.2 Depiction of IK in the lessons

Teacher C did teach about structures in the subsequent lesson, but it had nothing to do with IKS in the teaching of structures. However, there have been initiatives to show learners structures that exist around them with the goal of making them knowledgeable of what structures are and how to tell the difference between them. The teacher also mentioned the following:

> "The next lesson will be indigenous structures. It will be indigenous structures; are we clear?" (Teacher C).

Through lesson observations, this study discovered that the teachers did not employ IK integration in their teachings, which is mainly used when trying to make examples when teaching structures

in the grade 4 NS-Tech classroom. More work remains to be done in terms of integrating IK into the grade 4 NS-Tech, particularly in the teaching of structures. Also, while integrating IK, it is critical to ensure that sufficient training is offered to teachers, as some have stated that integrating IK can be challenging and can only be done when the opportunity avails itself. If IK is essential, the government and schools must ensure that teachers have the appropriate training for NS-Tech topics, specifically in the teaching of structures.

6.3 IK Integration in NS-Tech/Structures

The teachers expressed that integrating IK in their teaching of grade 4 NS-Tech is a challenge. This is because there is a lack of understanding of Western science from the learners, which further makes it difficult for the teachers to integrate IK. Because of the learners' lack of understanding western science, they do not seem to be motivated enough to learn IK, and there are inadequate teaching and learning materials in schools, which makes it more of an obstacle for teachers to integrate IK into their teaching.

The themes that came up in the post-observation interviews with the four participants are covered in this section. This section details the way in which the grade 4 NS-Tech teachers integrate IKS into the teaching of structures. It is worth mentioning that the level at which teachers understand and employ a variety of strategies in the integration of IK in their daily teaching was also a determining factor by which learners comprehend what is taught. The post-observation interviews revealed three main themes and three sub-themes. The themes consist of the following: understanding of both science worlds, level of learners' motivation, and teaching and learning materials, as evidenced in Table 6.1.

Table 6.1: IK integration in NS-Tech when teaching structures

IK integration in NS-Tech/Structures	Participants
Understanding of both science worlds	A, B and C
Level of learners' motivation	A and C
Teaching out-of-field and learning materials	A, B, C and D

6.3.1 Understanding of both science worlds

This study showed that both teachers and learners need to understand both scientific worlds, which include Western Science and Indigenous Knowledge. This is primarily due to the idea that both can work together instead of individually and share similar attributes. Therefore, according to some teachers, there needs to be an integration of both in the grade 4 NS-Tech classroom, in and beyond the classroom, in order for the comprehension of both worlds to exist.

6.3.1.1 Knowledge of Indigenous and Western practices

The study uncovered indigenous people's customs and practices, including those they utilised to survive in the past to forage for food and/or build structures, as well as how they passed their knowledge on to the following generation. These practices have proven to be important in the lives of the indigenous people and can play a pivotal part in the grade 4 NS-Tech should there be a proper integration of both. The teachers stated the following:

> "… they do understand it because we, as teachers, keep on emphasising the importance of our roots where they come from and the importance of knowing what the elders used to do in their times." (Teacher A).
>
> "… they have farms which have houses that were built indigenously. Their grandparents did not have to buy materials to build but used what they could find within their environment." (Teacher C).
>
> "… seeing the elders telling the young children stories whilst sitting around a fire." (Teacher A).

The teachers agreed on the importance of properly integrating Indigenous Knowledge within the grade 4 NS-Tech curriculum to teach learners about Indigenous knowledge. While Teacher C stated that it was not essential to acquire things in the past because the elders used what they could find in the environment, Teacher A also mentioned the need to emphasise how learners should know where they originate from. These attributes could prove to be important in the integration of IKS into the NS-Tech curriculum.

Furthermore, knowledge of indigenous and Western practices includes any knowledge that indigenous people may have about both Indigenous and Western activities that they engage in, and that might be imparted to learners. The study further showed that teachers require an understanding

of both indigenous and Western knowledge from their students. This is what some teachers mentioned:

> "… learners will be able to understand both indigenous and Western science so that they are not left behind in these things that are done nowadays, and they should know their heritage and where they come from and where they are going." (Teacher A).

> "… they are familiar with all the indigenous and Western science. About the indigenous, they are taught about things that they were done in the olden days, at home and school." (Teacher A).

Teacher A claimed that the learners' understanding of both worlds would enable them to keep up with modern technologies and prevent them from falling behind. This is in line with Kimwaga (2009) who argued that where IK is properly integrated, it will allow learners' knowledge of social order. This is because it is believed that actions from earlier times led to the technologies used today. Additionally, by being familiar with both worlds, they will comprehend the connection between them and learn about their histories. The teacher went on to say that the learners are taught about numerous past and present practices in addition to being conversant with both sciences.

> "… they do have a little bit of insight because, as I said, there is a section that speaks about indigenous structures, so they do have, but I would not say it is a broader information maybe that would help them know a lot with it." (Teacher B).

