An investigation on the integration of Indigenous Knowledge to teach 'Environmental Studies' at grade 11: A case of schools in Bakenberg South Circuit, Limpopo Province.

By

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A Dissertation submitted to the Faculty of Humanities, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements of the degree of Master of Education by Research

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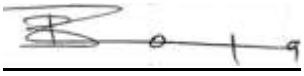
March 2024

DECLARATION

I, **Mmatshepo Brenda Thoka (1964461),** declare that the research is my personal work and all sources used have been properly acknowledged in the references. The dissertation is presented for a degree of "Master of Education" by Research at The University of Witwatersrand. The dissertation has not been presented previously for any qualification in another University.

Student's signature: 

Date: 11 March 2024

Supervisor's signature: 

Date: 11 March 2024

ACKNOWLEDGEMENTS

The successful achievement of this research study was a result of unlimited support and commitment from many people that played critical roles. I sincerely would like to recognise the support from:

- To God almighty for his protection, wisdom and the strength to successfully complete the study. All the glory belongs to him alone.
- To my supervisor, Dr. Caleb Mandikonza, I appreciate your guidance, patience, support and motivation throughout the study.
- To Dr. Khetho Ratshilumela Nemutandani, I am indebted to your commitment, dedication and support towards my studies. I would not have made to this point without your support.
- To my parents, my mother Violet Thoka and my father Lucas Mahlangu, thank you for all the investments you made towards my life and career.
- To siblings, Jane, Dumsani, Thulani and Lindiwe Mahlangu, thank you for your patience and understanding for all the times I spend away from home working on my studies, and for spending Christmas away from home.
- To my adorable son, Mahle Mbanjwa, thank you for your understanding, encouragement and motivation to not give up when times were not easy.
- To the school principals of participated schools, thank you for allowing me the opportunity to interact with their teachers and learners. A big thank you to the five teachers (participants) for agreeing to be a part of the study and to their learners for their willingness taking part in the study.
- The “Limpopo Department of Education”, thank you for allowing me to carry out the study within the school premises.

ABSTRACT

In the past two decades the academic field has experienced increasing efforts and academic discussions concerning Indigenous Knowledge and the incorporation of IK when teaching the science curriculum. The interest towards understanding IK is linked to increased criticism towards the dominion of Western epistemologies (science) across various education systems and discussions around Indigenous Knowledge Systems. The "Specific Aim three" in the Life Sciences "Curriculum Assessment Policy Statement" promotes the importance of integrating IK when teaching Life Science. CAPS states that knowledge obtained in the classroom should empower learners and link to their lives beyond the classroom. The study presents a case of five Life Sciences educators in the Bakenberg South Circuit in Mogalakwena District, Limpopo province. The objective of the study was to assess how teachers integrate IK when teaching environmental studies in grade 11. The study employed a qualitative research design and data was obtained using non-participant observations, semi-structured interviews and document analysis. The Grounded theory approach was applied to analyse and process the data. Collected data were classified into codes and later formulated into themes: knowledge of IK and integration in the classroom; perceptions towards IK; experience and training; and opportunities to integrate IK in the classroom. Data was analysed using thematic, discourse and content analysis methods. It was observed that Life Sciences teachers had varying degrees of knowledge of what IK is and its usefulness for the classroom. Only two participants (40% of the sample) demonstrated the ability to integrate IK during lessons. Teachers attributed their inability to include IK when teaching to insufficient knowledge and the absence of appropriate assistance from the Department of Basic Education. The study recommends that teachers should explore opportunity to improve their Pedagogical Content knowledge, invest in personal development and enroll for qualifications that advance their subject knowledge. The study also recommends that the DBE should organise workshops that focuses on equipping teachers with knowledge, skills and resources that promotes incorporation of IK in the classroom.

***KEY WORDS:** Indigenous knowledge; Science; Life Science curriculum; Environmental studies; Pedagogical Content Knowledge.

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ACRONYMS

AIKS – African Indigenous Knowledge Systems

CAPS – Curriculum Assessment Policy Statement

DBE – Department of Basic Education

DoE – Departments of Education

EIK – Explicit Indigenous Knowledge

IK – Indigenous Knowledge

IKS – Indigenous Knowledge Systems

MKO – More Knowledgeable Other

NSC – National Curriculum Statement

OBE – Outcome Based Education

PCK – Pedagogical Content Knowledge

RNCS – Revised National Curriculum Statement

TIK – Tacit Indigenous Knowledge

ZPD – Zone of Proximal Development

CHAPTE ONE

INTRODUCTION AND BACKGROUND

1.1. Introduction

Chapter one provides background information of the study and comprises of a discussion on the rationale and problem statement that supports the study. The chapter also highlights the implications of the study. Additionally the aim and the research questions are outlined. Lastly, chapter one contains the summary of the study by providing a short description of each chapter.

1.2. Background

In the previous two decades research demonstrated an upsurge in the interest around discussions concerning the incorporation of IK in the academic curriculums, specifically the science curriculum (Kim, 2015). The growing interest towards understanding IK is linked to increased criticism towards the dominance of Western epistemologies across various education systems in the world (Dziva, Mpofu & Kusure, 2011; Seehawer, 2018). The educational values, knowledge and practices of indigenous people are slowly being acknowledged as responsive and appropriate curriculum for learners in indigenous communities.

IK is associated with the learner's prior knowledge and it influences all teaching and learning activities (Dziva *et al.,* 2011). The learners' ability to construct new knowledge is centered on past experiences, observations, teachings and interactions with community members through different activities and social traditions such as songs, games, folktales, storytelling, ritual practices, initiation practices and others (Bruchac, 2014). Such knowledge is described as IK, traditional knowledge, local knowledge or pre-colonial knowledge (Ojei & Owujuyigbe, 2019).

IK is defined as knowledge based on culture, traditions, values, lifestyles and practices preserved and transferred across generations (Bamigboye, Tshisikhawe & Taylor, 2018; Yohannes, 2018). This specific knowledge is used as a guideline for societies during various

interactions with each other and with their immediate environment for survival (Dlamini & Ndzinisa, 2021; Yohannes, 2018). According to De Beer & Whitlock (2009) IK differs from one region to the other as it is based on knowledge and skills local people accumulate across generations, which enable them to utilise the natural environment in a sustainable manner. Banguru (2005) link IK to indigenous education systems that existed prior to colonialisation. IK can be traced back to traditional ways of learning which existed prior to colonialisation of the African continent by the Europeans.

Although IK has been disregarded in most parts of the world following the introduction of colonial education systems, the topic has gradually gained significance attention as a subject of interest. There is an increased interest in the benefits linked to use of IK in schools. The incorporation of IK in schools can assist indigenous learners conceptualise new knowledge by linking the new content with the learners' existing knowledge, and promotes an in depth consideration of the learners' environment (Mawere, 2015). The use of IK in the science related subjects is likely to yield positive results and can help indigenous learners make sense of the science content (Dziva *et al.,* 2011).