Similar to Teacher A, Teacher B agreed that although there is a part in the curriculum document that mandates that teachers educate about "indigenous structures," the content is constrained and does not allow learners to gain a deeper understanding.

6.3.2 Level of learners' motivation

The teachers argued that appropriate teaching and learning materials were necessary for the effective integration of IK and WS into the teaching and learning of NS-Tech so that the learners could remain focused on the lessons. It also became apparent that the learners do not seem to be particularly motivated for IK and WS.

6.3.2.1 Language barrier to learning IK and Western Science

According to the teachers, Western Science comprehension among the learners is lacking, and they also struggle to understand how IK and WS link in the grade 4 NS-Tech. The use of English as a teaching language frequently widens the gap in the learners. Although most township schools use English as the primary language of teaching and learning, it is common to see teachers teaching learners using native dialects. Despite this, some learners still struggle to understand Western Science. Teachers have argued the following:

> "… the language because the language sometimes becomes a barrier. Some things they do not understand, and the language that is not theirs. So maybe if they are taught in their language, they would understand easily, you see." (Teacher A).

> "… there are some aspects that which when you teach the learners seem to be confused and other teachers do not code switch to accommodate every learner." (Teacher C).

The learners' lack of knowledge of Western Science necessitates intensive assistance from subject advisors and curriculum developers. This is due to learners' lack of knowledge of various components of NS-Tech, particularly Western Science. The teachers noted that there is sometimes confusion among learners owing to the linguistic barrier that exists in learning Western Science. In this instance, learning Indigenous Knowledge in the English medium becomes more challenging.The language of teaching and learning in most schools is English, and as a result, learners who are not well-grounded in the English language have a further gap in their knowledge, leading to demotivation for studying.

6.3.3 Teaching out-of-field and learning materials

Teaching out of the field is one of the major issues faced in South African schools. This is because teachers become qualified to teach a particular subject but when they get to the teaching field, they are employed for subjects which they are unqualified for, resulting in demotivation and a lack of enthusiasm for the subject and teaching as a whole. Of the grade 4 NS-Tech teachers, only one, Teacher A, was qualified to teach NS-Tech. Also, learning materials are an important source of information in the teaching of aspects or concepts in any discipline, notably in NS-Tech. As a result, this study revealed a scarcity of teaching materials that teachers might use to pass on their knowledge to learners and that they can use to their benefit. Also, some learners learn better by seeing and touching things, which makes effective teaching and learning challenging. The sub-

themes of important teaching texts for NS-Tech and the availability of teaching resources will be discussed.

6.3.3.1 Relevant teaching documents for NS-Tech/Structures

Teaching documents are essential in schools, and when they are unavailable, teachers are unable to impart their knowledge to learners. Examples of such documents include but are not limited to, curricular documents and textbooks. Regarding teaching materials, the teachers stated the following:

> "… I'm informed by an annual teaching plan, which is an ATP and policy document for grade 4 NS/T." (Teacher A).

On the one hand, Teacher A indicated that the Annual Teaching Plan (ATP) is used to determine what needs to be taught and that when this is not available, it becomes difficult to plan for classes. The ATP is used by many teachers, not just the above teacher because the government issues it as a guide of the topics that must be covered in each term.

> "I would say that the CAPS and the ATP inform me. The CAPS, which is the Curriculum and Assessment Policy Statement and the ATP which is the Annual Teaching Plan. These two documents determine what is to be taught and also include indigenous knowledge." (Teacher C).

> "But also, if the curriculum documents and the teachers played their role in making it make sense to the learners." (Teacher C).

Teacher C, on the other hand, stated that the utilisation of the ATP, as well as the Curriculum and Assessment Policy Statement (CAPS), is what informs what and how should be taught. As a result, these documents emphasise the need to teach IK. However, as previously said, the necessity to teach IK is only mentioned briefly. As a result, it is difficult to teach it properly, and it is not well explained in the same way that other components are, creating an issue with its integration. Relevant teaching documents will also enable learners to refine new thoughts, thus giving possible solutions to issues they encounter (Mawere, 2015).

Moreover, this study revealed that the usage of teaching materials is the most crucial component of the teaching and learning process, and as such, if they are not made available, teachers, like

learners, face problems. As previously said, some learners require seeing and touching the materials they are studying to gain a deeper comprehension. Some teachers argued about the availability of relevant teaching materials as follows:

> "The resources that could be used would be books and stories that their parents used to tell stories about their past and the dances, dances that were done a long time ago." (Teacher A).

> "Hahaha, eh, maybe I can bring a picture of an old Xhosa house, an old Zulu house, and that Khoi-San house so they can see how the people who were living in those houses a long time ago. So those are the ways that they will be able to know how they were in indigenous time." (Teacher D).

Teacher A and Teacher D expressed similar concerns, mentioning the necessary teaching resources that can be used in the teaching and integration of IK. The teachers mentioned using resources such as books and stories, as claimed by Teacher A, and giving learners photographs of old dwellings created by indigenous people from various cultures and tribes, as claimed by Teacher D.