The 'Specific Aim 3' found in the Life Sciences "Curriculum Assessment Policy Statement" (CAPS) states that knowledge obtain in the classroom should empower all learners towards developing an in-depth comprehension of science related topics, and should be relevant to the learner's lives outside the classroom (Department of Basic Education, 2011). This curriculum document stipulates that learners must be exposed to both science and IKS for education to be considerate of learners from varying cultural backgrounds. The learners' social context and cultural background are important factors during educational processes and they influence the learner's ability to achieve learning outcomes (Dziva *et al.,* 2011). Research shows that learners from rural and disadvantaged communities struggle to connect their individual experiences to the science topics taught in schools (Hlalele, 2014; Mandikonza, 2019). Consequently, the 'Specific Aim 3' is not achieved. The 'Specific Aim 3' specifies the purpose of teaching Life Sciences as "to assist all learners towards developing an appreciation of the role of Life Sciences

in their daily lives, and develop a comprehension of the historical developments of science and its connections to IKS" (DBE, 2011). In South African, the current education system embraces diverse cultures and contexts that exist in different communities and constantly investigates opportunities to make education relevant to all learners (DBE, 2011).

1.3. Context of the study

The research was carried out in the Bakenberg South Circuit, Mogalakwena District in the Limpopo province in South Africa. The Bakenberg South Circuit has a total of 32 schools, of which 13 are secondary schools and 19 are primary schools. The secondary schools are further divided into four clusters, namely the Mathulamisha cluster, Nkgoru cluster, Matopa cluster and Rakudubane cluster. The study only focused on schools in Matopa cluster which has a total of six schools. Five schools were identified as research participants, while the remaining school was classified as a pilot study. Therefore, the study presents a case of five Life Sciences' teachers from Matopa cluster.

The schools in the Bakenberg South Circuit are classified as quantile one or quantile two schools. The quantile ranking system is a South African standardised system used to classify schools based on the allocation of funds, financial records and socio-economic standards of the school and community (van Dyk & White, 2019). Schools in quintile one and quantile two rankings are classified as impoverished school and schools in quintile five ranking are classified as affluent schools. The study encompassed schools based in the rural and disadvantaged communities, and therefore four schools were quantile one schools and one school was classified as quantile two school.

The study area was purposively selected due to its location which is the rural area of the Waterberg Biosphere Reserve and being surrounded by a large natural environment. The Bakenberg area is located within the Waterberg Biosphere reserve. The area was declared a biosphere reserve in 2001 by the "United Nations Educational Scientific and Cultural Organisation" (Pool-Stanvliet, 2013). The area was recognised for its outstanding, rich and

unique biodiversity which includes endemic and endangered plant and animal species found in the area. All participating schools are located within communities that are surrounded by a natural environment with rich biodiversity, culture and heritage (UNESCO, 2021). IK is commonly referred to as cultural, native, local, community or traditional knowledge (Nnebuogor & Abimbola, 2019). Therefore, it is expected for people living in communities surrounded by nature and heritage with less industrial influence to rely on IK to survive in their environment. Hence, schools located in rural communities were identified as area of interest for the study.

According to Orgar, Pecl & Musttonen (2020), majority of international problems including global warming, loss of biodiversity, environmental degradation, poverty and other socio-ecological issues are linked to destructive human behavior towards the environment. This concern points to a need to revisit indigenous and traditional knowledge systems used over generations by indigenous communities to live harmoniously with nature (Ogar *et al.,* 2020). The incorporation of IK mainly in the science subjects has the potential to create environmental awareness, relate the scientific concepts to the learners' lives and simplify the science content (Abah, Mashebe & Denuga, 2015; Kaya & Seleti, 2013). The addition of IK in a science classroom could contribute positively towards future development and advancement of scientific knowledge. This study intended to investigate how Life Sciences teachers implement IK when teaching and if the learner's context is taken into consideration when teaching environmental studies.

1.4. IK and Environmental science topics in Grade 11

The CAPS document is a teaching tool that was developed by the DBE in 2012. The DBE requires all teachers in public and private school to use the CAPS document as a teaching guideline for all teaching activities, with the exception of schools using different curriculums. The CAPS document is used as a teaching guideline to align the subject content in different grades, maintain progression and to guarantee that knowledge is relevant to the local and global context (DBE, 2012). Teachers use the CAPS document to familiarise themselves with the

subject content and during lesson preparations. The CAPS document states that IK should be included in all grades and all learning areas (Mavuso *et al.,* 2021). The Life Sciences content taught in grades 10 to 12 is divided into "Three Broad Subject-Specific Aims". The three specific aims are:

1. "The 'Specific Aim One' outlines the specific subject content;
2. The 'Specific Aim Two' focuses on practically doing science which includes practical activities and investigations; and
3. The 'Specific Aim Three' explores the applications of scientific knowledge in daily lives, including the historical developments of scientific discoveries and its relationship to IK" (DBE, 2011).

The study investigated how IK is incorporated during lessons to teach Environmental studies in grade 11. The focus of the study linked with the 'Specific Aim Three' that focuses on the relevancy of science content and its application to the learners' lives. This specific aim also promotes that learners must learn the historical development of science and IKS based on different cultural backgrounds (DBE, 2011). Therefore, acknowledging the value of IK in the curriculum and its importance in the learners' lives. The content in grade 11 is divided into three strands: "Diversity, change and continuity"; "Life processes in plants and animals"; and "Environmental studies" (DBE, 2011).

The study focused on the third strand which consist of topics such as the environmental degradation, climate change, population ecology, resource management, waste management, biodiversity loss and food security (DBE, 2012). Life Sciences teachers are encouraged to incorporate learners' prior knowledge, use local examples and familiar materials to illustrate scientific concepts and clarify concepts using local languages (Mavuso *et al.,* 2021). These strategies create opportunities to connection the new knowledge (science concepts) and the prior knowledge (IK), to use local examples and vocabulary learners can relate to (De Beer & Whitlock, 2019). The incorporation of IK with science is likely to enrich lessons and support

learners towards connecting acquired knowledge with their real-life situations (Handayani, Wilujegu & Prasetyo, 2018). Teachers are required to investigate and familiarise themselves with different teaching practices that are likely to enhance the learning experience and link different knowledge systems to accommodate learners from different backgrounds.

IK is an important part of everyday decision-making in rural communities and it influences decision linked to sustainable utilisation of resources, conservation of ecosystems, fishing and ploughing techniques, forestry, catchment management and waste management (Daas, 2018; Govender *et al.,* 2013; Jaiswal, 2019; Nnebuogor & Abimbola, 2019;). IK also contains valuable knowledge essential towards biodiversity and species conservation within local communities (Bamigboye *et al*., 2018). IK incorporates using advanced technologies and practices developed by indigenous people that promote their survival in a constantly changing environment (Handayani *et al.,* 2018). The use of IK in the school could ensure that knowledge learned at school is transferred into the communities (Nnebuogor & Abimbola, 2019; Pelletier, Gelimas & Potvin, 2019).