> "Uh, I think us what we lack here to teach our children properly is the correct resources or rather materials to teach the children" (Teacher B).

Similarly, Teacher B acknowledged a shortage of teaching materials when attempting to integrate IK into NS-Tech. There is a visible paucity of teaching materials, which is a critical necessity for teachers for successful teaching and learning to occur. Additional consideration should be given to the need to provide additional teaching resources and a larger budget for schools to avoid resource shortages.

6.4 Summary of Findings of Research Questions Two

Research Question Two stated: "*Do grade 4 NS-Tech teachers integrate IK in the teaching of structures? If so, how? And if not, why?*"

The findings of Research Question Two were drawn from the structured lesson observations and post-observation interviews that were held with the four grade 4 NS-Tech teachers. The focus of this research question was on regard to whether the teachers integrate IK in their teaching of structures in grade 4 NS-Tech, as explicated by the research methodology (see Chapter 4).

It is evident from the analysis of results from the lesson observations that the teachers did not integrate IK into their teaching, and the resources and activities for the lessons did not constitute any IK aspect. It was also clear that the teachers only used IK as mere examples in their teaching to enhance learners' understanding of concepts concerning Western science in the teaching of NS-Tech/Structures. It is noticeable that the integration of IK in the teaching of NS-Tech is very much in its early stages, as evident from the teachers' lack of integration in their teaching (Jacobs, 2015; Keane et al., 2017; Mkosi, 2019; Moyo, 2011). This is an issue considering that in order to enhance learners' understanding of their surroundings, thus being able to address problems technologically and scientifically, as expounded by Chikaire et al. (2012), Mawere (2015) and Shizha (2010), there needs to be an integration of IK in the teaching of NS-Tech, particularly in the teaching of structures.

Moreover, the post-observation interviews uncovered that IK is difficult to integrate, as argued by the teachers due to the difficulty in teaching NS-Tech; therefore, integrating IK is also difficult as learners merely understand what is taught in NS-Tech (Nkopodi & Mosimenge, 2009). Furthermore, the analysis of research question two alluded that there are inadequate teaching materials in the schools, which is also a contributing factor to the difficulty in integrating IK in the NS-Tech classroom (Keane, 2015; Lubben, 2011; Mkosi, 2019).

In addition, the medium of instruction (English) was also attributed as one of the challenges that teachers encounter in integrating IK in the NS-Tech classroom. As such, the learners are not fluent in the medium of instruction, which further delays their progress. This is in line with the assertions brought to the fore by Sebola (2015) and Papp (2016), wherein the language of learning and teaching does not accommodate the learners, and the integration of IK further widens the learning gap. This highlights the fact that the language of learning and teaching should be looked into in terms of allowing learning to take place in the learner's language, which may be the first progressive stance for indigenous learners, also because their classes are widely dominated by indigenous instead of non-indigenous learners (Mahlangu & Garutsa, 2019).

6.5 Summary of the chapter

This chapter explored teachers' integration of IK in the grade 4 NS-Tech/Structures in response to Research Question Two: "*Do grade 4 NS-Tech teachers integrate IK in the teaching of structures? If so, how? And if not, why?"* Structured lesson observations and semi-structured post-observation

interviews (see Appendices E and F) were used to answer Research Question Two. The chapter analysed the data collected using structured lesson observations and open-ended semi-structured post-observation interviews with the four participants of the study to address the second research question, which was stage two of the data collection. The research findings, summary, recommendations and conclusion will be discussed in the following chapter.

CHAPTER 7: DISCUSSION OF FINDINGS, SUMMARY, RECOMMENDATIONS AND CONCLUSION

7.1 Introduction

The data collected by using structured lesson observations and post-observation interviews were analysed and discussed in the previous chapter. This chapter will present the findings and make recommendations based on the findings. The data was collected in two stages; namely, stage one focused on collecting data using open-ended semi-structured questionnaires, and stage two used structured lesson observations and semi-structured post-observation interviews. This chapter will present and discuss the findings from the data, followed by recommendations and a conclusion. The research questions that were posed were as follows:

1. *What are grade 4 Natural Sciences and Technology teachers' understanding of the integration of Indigenous Knowledge in the teaching of structures?*
2. *Do grade 4 NS-Tech teachers integrate IK in the teaching of structures? If so, how? And if not, why?*

7.2 Presentation of key findings

The findings of this study revealed that grade 4 NS-Tech teachers are confronted with numerous challenges regarding the integration of IK in the teaching of structures in their respective schools. The study also exhibited that the teachers do understand IK and the meanings of IK, which they attach to themselves. The study reported IK as informal knowledge, intergenerational learning, lost knowledge, and IK as knowledge of traditions and practices. These findings suggested that IK is still not yet documented, which is a concern considering that this knowledge will be lost. The fact that the elderly hold this knowledge is another issue because as they get older with age, the knowledge falls prey to becoming extinct.