The CAPS document also encourages teachers to use teaching strategies that promotes development of problem-solving skills, particularly skills that can be used to solve local issues (DBE, 2012). This requires teachers to prepare lessons that create opportunities to conduct investigations in the communities, collect information from community members, and share findings in the classroom. Stories, discoveries, experiences, knowledge and skills from community members could be used as sources of information and presented in a manner that supports educational activities in the classroom (Vitali, 2016). Teachers can also encourage learners to investigate environmental issues concerning land use, pollution, human impact on the environment and other supernatural forces (Bruchuc, 2014).

1.5. Rationale

The growing interest and accumulation of studies that investigate IK have identified a negative relationship between the learners' knowledge learned at home and knowledge learned at

school (Seehawer, 2018). A majority of learners in rural communities are not able to find a link between the science content and their everyday lives (Mandikonza, 2019). Therefore, they have to constantly switch between home knowledge and school knowledge. This phenomenon is caused by school curriculums that are dominated by Western philosophies and scientific discoveries that promote dichotomy of knowledge and do not address local social issues (De Beer & Whitlock, 2009; Tsindoli, 2018). The current South African curriculum clearly states the importance of using IK in a science classroom but it leaves out the implementation process in the discretion of the teachers (DBE, 2011). This could be a problem as Dziva *et al.,* (2011) eluded that majority of science teachers in non-western countries share a similar perception that promotes science as superior to IK. Therefore, displaying lack of interest and knowledge of indigenous traditions found in their local indigenous communities.

The teacher's perception and knowledge of a subject matter is a significant component of lessons. Teachers are usually described as 'subject specialists' and therefore must have the subject knowledge they intend to teach (Obiekezie & Timothy, 2011). This implies that the teacher's perceptions and knowledge towards IK has an influence on the likelihood of teachers to use IK or not. Dziva *et al.* (2011) discovered that there is inadequate evidence on efforts and initiatives that promotes the implementation of IK in the curriculum and to promote community engagement in schools. There is a need to implement strategies that will improve the habit of incorporating IK in the science classrooms and make education relevant, beneficial and accommodative to all learners from different contexts. This study identified gaps and opportunities that can be explored to assist teachers towards improving the integration of IK when teaching the Life science content.

1.6. Problem statement

The CAPS document outlines the significance of IK in a Life Sciences classroom. The 'Specific Aim 3' conveys that "learners should be made aware to the historical developments of scientific discoveries and its connection to IKS that previously formed the foundation of cultures and heritage" (DBE, 2011). The 'Specific Aim 3' further stipulates that using IK during a science

lesson will ensure that lessons are relevant to all learners' context (DBE, 2011). The CAPS document states that teachers must use examples of IK that are aligned with topics in the Life Sciences content, and those examples must reflect different cultural groups that exist in the country (DBE, 2011). However, the curriculum document does not provide the IK that should be taught or guidelines on how teachers can integrate IK the classroom: The CAPS document does not state any procedure or guidelines teachers can implement to integrate IK and science (Angaama, Fatoba, Riffle & Ogunniyi, 2016). Though the curriculum document states that teachers must integrate IK when teaching science topics, it lacks the IKS content (Madlela, 2023). The above statements lead to many questions that investigate the practicality of incorporating IK in class. It prompts questions such as "what IK content should be taught; when should the IK content be taught; and how should this content be taught (Higgs, 2016)?

1.7. Aim of the study

The intention of the study was to investigate how Life Sciences teachers incorporate IK during an 'Environmental studies' lesson in grade 11. The study further aimed to identify opportunities that can be used to integrate IK during lessons.

1.8. Research questions

Primary research question:

In what ways can Life Sciences teachers use indigenous knowledge to teach environmental studies in a grade 11 classroom?

Sub-questions

1. What are the Life Sciences teachers' knowledge and perceptions about the use of IK to teach environmental studies in a grade 11 classroom?
2. How do Life Sciences teachers use IK when teaching environmental studies in a grade 11 classroom?
3. What guides teachers on the use of IK when teaching environmental studies in a grade 11 classroom?

1.9. Significance of the study

The study will add value towards increasing the knowledge, perceptions and discussions around the value of IK in the education systems. The research findings will be used by different stakeholders such as policy developer, curriculum advisors and implementers, education managers and teachers during discussion that seek to improve the country's education system. The study will motivate Life Sciences teachers to assess their knowledge and perceptions towards IK and identify the value of using IK in a science classroom and other subjects. The findings will stimulate and guide discussions within the DBE and highlight gaps that exist between the science content and the learner's social context, and how IK can bridge those gaps. It will also influence future research and academic discoveries. Lastly, the study will contribute towards advancement of the South African education system towards becoming a valuable tool for all South African citizens.

1.10. Overview of the dissertation

1.10.1. Chapter one

Chapter one contains the introduction and background of the study. Chapter one also introduces the research topic, context, problem statement, rationale and the significance of the study. In addition, the research question, including the research sub-questions are outlined. Lastly, chapter one also presents a summary of each chapter presented in the dissertation.

1.10.2. Chapter two

The chapter two offers a literature review of studies that relates to the incorporation of IK during science lessons. It also focuses on building a concrete foundation and justification for the study. The literature review defines IK, discusses the relationship between IK and Environmental sciences, recent curriculum reforms in the country, and the impact of the teachers' 'Pedagogical Content Knowledge' towards the integration of IK. This section further evaluates the 'Theory of Social Constructivism' as the proposed framework for the study, including analysis of its strength, limitations and application to this study.

1.10.3. Chapter three

Chapter three outlines the research design and research methodology used for the study. This study followed a qualitative research design and the purposive sampling method was used to identify research participants. Data collection combined multiple techniques including semi-structured interviews, nonparticipant observations and document analysis. The chapter also elaborates on how trustworthiness was achieved during the research. Lastly, the importance of ethical consideration and compliance in a qualitative study was analysed.

1.10.4. Chapter four

Chapter four reports on data gathered throughout the study. The organisation of results obtained from interviews and observations was informed by themes derived from the data. The research findings are then discussed guided by the Grounded theory approach. Chapter four includes presentation of the interview transcripts from all five interviews. Lastly, the chapter presents findings from the CAPS document, grade 11 textbooks and the teacher's lesson plans.

1.10.5. Chapter five

The chapter outlines an interpretation of the findings and formulates a conclusion constructed from the results. The conclusion reports on the participant's knowledge and perceptions towards IK, integration of IK when teaching environmental studies and approaches that can be utilised to improve the integration of IK in the classroom. Furthermore, the chapter discusses the study limitations and recommendations centered on the findings.