As much as the curriculum document, the Curriculum and Assessment Policy Statement (CAPS), mentions that IKS should be taught in schools, particularly the grade 4 NS-Tech document (DoE, 2012), teachers are finding it difficult to teach it due to the fact that not all the learners understand what IK is and it being difficult to integrate it into their teaching. This is a clear indication that the teachers cannot play the role of being cultural brokers of knowledge to the learners when the learners cross borders (Jegede & Aikenhead, 1999). This is also because IK, to date, is regarded

as primitive and unscientific (Mposhi et al., 2013). This is in line with Semali and Kincheloe (1999), wherein they argued that IK should integrated fully into the curriculum documents instead of being treated as a separate body of knowledge. It is noteworthy that integrating the IK and Western science will significantly benefit the learners as it would also teach them about the spirit of Ubuntu, which is an imperative aspect regarding the integration of IK (Hlatshwayo & Shawa, 2020).

Table 7.1: Summary of the findings of the study

Research Question	Theme	Key Findings
What are grade 4 Natural Science and Technology teachers' understanding of the integration of Indigenous Knowledge in the teaching of structures?	Meaning of IK	IK as informal knowledge IK as intergenerational learning IK as lost knowledge IK as knowledge of past traditions and practices
	Understanding of integration of IK	Amalgamation of Indigenous Knowledge and Western Science IK as the use of skills
2.1 Do grade 4 NS-Tech teachers integrate IK in the teaching of structures?	No	No
2.2 Why?	Understanding of both science worlds Level of learners' motivation Teaching out-of-field and learning materials	Knowledge of Indigenous and Western practices Language barrier to learning IK and Western Science Relevant teaching documents for NS-Tech/Structures

It is evident from the findings of the table above that the grade 4 NS-Tech teachers do attach some meanings of IK to themselves, such as IK being informal knowledge, intergenerational learning,

lost knowledge, knowledge of past traditions and practices. This indicates that the teachers perceive it in this way due to IK not being documented in the past and it is the kind of knowledge that is learnt from the elders, past down from one generation to the next, and it has only recently been a topic of discussion. This correlates with the assertion brought forward by Onwu and Mosemege (2004) that this type of knowledge is acquired from a particular culture in a particular location. When IK is not documented, it stands a chance of being extinct because when knowledge is held by the people, particularly the elders, when they die they die with the knowledge. This knowledge is cultural knowledge and has been practiced in the past and to date, such practices are the way of life for the indigenous people, it is their means to survive.

Furthermore, the findings from the table above revealed that there is a requirement for the amalgamation of both science worlds and that IK is perceived as a skill. This is because both IK and western science are compatable and most of what is taught has to do with nature and in nature there needs to be the use of skills which have been learnt from the elders in the community, such knowledge and skill are essential for the survival of the indigenous people. This denoted the fact that the teachers are also of the view that IK and Western science should be integrated because the teaching content that Western science has can be correlated with IK content. This integration of IK and Western science could potentially alleviate the learning gap that is evident from the learning of grade 4 NS-Tech, which is also partly due to the language of learning and teaching being the learning barrier (Sebola, 2015; Tema, 2002; Taylor & Coetzee, 2013).

As much as the findings revealed that the teachers attach to themselves meanings of IK and have an understanding of IK integration, they do not integrate IK in their teaching of structures. This clearly denotes their lack of thorough understand and how it can be integrated into their teaching. These findings are crucial for an effective integration of IK into the grade 4 NS-Tech classroom. Since teachers are failing to play their role as cultural brokers of knowledge, there is a need for proper professional development programs for the teachers (Diwu & Ogunniyi, 2011). The study also revealed that there was a lack of learners' motivation levels and inadequate teaching materials in the schools to integrate IK. The level of motivation that the learners have in learning a particular aspect denotes whether the aspect can be integrated into the classroom and also the inadequate teaching materials for the teachers to use. This creates a further gap in the teaching and learning process (Diwu & Ogunniyi, 2011; Lubben, 2011).

7.3 Recommendations for the study

The purpose of this study was to explore the integration of Indigenous Knowledge in the teaching of structures in the grade 4 Natural Sciences and Technology classroom in accordance with the Curriculum and Assessment Policy Statement (CAPS).

The study revealed evidence that the teachers were unsuccessful in terms of playing a role as cultural brokers assisting the learners shift from their culture to the next, indigenous knowledge and science knowledge of the aspect of structures. It is worth mentioning that they lack the understanding of the principles and ideas on which indigenous knowledge can be integrated into the grade 4 NS-Tech classroom. It was also clear that the curriculum document pays much attention to the ideas and principles on which IK is to be integrated into the teaching of NS-Tech. However, it does not state how teachers are to integrate IK in their teaching. Also, the teachers did not receive any form of training for the integration of IK into the teaching and learning of grade 4 NS-Tech, particularly in the teaching and learning of structures. The recommendations are directed to the teachers in the classroom, curriculum designers, and for further studies in the area of IK integration in education.