11. Conclusion

Chapter one introduces the study, outlines the background information and the context of the study. Chapter one also discusses the rationale, problem statement including the significance of the study. Lastly, the chapter includes an outline of the study by presenting a short narrative of each chapter.

CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1. Introduction

Chapter two evaluates the literature relating to the incorporation of IK during science lessons. This includes analysis of previous studies to build an argument for the current study through careful evaluation of how other researchers have studied similar topics. Chapter two build a concrete foundation and justification for the study. The literature review defines 'Indigenous Knowledge' (IK), review links between IK and science, curriculum reforms in South Africa, IK and Life Sciences, and 'Pedagogical Content Knowledge' (PCK) and the incorporation of IK in the class. This section further evaluates the proposed theoretical framework, Theory of Constructivism, including analysis of its strength, limitations and application to this study.

2.2. Indigenous Knowledge

The last two decades have experienced an increase in awareness among non-western countries to revisit the science-dominated curriculum implemented in non-western countries (Ogunniyi, 2004). The literature reveals an emergent interest towards exploring IK and this led to IK developing multiple faces, interpretations and numerous fluid definitions (Msimanga & Shizha, 2014). These definitions are a result of a growing interest among researchers and the nature of academic conversations towards understanding IK and its practices (Magni, 2017). IK is also identified as local, cultural, traditional or community knowledge that contains essential and unique knowledge endemic to a particular geographic area (Bamigboye, 2016; Govender, Mudaly & James, 2013; Nnebuogor & Abimbola, 2019). IK is also defined as knowledge developed and shared among local people to achieve a complete understanding of their immediate environment (Seehawer, 2018; Yohannes, 2018).

IK is based on culture, traditions and lifestyle practices developed through trial and error, experiments, wisdom and historical experiences among local people. It consists of sophisticated and dynamic systems based on tested, logical concepts and values representing generational Check this space knowledge and customs preserved through oral traditions, rituals, social observations and practices endemic to a particular region (Bruchuc, 2014). The knowledge is developed and preserved by indigenous people within their geographical region and it is distinguishable from knowledge found in other regions.

There is evidence of IK discovered as early as during the evolution of humans and among native communities in Africa including the Khoi-San and the Bantu people in Southern Africa (Kaya & Seleti, 2013; Seroto, 2011). There is evidence of educational practices, ceremonies and rituals that were practiced as early as the pre-colonial era in African. During these times teaching was mainly conducted by community elders such as chiefs, headmen, diviners, spiritualists and herbalists through formal or informal practices, with the purpose of transferring knowledge to the younger generation (Govender *et al.,* 2013; Nnebuogor *et al.,* 2019). According to Kaya and Seleti (2013) community elderly are regarded as teachers and guardians of knowledge, hence an African proverb that states “when an old man dies a library burns to the ground” (Merculieff & Roderick, 2013).

IK is linked to different rites and rituals that young boys and girls practice depending on their ethnic group and cultural practices. These practices encouraged the transfer of knowledge and preservation of cultural practices endemic to local communities. Indigenous lessons include various aspects of life such as psychology, emotional intelligence, social interactions, cultural values, morality (ubuntu) and spiritual growth as the foundation of wisdom (Govender *et al.,* 2013). IK is an important component of peoples’ wellbeing because it encourages conversations around sensitive issues relating to ethnicity, spirituality, politics, history, culture, nature and environment management (Yohannes, 2018). IK is an important tool towards understanding factors that influenced the structure of ancient and modern societies, culture transformations, spirituality, ensuring sustainability and harmony between communities and the environment

(Muhammad, 2018). IK provides essential information that can be used towards biodiversity and species conservation (Bamigboye, 2016).

The arrival of Europeans in Africa threatened the survival and integrity of IK, however indigenous people adapted different strategies to preserve this knowledge (Bruchuc, 2014). Indigenous communities have developed different practices such as sharing folktales, proverbs, poems, songs and dances, games, rites and rituals, festivals and political practices to preserve IK within their communities (Bruchuc, 2014). In recent years, research has focused on investigating opportunities of using IK to mitigate challenges caused by human developments, advanced technologies and the rapid human population growth. IK is integrated into different fields of study such as health, ecology, natural resource management, biodiversity, environmental conservation and education (Magni, 2017).

The South African institutions of higher education has demonstrated efforts towards promoting IK through research and scholarships that addresses Indigenous Knowledge Systems (IKS), nature conservation, climatology, agriculture and other environmental studies (Osman, 2010). However, despite recent developments, IK is often classified as unscientific, primitive, rural, savage and backward, and as a result it is often neglected by most academics in favor of Western philosophies (Da Silva, Pereira & Amorim, 2023). Mdhluli *et al.* (2021) have identified recent developments as 'little efforts' and not sufficient to preserve the African Indigenous Knowledge Systems, which may consequently lead to potential extinction of old methods of knowledge within communities. Kaya & Seleti (2013) also referred to the developments as 'limited efforts' due to lack of a clear conceptualisation of 'knowledge' grounded on intellectual and origin of ideas based in Africa. Therefore, researchers should increase efforts to improve the understanding of knowledge that promotes the incorporation of IK in academic institutions (Govender *et al.,* 2013). African scholars should develop an African indigenous paradigm and philosophy or theoretical framework that could provide principles towards integrating AIKS into the education systems (Owusu-Ansah & Mji, 2013).

There is limited literature on different types of IK. Slade & Yoong (2014) identified two forms of IK as the “Explicit” and “Tacit” Indigenous Knowledge as presented below:

1. Explicit Indigenous Knowledge (EIK)

EIK is defined as cultural knowledge that is simply processed, conversed and preserved in many forms of data base (Aksa, 2020; Slade & Yoong, 2014). EIK is also referred to as the ‘know-what’ knowledge (Gamble, 2020). It is a combination of facts, laws and policies that can be collaborated in books, printed material or any electronic form and shared without the need for justification (Slade & Yoong, 2014). Examples of EIK include names of trees and animals, ploughing methods and haunting techniques. EIK can easily be stored in computer based models and printed materials such as books, making it easier to transfer and share with a larger audience (Dalkirk, 2013).

2. Tacit Indigenous Knowledge (TIK)

TIK is based on practice or action-oriented knowledge that cannot be easily expressed (Aksa, 2020; Slade & Yoong, 2014). TIK refers to the abilities, skills and information obtained through personal experiences that may not be easily expressed verbally (Kumar & Sivakumar, 2023). TIK is also referred to as an ‘individual’s intuition’ or the ‘know-how’ knowledge that exists in the individuals mind; therefore it is difficult to encode or express TIK verbally (Gamble, 2020). This knowledge is mainly based on personal insights, observations, past experiences, emotions, values and perceptions accumulated over time. Contrarily to EIK, TIK is seldom found in books, printed materials or any electronic forms (Slade & Yoong, 2014). Examples of TIK include values, wisdom, intuition and the ability to adapt to challenging situations. TIK can be transferred through formal and informal education settings including one-on-one approach such as couching or mentoring (Dalkirk, 2013). Formal education setting can also be referred to as western educational settings commonly used in schools and informal education usually takes in a form of knowledge sharing within the communities.

2.3. Ontology and epistemology of IK and Science

There is a general agreement and common view amongst scholars when defining ontology and epistemology in research (Kant, 2014). Ontology is the study of reality, existence and the nature

of existence (Kant, 2014; Kayumove & Strom, 2023). It investigates the nature of knowledge that exist in the world and structure of reality (Ahmed, 2008; Al-Saadi, 2014). Ontology is concerned with the question "what is" (knowledge) (Al-Saadi, 2014). On the other hand, epistemology investigates and provides a philosophical understanding on "how we know what we know" (Ahmed, 2008). Epistemology enables researchers towards understanding the origin of knowledge, how it can be obtained, communicated and shared with others (Al-Saadi, 2014).

Ontology is concerned with "what knowledge exists", while epistemology is concerned with "how the knowledge can be obtained and shared". According to Guarino, Oberle & Staab (2009) every knowledge or knowledge-based system is supported by specific ontological and epistemological stances. These ontological and epistemological stances lay a foundation for the nature and structure of knowledge. The next section outlines ontological and epistemological stances that support IK and science as knowledge-based systems.

The immediate similarity between IK and science is that both systems are sources of knowledge (Ezeanya-Esiobu, 2019). Each knowledge system possesses its unique strength and weaknesses. Different knowledge systems may differ in various ways including their ontology, epistemological assumptions, methodologies, cognitive structures, social strategies and contexts (Naidoo & Vithal, 2014). There are numerous ontological and epistemological stances that support different knowledge-based systems. Figure 2.1 presents ontological and epistemological assumptions that support science and one that supports IK.

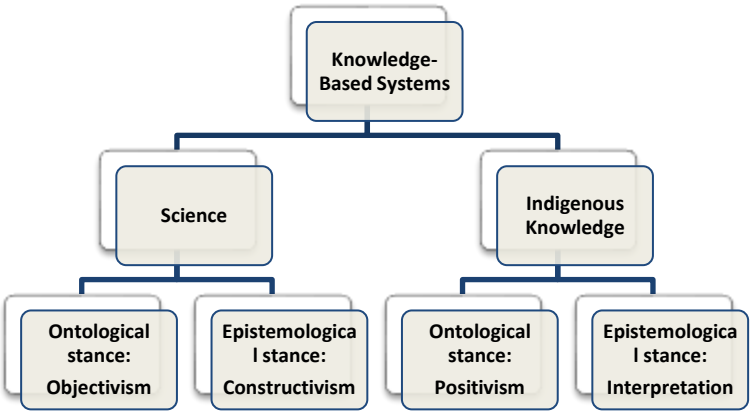

Figure 2.1: Ontological and epistemological stances supporting science and IK.

The ontological stance that supports science knowledge is objectivism. Objectivists uphold that reality is objective and exists independently of human consciousness and beliefs (Ahmed, 2008; Kanti, 2014). Objectivists only accept knowledge based on material and physical world (Al-Saadi, 2014). The Ontological stance that supports IK is constructivism. Constructivist promote that knowledge is not discovered but constructed through interactions between humans and their world, therefore reality is subjective (Ahmed, 2008; Al-Saadi, 2014). IK is local knowledge preserved within a single geographical area or a cultural group, and shared through various forms of oral communication (Seehawer, 2018; Yohannes, 2018). Contrary to IK, science is based on nature and it is established through accumulation of knowledge within various global research institutions; it is documented and easily accessible to a larger audience (Ezeanya-Esiobu, 2019; Naidoo & Vithal, 2014).

The epistemological stance that supports science knowledge is positivism. Positivists focus on obtaining evidence of knowledge that supports the reality of the world, unaffected by humans. Positivists separate themselves from the true reality that exists and rely on facts and values to interpret the world around them. It employs inquiry-based methods of natural sciences and only knowledge obtained through senses is recognised as the reality (Al-Saadi, 2014).

IK follows interpretivism as an epistemological stance. According to interpretivists, knowledge is acquired through “exploring and understanding of the social world”. Knowledge is perceived as subjective to personal experiences influenced by social interactions, and it does not rely on natural sciences and inquiry-based methods (Al-Saadi, 2014). IK is based on practices and past experiences while science is based on tested theories; and IK is shared through oral traditions while science is documented and readily available (Le Grange, 2004). IK considers learning as a life-long process without boundaries whereas science is limited by time-frames and research limitations (Lauter, 2020).

Science is occasionally considered superior to IK because of its objectivity and the ability to provide reliable data based on experimental models, whereas IK is viewed as an inferior source of knowledge due to its subjective nature and being evaluated based on Western criteria (Mazzocchi, 2018; Naidoo & Vithal, 2014). Various studies have provided arguments that contest against the dominance of Western epistemologies in the school curriculum of developing countries. Da Silva *et al.* (2023) argued that IK has a place in academia and educational policies, and should be recognised as a source of knowledge that promotes social justice for learners in rural communities.

IK is diverse, developmental and adaptive to constant changes in the environment, whereas science provides a better understanding of the growing global interest in scientific concepts and technology (Lauter, 2020). Therefore, the two knowledge systems are complementary. IK accumulated in different communities about the local fauna, flora, cultural belief systems, politics, climate change, farming techniques and other topics can be coded, documented and shared on different educational platforms including in schools (Slade & Yoong, 2014).

Integrating IK in schools could improve learners' motivation and self-esteem, promote cultural awareness and its relevance in the science dominated world, and lead towards positive learning experiences (Naidoo & Vithal, 2014). The integration of IK and science will also promote contextual learning based on community values and development of skills necessary towards addressing modern day environmental problems (Sindhya, 2018).

2.4. Curriculum reforms in South Africa

South Africa obtained its independence in 1994 when the new Government of National Unity took over. Prior to the new governance, education was primarily built on the "Bantu Education Act of 1959" and one of the priorities of the new government was to address the injustices created by the apartheid education system (Gumede & Biyase, 2016). In the past two decades IK has gained popularity and interest from many developing countries, including South Africa, and the relevancy of IK towards education has gained enormous attention (Mawere, Kugara &

Tshamano, 2022). South Africa has also experienced an increase in research, publications, conferences and discussions addressing curriculum challenges and opportunities arising since the new governance took over (Gumede & Biyase, 2016). In the recent years scholars have been evaluating the advantages of incorporating IK into the curriculum (Mavuso, Olawale & Mkosi, 2021; Mawere *et al.,* 2022). IKS have become an important component of educational policies and curriculum development discussions in South Africa under the new governance (Naidoo & Vithal, 2014).