7.3.1 Recommendations for teachers

First, the teachers need to note that successful integration of indigenous knowledge in the grade 4 NS-Tech classroom lies in their ability to understand and effectively integrate IK in the classroom; without proper training for the integration of IK in the teaching of grade 4 NS-Tech, specifically in the teaching of structures, effective teaching and learning of IK will not occur. For this reason, the grade 4 NS-Tech teachers require thorough training of IK integration in the teaching of structures. This is because their ability cannot evolve without their understanding of how and why IK should be integrated into the grade 4 NS-Tech classroom. Second, the teachers need to know what integrating IK in the grade 4 NS-Tech classroom entails and not just what the curriculum document presents. The teachers need to understand that the curriculum document is more about what is to be taught and not how it is to be taught. Teachers also need to know that when integrating IK, they play the role of being cultural brokers due to the facilitation they give to the learners who shift from one culture to the next, the familiar to the unfamiliar. Recommendations for curriculum designers

Curriculum designers ought to know and understand that there is a requirement to enable the ideas of the curriculum documents to be more precise in that they include effective teaching strategies in the documents. Also, as a curriculum designer, it would be paramount that one can develop the ideas and another administers those ideas. Working together would allow an effective outcome. Moreover, there could be resources that exhibit what the document aims to do, including but not limited to videos, books, etc., which illustrate how what is to be taught could be enacted in the classroom.

7.3.2 Recommendations for further studies

Future studies need to need to take into consideration that it is imperative to note and comprehend that studies that particularly consider how teachers integrate indigenous knowledge of a specific group of learners will be significant in terms of the understanding of how teachers act as cultural brokers and enable the learners to cross the border from one culture to the next. Also, studies that investigate the notion of how learners' ideas of aspects when their indigenous and scientific knowledge have been utilised in the teaching and learning of the aspects will at most be convenient regarding the understanding of how learners cross borders in their contemporary schooling.

7.4 Limitations of the study

The predicted challenges or limitations for this study were the case study approach and the sample size, which were five schools and five NS-Tech teachers, as well as the fact that all schools are distinct and thus cannot be generalised. However, it is worth noting that a case study design can offer an in-depth understanding of how various aspects of the case interrelate. The potential transferability of these findings to similar contexts can only be partly suggested by the author, but ultimately is the responsibility of the reader who can compare the case to another context (Yin, 2017).

7.5 Summary of the chapter

The purpose of this study was to explore the integration of indigenous knowledge in the teaching of structures in the grade 4 Natural Sciences and Technology classroom. The research in this study revealed that the grade 4 NS-Tech teachers do have knowledge and understanding of IK and its essence in teaching and learning. However, the study also revealed that there is a lack of IK integration in the teaching of structures. On the one hand, the teachers expressed similar concerns regarding the meaning of IK. Some of the meanings they attached to IK were IK as informal

knowledge, IK as intergenerational learning, IK as lost knowledge, and IK as knowledge of traditions and practices. On the other hand, the teachers shared that integrating IK is a challenge, considering that the learners need to comprehend both science worlds, which would enable its integration to be smooth. They mentioned that the learners' level of motivation seems to be lacking, and there are not enough adequate teaching and learning materials for effective teaching and learning to take place. It is noteworthy that the teachers raised concerns that the CAPS document shows very little in terms of how and what to integrate in the teaching of NS-Tech, specifically in the teaching of structures.

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APPENDICES

Appendix A: Ethical clearance



Appendix A: Ethical clearance

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

17 October 2022

Malibongwe Percival Gambushe (216033031)
School Of Education
Edgewood Campus

Dear MP Gambushe,

Protocol reference number: HSSREC/00004857/2022
Project title: Integrating indigenous knowledge in the teaching of structures in the grade four Natural Science-Technology classroom.
Degree: Masters

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 06 October 2022 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL**.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

This approval is valid until 17 October 2023.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

HSSREC is registered with the South African National Research Ethics Council (REC-040414-040).

Yours sincerely,

[redacted]

Professor Dipane Hlalele (Chair)

/dd

Humanities and Social Sciences Research Ethics Committee
Postal Address: Private Bag X54001, Durban, 4000, South Africa
Telephone: +27 (0)31 260 8350/4557/3587 **Email:** hssrec@ukzn.ac.za **Website:** http://research.ukzn.ac.za/Research-Ethics
Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville
INSPIRING GREATNESS

Appendix B: Gatekeeper's permission

Appendix B:
Gatekeeper permission

KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

OFFICE OF THE HEAD OF DEPARTMENT

Private Bag X9137, PIETERMARITZBURG, 3200
Anton Lembede Building, 247 Burger Street, Pietermaritzburg, 3201
Tel: 033 392 1051
Email: Phindile.duma@kzndoe.gov.za

Enquiries: Mrs B.T. Ntuli **Ref.**:2/6/7318

Mr Gambushe

12 Alan Paton road

Pietermartizburg

Dear Mr Gambushe

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct research entitled: **"Integrating indigenous knowledge in the teaching of structures in the grade 4 Natural Science-Technology classroom"** in the KwaZulu-Natal Department of Education institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the Intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from **19 July 2022 to 31 March 2025**.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Miss Phindile Duma at the contact numbers above.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report/dissertation/thesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.