The "Outcome-Based Education" (OBE), also known as "Curriculum 2005", was launched in 1997 for the Grade R to Grade 9 (Rankhumise, 2015). Curriculum 2005 marked a paradigm shift from a "content-based teaching" towards an "outcome-based education" that introduced learner-centered teaching strategies that accommodates all learners. One of the strategies listed in the Curriculum 2005 policy states that the curriculum should embrace South Africa's rich cultural diversity, belief systems and worldviews (DBE, 2002). Curriculum 2005 introduced IK in its policies and also introduced Life Orientation as a new learning area to stimulate discussions around cultural diversity, heritage and knowledge systems that exist in the country (Mvenene, 2017). Discussions around IK have since shifted from addressing the "why" question towards identifying opportunities and challenges of successfully integrating IK in the all learning areas (Naidoo & Vithal, 2014).

The "Revised National Curriculum Statement" (RNCS) was launched in 2002 as an effort to address problems encountered during implementation of the Curriculum 2005 (Gumede & Biyase, 2016). The RNCS did not introduce IK as an independent subject but integrated it as one of the principles that supports the curriculum (Naidoo & Vithal, 2014). Principle eight of the RNCS highlights that IK should be part of all subjects taught and the "Learning Outcome Three" (LO3) states that the science content taught in schools should reflect the learners' societal and cultural circumstances (DBE, 2003; Hewson, Java & Holtman, 2009). The "Curriculum Assessment Policy Statement" (CAPS) that was launched in 2012, and over the past decade IK

remained an integral part of the curriculum which is evident in all its policy documents (Naidoo & Vithal, 2014).

Kaya and Seleti (2013) alluded that the "African Indigenous Knowledge Systems" (AIKS) could be used to close the gap between education and developmental challenges in rural communities. The CAPS policy identifies the need to incorporate IK within the curriculum as a strategy to link science concepts and the learners' context. However, there is no specific framework, guiding principles or resources that inform the incorporation of IK in the class (Riffel, 2015). There is an abundance of knowledge among indigenous elders and intellectuals in the communities that should be documented, shared and integrated into the school curriculum. African scholars should also develop an African Indigenous theoretical framework that can be used as a guideline on knowledge construction in an African perspective (Mawere *et al.,* 2022).

2.5. Integrating IK and Science curriculum

While some Western academics portrait IK as outdated and static knowledge, African academics recognise IK as the foundation of modern science and acknowledge the potential for integrating IK and Science (Lauter, 2020; Msimanga & Shizha, 2014). As discussed earlier, there are apparent similarities and differences between philosophies and epistemologies applicable to IK and Western knowledge (science). However, these differences do not prevent the possibilities of integrating the two knowledge systems (Daas, 2018; Bynum *et al.,* 2011). Integration of IK and Science is not a new approach to scientists and academics as history reveals evidence of links between scientific discoveries and knowledge gathered from indigenous communities (Bynum *et al*., 2011).

There are recognisable similarities between IKS and scientific theories in different fields such as agriculture, pharmacology, healthcare, taxonomy, astronomy, conservation and environmental management (Daas, 2018). The similarities between the two sources of knowledge create opportunities for collaborations and integration. Example could include the use of traditional medicinal plants such as *Aloe spp.* to treat skin problems such as infections, injuries and

wounds is also evident in medical sciences and pharmacology (Akaberi *et al.,* 2016). IK provides insightful knowledge for agricultural advancements such as crop production, plant breeding, biodiversity conservation, sustainable development and strategic management (Mashoko *et al.,* 2016; Nicholas-Figueroa *et al.,* 2017). Such examples may include the use of indigenous species as biological control of alien species, the use of medicinal plants in the pharmaceutical industry, the use of indigenous plants to prevent soil erosion in agriculture and forestry, integration of indigenous farming techniques and other relevant examples.

2.6. Challenges towards integration of IK and science

The CAPS curriculum implemented in most South African schools poses a challenge towards the use of IK in the classroom. The CAPS curriculum integrates IK as one of core principles; however Ogunniyi (2004) argues that not much has been done to reflect IK in the school curriculum content. The Life Sciences syllabus in grade 10 to 12 is divided into three knowledge strands as discussed in chapter 1. However, the three knowledge strands are based on and promote science education, and there is no strand based on IK (Madlela, 2023). Attempts to incorporate IK during lessons are limited to "bits that fit" into the existing science syllabus (Mpofu, Otulaji & Mushayikwa, 2014). This therefore limits the type and degree of knowledge that can be incorporated in the classroom.

The shortage of informative textbooks and teaching materials that support teachers with detailed strategies and practical examples remains an obstacle towards the incorporation of IK in the curriculum (Mavuso *et al.,* 2021). Although a majority of textbooks acknowledge the value and benefits of incorporating IK with science, they lack the content and pedagogy that can be used during lessons (Ogunniyi, 2004). There is an apparent need for research to focus on rediscovering knowledge within indigenous communities, document and distribute to different stakeholders (Riffel, 2015). The DBE should initiate collaborations and build relationships between researchers, teachers, scientists, health practitioners and indigenous leaders to co-teach IK at different educational institutions (Mavuso *et al.,* 2021). There is an accumulation of knowledge amongst indigenous elders and other knowledge bearers that can be utilised by

African scholars to establish a connection between IK and the science content (Mawere *et al.,* 2022).

The other challenge towards integration of IK in the classroom is that the curriculum content and training of teachers in higher institutions of learning is based on "scientific mode of inquiry" (Oguniiyi, 2004). Consequently, teachers lack the pedagogical knowledge and subject knowledge to effectively incorporate IK and science (Angaama *et al.,* 2016). A study conducted by Mandlela (2023) established that different education stakeholders, subject specialists and teachers have limited capacity about IK; a majority of teachers have received limited or no training towards the use of IK; schools are understaffed and teachers are overloaded with work; there are no teaching resources to integrate IK in the classroom; and there is lack of support from the DBE. However, a study conducted by the South African Social Attitude Survey (SASAS) in 2009 assessed perceptions and attitudes of South African teachers towards IK and revealed that sixty six percent of teachers believed that the integration of IK in the classroom could be beneficial to learners (Madlela, 2023).

A majority of industrialised countries such as the United States, New Zealand, Australia and Canada have invested in educational initiatives that accommodate indigenous learners through the use of IK when teaching the science content (Desmarchelier, 2020). African scholars should identify and explore opportunities to learn from countries that have successfully integrated IK in their schools. This will assist researchers in developing policies and resources that can be utilised to incorporate IK in the curriculum, link the home knowledge and school knowledge, and contextualise the curriculum in schools. The combination of IK and scientific concepts could improve the value of education to the learners' lives and lead towards improved quality of lives in rural communities (Msimanga & Shizha, 2014).

2.7. Linking teachers' PCK and integration of IK

Pedagogical Content Knowledge (PCK) was first integrated into educational research by Shulman (1987). PCK developed as a counterpart to the "Missing Content Paradigm" which

focused on teacher development (Shing, Saat & Loke, 2015). Shulman was concerned about the teachers' training programmes, which he described as focusing on teaching methods (pedagogical knowledge) and ignored the teachers' content knowledge (Rollnick & Mavhunga, 2014). Over the years different researchers such as Grossman (1990), Veal & Makinster (1999), and Barrnett & Hodson (2001) have expanded and modified the concept and their contributions include development of different models that enhance interpretation and application of the PCK.

PCK is defined as the teacher's unique understanding of the subject and pedagogical knowledge (Cochran, DeRuiter & King, 1993; Puteh, 2014). PCK is centered on what the teacher knows about the subject and what the teachers know about how to teach. PCK combines the teacher's subject knowledge and teaching practices that promote an effective learning environment for learners with different learning abilities and disabilities Guerriero (2017). PCK focuses on ways to improve learner's understanding, organisation of content, accommodation of diverse learners and elimination of teacher's misconceptions in the classroom (Puteh, 2014). PCK considers what the teacher knows and how the teacher presents the subject to the learners.

Cochran *et al.* (1993) developed a revised version of Shulman's original PCK model. The revised PCK model was designed to support the constructivist perspectives on teaching and learning processes. The revised model was divided into four major components:

1. Pedagogical knowledge – knowledge of different teaching strategies and selection of the most appropriate strategy for the lesson, content and learners;
2. Subject knowledge – curriculum and subject content knowledge;
3. Knowledge of learners and learning - learner profiling which includes the learners' cognitive development and learning barriers that may exist;
4. Knowledge of general and specific educational contexts (Cochran *et al.,* 1993; Martina *et al.,* 2020b).

The revised PCK model demonstrates four major components of the teacher's PCK composed of diverse forms of knowledge that includes the pedagogy, subject, curriculum, contexts, and knowledge of learners and learning. A teacher should be knowledgeable of his or her learners and be considerate their learning abilities and disabilities, motivations, attitudes, values, cognitive developmental levels and prior knowledge. The knowledge of specific contexts incorporates the knowledge of factors that may influence the learning process such as culture, traditions, societal values, economics, politics and other factors relevant to the learner's context (Cochran *et al.,* 1993).

Although there is inadequate research on how teachers construct PCK, previous studies confirm that PCK is influenced primarily by the teacher's attitude, motivation, subject knowledge and classroom experience (Mohammed, 2015; Shing *et al.,* 2015). Other factors that may influence PCK includes the teacher's learning background, values, belief systems, teaching preferences and previous experiences (Shing *et al.,* 2015). Novice teachers begin their teaching careers with limited PCK based primarily on their personal perceptions and subject matter knowledge obtained during training in college or university. The knowledge advances as the teacher accumulates more knowledge and experience while working as a teacher Thus it is expected of novice teachers to have limited or no PCK, while experienced teachers have advanced PCK (Krepf *et al.,* 2017).

Teachers are classified as subject specialists and bearers of knowledge, therefore they are expected to possess sufficient knowledge of the subject they intend to teach (Guerriero, 2017; Obiekezie & Timothy, 2011). The teacher's subject knowledge influences the teacher's perception towards the subject, and consequently influencing the teaching practices in the classroom (Putch, 2014). PCK influences the teachers' competency towards delivering the subject and it also influences the learner's overall achievement (Martina, Syafryadin & Rakhmanina, 2020). The teacher's perception of IK is also influenced by pedagogical practices implemented in institutions of higher learning which continues to perpetuate Western philosophies and under-value IK (Mavuso *et al.,* 2021).

A majority of science teachers in non-western countries, which includes South Africa, share a similar worldview towards science and have limited knowledge of IKS (Dziva *et al.,* 2011). Most science teachers perceive science as superior knowledge in comparison to IK (Mazzocchi, 2018; Naidoo & Vithal, 2014). When a teacher's PCK is limited, it reduces the teacher's confidence to present the subject and increases probabilities of misconceptions on the subject matter (Putch, 2014). PCK also influences the teacher's decision-making processes such as lesson planning and design, teaching approach and spot-on decisions made in the classroom (Guerriero, 2017). Therefore, the teachers limited knowledge of IK and perceptions results in teachers neglecting the integration of IK when teaching science concepts (Mavuso *et al.,* 2021).

Thus far, research indicates that the teachers' PCK is critical towards achieving excellence in teaching and knowledge attainment. Teachers should have sufficient PCK and necessary skills to transfer knowledge to the learners in a meaningful manner (Putch, 2014). Teachers who possess little or no knowledge of IK will be reluctant to use IK in the classroom. Despite gradual increase in awareness with regards to the connection between the teacher PCK and learner's achievement, there is limited research that investigates this relation based on classroom observations to support Shulman's theory (Guerriero, 2017).

2.8. Theoretical framework

A theoretical framework is commonly referred to as a "blueprint" that guides the research process (Adom, Hussien & Agyem, 2018). Similar to any blueprint, a theoretical framework sets a foundation or principles that inform a study and it provides justification for conducting the research and the choice of approach and methodology (Crawford, 2020). Grant and Osanloo (2014) identified a theoretical framework as a research strategy that guides the rationale, literature review, research approach, design, technique(s) and other important aspects of research. A theoretical framework is established from a single theory or multiple theories in the same field of study (Adom *et al.,* 2018). It provides a common ground for a particular research focus and outlines findings of previous studies. A theoretical framework can be used to identify

significant developments, existing research opportunities and position the study in the academic field (Kivunga, 2018). Choosing an appropriate framework is important as an inappropriate choice may result in deviating from research objectives and consequently loosing focus (Adom *et al.,* 2018).

A theoretical framework is informed by research objective(s) and the researcher should select a Theoretical framework or Conceptual framework suitable for the study. A theoretical framework informs the researcher on how to explore the research problem or hypothesis (Adom et al., 2018). The Theory of Social constructivism was selected for this study. Constructivists hold the assumption that learners construct knowledge individually and collectively from their social environment through personal experiences and reflections (Akpan *et al.,* 2020; Degar & Yadav, 2016).

The theory of Social constructivism is appropriate for this study as it acknowledges the influence of the social environment on the learners' ability to construct knowledge. The literature review defined IK as local knowledge essential for the survival of indigenous people in a particular geographic area (Bamigboye, 2016; Govender *et al.,* 2013; Nnebuogor & Abimbola, 2019). IK is composed of peoples' experiences, expressions, understanding and interpretation of different phenomena, collaborative learning and social interactions (Yohannes, 2018; Seehawer, 2018). The knowledge is preserved and shared through various oral traditions between community members and transferred from one generation to the other (Govender *et al.,* 2013).