UMLAZI DISTRICT

[redacted]

Mr GN Ngcobo
Head of Department: Education
Date: 19TH July 2022

GROWING KWAZULU-NATAL TOGETHER

Appendix C: Informed Consent Letters: Principal and Teacher



Science and Technology Cluster,
School of Education,
College of Humanities,
University of KwaZulu-Natal,
Edgewood Campus, KwaZulu Natal

23 April 2022

INFORMED CONSENT LETTER

Dear Principal and Teacher

My name is Malibongwe Percival Gambushe, a **Master of Education (M. Ed in Technology)** student. I am a student from the Science and Technology Cluster, School of Education, College of Humanities, University of Kwa-Zulu Natal. I am collecting data to complete a study that explores the integration of indigenous knowledge in grade 4. Please be advised that participation in this study is voluntary. My research is titled as follows:

"Exploring the integration of Indigenous Knowledge in Natural Sciences and Technology education in the teaching of structures in grade 4."

The literature review suggests that the impetus of indigenous education is to locate knowledge within the conditions of the user (Dei, Hall & Rosenburg, 2002 & Wane, 2002). During the colonial era, it is argued that the majority of Kenyan ethnic societies, like other segments of Africa, were piloted by worldviews and value systems where spirituality became the steering force for all mortal activities and growth (Dei et al., 2002 & Wangoola, 2002). Ogunniyi (2000) records that teachers' teaching pursuits are headed in approval of Western ideologies, more so if indigenous learners

subjugate their classes. In the prevailing educational reasoning, many educators sense that they are losing track of authority if learners do not fit in with their indigenous teaching content and teaching strategies (Van Wyk, 2002).

The objectives of this study are:

1. To establish grade 4 Natural Sciences and Technology teachers' understanding of the integration of Indigenous Knowledge Systems in the teaching of structures.
2. To establish whether grade 4 Natural Sciences and Technology teachers integrate Indigenous Knowledge Systems in their teaching of structures.
3. To determine how they integrate IKS when teaching structures and why they integrate IKS the way they do.

Please note the following:

- If you do not take part in this study, you **will not be penalised** in any way.
- Your confidentiality will in no doubt, be guaranteed as your responses will not be attributed to you in person but recorded as a population member opinion.
- Any information that you will give will not be utilised against you in any way possible but rather generated as data and utilised for the motive of this this research study.
- Your participation in this study is purely for academic motives only, and there are no financial compensations.
- Data will be in the form of a questionnaire and will be kept in a safe and secure storage and destroyed after five (5) years.
- The post-observation interviews will, at most, last for about 20-30min.
- You have a choice to take part, not to take part or stop taking part in the research study, and you will not be penalised for any of the above.

Yours truly,

Mr. MP Gambushe

[redacted]

[redacted]8/[redacted]

My supervisor is Dr. A. Singh-Pillay. She is a Lecturer in the School of Education, College of Humanities, Edgewood Campus, University of KwaZulu-Natal.

My supervisor's contact details are as follows:

Email: Pillaya5@ukzn.ac.za

Phone number: [redacted]

DECLARATION

I…… (Full names of participants) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participate in the research project. I am also aware that I have the right to withdraw from the study at any time without any negative consequences. If I have any questions or concerns about any aspect of the study or the researchers, then I may contact:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus

Govan Mbeki Building

Private Bag x 54001

Durban

4000

Kwa-Zulu Natal, South Africa

_____ _____

Signature Date

Appendix D: Informed consent letters: Learners



Science and Technology Cluster,
School of Education,
College of Humanities,
University of KwaZulu-Natal,
Edgewood Campus, KwaZulu Natal

23 April 2022

Dear Learner

My name is Malibongwe Percival Gambushe, a **Master of Education (M. Ed in Technology)** student. I am a student from the Science and Technology Cluster, School of Education, College of Humanities, University of Kwa-Zulu Natal. I am collecting data to complete a study that explores the integration of indigenous knowledge in grade 4. My study focuses on the practices of your teacher's integration of indigenous knowledge in the teaching of structures. Please be advised that participation in this study is voluntary. My research is titled as follows:

"Exploring the integration of Indigenous Knowledge in Natural Sciences and Technology education in the teaching of structures in grade 4."

The study will involve a lesson observation, and the focus will be on the teacher's implementation of the content and not on you. Nonetheless, ethical research executions require that you be in the know of the study and, therefore, provide your acknowledgement to take part. Also, there will be no harm, or any risks brought to you in participating in this study. The data that will be gathered will not be made public in any manner but will only be utilised for research purposes. The school and teacher's identity will be kept confidential. Should there be any issues or concerns, you may kindly contact the researcher at [redacted] or my supervisor, Dr. A Singh-Pillay, at pillaya5@ukzn.ac.za.

Yours truly,

Mr. MP Gambushe

DECLARATION

I…… (Full names of participants) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participate in the research project. I am also aware that I have the right to withdraw from the study at any time without any negative consequences. If I have any questions or concerns about any aspect of the study or the researchers, then I may contact:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus

Govan Mbeki Building

Private Bag x 54001

Durban

4000

Kwa-Zulu Natal, South Africa

_____ _____

Signature Date

DECLARATION OF Consent .....

I (Name) ……, a learner in Grade..... have been informed regarding the study, **Exploring the Integration of Indigenous Knowledge in Natural Sciences and Technology in the Teaching of Structures in grade 4** by **Malibongwe Gambushe**.

I understand the motivation and processes regarding the study. I, therefore, give consent for lesson observations during my Natural Sciences and Technology lessons.

If I have any further questions, concerns and/or queries that are related to the study, I understand that I have the right to contact the researcher at p[redacted] or Dr. A Singh-Pillay at pillaya5@ukzn.ac.za. If I have any questions or concerns regarding my rights as a study participant, or if I am concerned about a component of the study or the researchers then I may contact: HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION Research Office, Westville Campus Govan Mbeki Building Private Bag X 54001 Durban 4000 KwaZulu-Natal, SOUTH AFRICA Tel: 27 31 2604557 - Fax: 27 31 2604609 Email: HSSREC@ukzn.ac.za

I hereby assent to be present during lesson observations of Natural Sciences and Technology lessons: **YES / NO**

Signature of Learner: _____

Date: _____

Appendix E: Informed consent letters: Parents



Science and Technology Cluster,
School of Education,
College of Humanities,
University of KwaZulu-Natal,
Edgewood Campus, Kwa-Zulu Natal

23 April 2022

Dear Parent

My name is Malibongwe Percival Gambushe, a Master of Education (M. Ed in Technology) student. I am a student from the Science and Technology Cluster, School of Education, College of Humanities, University of Kwa-Zulu Natal. I am collecting data to complete a study that explores the integration of indigenous knowledge in grade 4. My study focuses on the practices of the teacher's integration of indigenous knowledge in the teaching of structures. Please be advised that the participation of your child in this study is voluntary. There is no compensation for participating and should your child wish to withdraw from participating he/she can do so at any moment without any penalty. My research is titled as follows:

"Exploring the integration of Indigenous Knowledge in Natural Sciences and Technology education in the teaching of structures in grade 4."

The study will involve a lesson observation, and the focus will be on the teacher's implementation of the course content and not on your child. However, ethical research implementations require that you be informed of the study and, therefore, provide your acknowledgement for your child to take part. Also, there will be no harm, or any risks brought to the child in participating in this study. The data that will be generated will not be made public in any way but will only be used for research purposes. The school, teacher and learner's identity will be kept confidential. Should there

be any rising issues or concerns, you may kindly contact the researcher at [redacted] or my supervisor Dr. A Singh-Pillay, at pillaya5@ukzn.ac.za.

Yours truly,

Mr. MP Gambushe

DECLARATION

I…… (Full names of participants) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participate in the research project. I am also aware that I have the right to withdraw from the study at any time without any negative consequences. If I have any questions or concerns about any aspect of the study or the researchers, then I may contact:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus

Govan Mbeki Building

Private Bag x 54001

Durban

4000

Kwa-Zulu Natal, South Africa

_____ _____

Signature Date

Appendix F: Questionnaire



Science and Technology Cluster,
School of Education,
College of Humanities,
University of KwaZulu-Natal,
Edgewood Campus, Kwa-Zulu Natal

23 April 2022

QUESTIONNAIRE

Question 1:

What teaching qualification/s do you have?

Qualification/Year/Majors

Doctorate

Masters

Honours

Post Graduate Certificate in Education

Degree

Other:

Question 2:

Did you have any training in the new NS-TECH curriculum for grades 4-6? Please elaborate and state the duration of training if yes.

Question 3:

Does the indigenous knowledge system mean anything to you?

Yes /No

If yes, please elaborate:

Question 4:

What is your understanding of the integration of indigenous knowledge in NS-TECH?

Question 5:

Do you integrate indigenous knowledge in the teaching of Structures?

? If so, how? and why

Question 6:

Do you think that indigenous knowledge is an important aspect that should be recognised? If so, why?

Question 7:

Do you think there is/are content(s) available in the curriculum document for NS-Tech grades 4-6 that relates to indigenous knowledge? If so, please elaborate.

Question 8:

What are some possible challenges you have encountered in trying to integrate indigenous knowledge in the teaching of structures? Please elaborate.

Question 9:

What has your experience been like in the teaching of structures? Please elaborate.

Question 10:

What recommendations would you have to make integrating indigenous knowledge more recognisable? Please elaborate.

Appendix G: Lesson observation schedule



Science and Technology Cluster,
School of Education,
College of Humanities,
University of KwaZulu-Natal,
Edgewood Campus, Kwa-Zulu Natal

23 April 2022

Lesson observation schedule:

The lesson observation will be guided by the following:

- Any manifestations of IK in the teachers'/learners' activities as well as in the resources used for the lessons.

- How is IK represented in the lesson?

Lesson stage	Teacher activities	Learner activities	Resources
Introduction			
Development			
Conclusion			

Appendix H: Post observation interview



Science and Technology Cluster,
School of Education,
College of Humanities,
University of KwaZulu-Natal,
Edgewood Campus, Kwa-Zulu Natal

23 April 2022

Post observation interview:

1. What informs the way you integrate /do not integrate IK in your teaching of structures in the grade 4 NS-TECH classroom?

2. Do you think/believe that learners have an insight into what indigenous knowledge is? If so, why?

3. Would you propose a thorough integration of indigenous knowledge, if any exists, in the curriculum document? If so, why?

4. Should you be given an opportunity, what would you bring into the teaching of structures to show the integration of IK, and why?

5. Would you say that there is a struggle in learners' understanding of Western science? Please elaborate.

6. In response to question 5, what do you think would be the solution to the challenge?

7. Do you think it would be easy/hard for learners to integrate scientific knowledge learned from home with Western science into the classroom? Please elaborate.

8. What resource(s) would you use to demonstrate to the learners the role Indigenous Knowledge have in teaching and learning? Please elaborate.

9. Would you say it is possible to enable learners to understand Western scientific knowledge through the lens of indigenous ways? If so, how?

Appendix I: Audio recording consent form



Science and Technology Cluster,
School of Education,
College of Humanities,
University of KwaZulu-Natal,
Edgewood Campus, Kwa-Zulu Natal

23 April 2022

Dear Teacher

My name is Malibongwe Percival Gambushe, a **Master of Education (M. Ed in Technology)** student. I am a student from the Science and Technology Cluster, School of Education, College of Humanities, University of Kwa-Zulu Natal. I am collecting data to complete a study that explores the integration of indigenous knowledge in grade 4. My study focuses on the practices of your teacher's integration of indigenous knowledge in the teaching of structures. Please be advised that participation in this study is voluntary. My research is titled as follows:

"Exploring the integration of Indigenous Knowledge in Natural Sciences and Technology education in the teaching of structures in grade 4."

The study will involve a lesson observation, and the focus will be on the teacher's implementation of the content and not on you. Nonetheless, ethical research executions require that you be in the know of the study and, therefore, provide your acknowledgement to take part. Also, there will be no harm, or any risks brought to you in participating in this study. The data that will be gathered will not be made public in any manner but will only be utilised for research purposes. The school and teacher's identity will be kept confidential. Also, the lesson observations will be audio recorded for the study and as such this requires your acceptance of the lesson observations and post-observation interviews to be audio recorded. Should you be willing for the audio recordings of lesson observations and post-observation interviews to take place, please indicate by ticking the

applicable box. Should there be any issues or concerns, you may kindly contact the researcher at [redacted] or my supervisor, Dr. A Singh-Pillay, at pillaya5@ukzn.ac.za.

	Willing	Unwilling
Audio equipment		

Yours truly,
Mr. MP Gambushe

DECLARATION

I .....(Full name of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participate in the research project. I am also aware that I have the right to withdraw from the study at any time without any negative consequences. If I have any questions or concerns about any aspect of the study or the researchers, then I may contact:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus

Govan Mbeki Building

Private Bag x 54001

Durban

4000

Kwa-Zulu Natal, South Africa

_____ _____

Signature Date

Appendix J: Editor's receipt

CHIEFEDITORS
"WE ARE HERE TO SERVE!"

Website: www.chiefeditors.net

Email: info@chiefeditors.net or boldwin@chiefeditors.net

Cell: [redacted] or [redacted]

Dear Sir/madam

Re: Confirmation of editing and proofreading

This letter informs the responsible authorities that our team proofread and edited the work authored by **Malibongwe Percival Gambushe (216033031)** to the best of its ability. Our editing involves spelling check, punctuation, grammar, sentence construction, word reduction, cross reference citations, basic formatting (general layout), presentation style, indexing, and other mechanics of the English language. No technical alterations have been made.

Corrections were made using track changes, which have been clearly outlined for the author's reference. It is the onus of the author to accept or reject the suggested changes.

Please do not hesitate to contact us on the details provided above for more information.

Disclaimer: The editor will not be held responsible for any errors introduced due to the changes made after editing.

Yours,

[redacted]

B. Mutsvene (Coordinator)

Affiliation: International Affiliation of Writers Guilds (IAWG)

IAWG

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