IK is an essential component of the learner's culture and social environment, as it influences the learner's prior knowledge. Consequently, the learner's prior knowledge, understanding of concepts and their immediate environment influences their ability to construct and conceptualise new knowledge (Liu & Matthew, 2005). The study focuses on how Life Sciences teachers integrate IK during lessons when teaching environmental studies in grade 11. Social constructivism considers the influence of societal and cultural structures during the teaching-

learning processes (Roy & Saha, 2021). The theory perceives learners as active participants, and knowledge is based on perceptions, experiences and the learner's social context. The study investigated how Life Sciences teachers integrate the learner's knowledge gained from the society they live in.

2.8.1. Key concepts under Social Constructivism

2.8.1.1. Mediator of learning

Mediation of learning is one of the key concepts that distinguish the theory of constructivism from other theories (Fadeev, 2019). The theory describes a teacher as a mediator who facilitates the learning process between the learner and subject. The teacher's responsibility as a mediator of learning includes providing learners with support towards developing knowledge and problem solving skills necessary to work independently and collectively with their peers (Cholewinski, 2009). Teachers as mediators of learners should create a positive learning environment where learners can share ideas, encourage active participation of all learners, promote a democratic classroom by encouraging self-motivation, and integration of interactive activities that encourage collaborative learning (Hamamorad, 2016; Terpollari, 2023).

2.8.1.2. Zone of Proximal Development

Teachers mediate learning within the learner's "Zone of Proximal Development" (ZPD) as demonstrated on figure 2.2. The ZPD model is divided into three zones of development:

1. The first zone is the 'Actual Developmental Zone' that describes the learner's current understanding of the subject or 'what the learner can do independently' without the assistance of a teacher as the mediator of learning;
2. The second zone is the ZPD that describes what the learner can achieve with the assistance of a teacher. The ZPD portraits a teacher role as a mediator of learning that promotes cognitive development. Some scholars identify the ZPD as the "Zone of Potential Development" or desired development level achieved with the guidance of a teacher. The ZPD is determined by the learner's problems skills after mediation has taken place;

3. The third and last stage is the zone beyond the learner's reach which describes 'what the learner cannot do even with the help of the teacher'. (Nino, 2023; Shabani, Khatib & Ebati, 2010; Thompson, 2013).

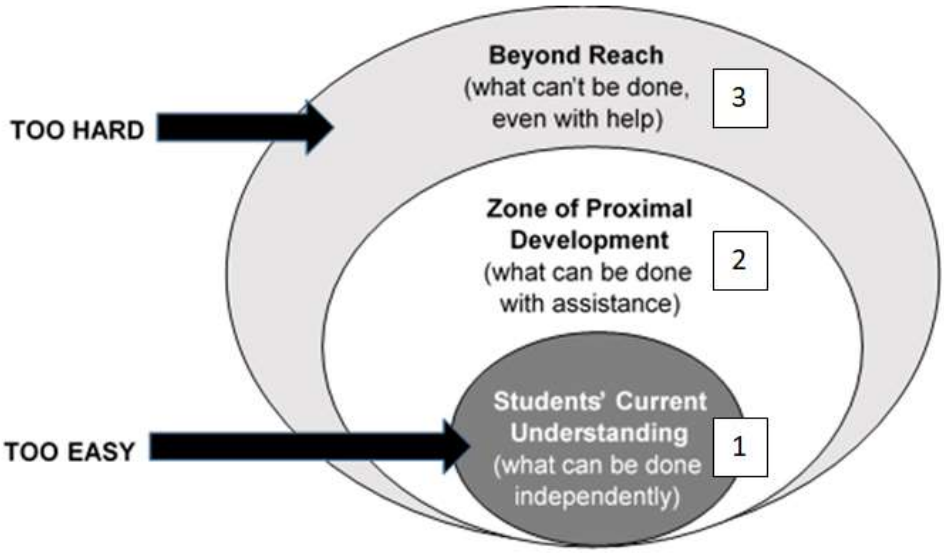

Figure 2.2: An illustration of the ZPD model (Fadeev, 2019; Roy & Saha, 2021).

2.8.1.3. More Knowledgeable Others

The theory of Constructivism also describes a teacher as a More Knowledgeable Others (MKO). The theory describes MKO as an individual who is more knowledgeable when compared to the learner, and who occupies the role of a mediator within the ZPD (Fadeev, 2019). Teachers, peers, adults or any young person who has a better understanding of the subject can be identified as a MKO. Teaching resources such as videos, computers, pictures, books, articles and other object that promotes learning are also classified as agents of learning within the ZPD (Thompson, 2013).

The ZPD and MKO demonstrate that for learning to take place, teachers should take on the role of a mediator and facilitate the learning process. This process is then evaluated based on the learner's initial or actual developmental zone prior to the lesson and the learners ZPD when the

lesson is completed (Cholewinski, 2009). The initial developmental zone is evaluated based on the learner's initial problem solving skills prior to learning and the potential developmental zone is based on the learners' problem solving skills after being guided by a MKO (Nino, 2023). The ZPD is a gap between what learner cannot do prior to mediation and what learners can do after mediation has taken place (Roy & Saha, 2021). The next section presents scaffolding as a teaching strategy used during learning and teaching processes.

2.8.1.4. Scaffolding

Scaffolding is a teaching strategy that was developed by Vygotsky as a concept of working in the ZPD (Shabani *et al.,* 2010). Scaffolding is associated with socio-cultural theories and it focuses on the learner's ability to construct new knowledge through the help of a MKO (van de Pol, Volman & Beishuizen, 2010). Scaffolding is based on three key features or characteristics: 1) it encourages dialog that promotes sharing of knowledge; 2) it promotes problem-solving activities that require temporary support from a teacher and 3) it incorporates the use of artifacts that mediate knowledge (Cholewinski, 2009; Nino, 2023; Shabani *et al.,* 2010).

Scaffolding requires teachers to logically organise the educational activities in a fun and interactive manner which avoids repetition that may lead to boredom, promote knowledge construction, and development of connections between concepts (Taber, 2018). Through the use of scaffolding, a teacher provides learners with necessary support to move from the Initial Developmental Zone towards the ZPD. The desired zone is characterised by the learner's able to internalise knowledge and work independently to solve his or her problems. This therefore means that scaffolding within the ZPD demonstrates the importance of social relations and the teacher's role as a MKO in the teaching-learning process (Nino, 2023).

2.8.2. Principles underpinning the theory of constructivism

Constructivism takes a learner-centered approach in the classroom (Ultanir, 2012). As discussed earlier, a teacher in a constructivism classroom takes a role of a mediator and learners are active key role players. The theory creates an opportunity to integrate the learners' 'real world

contexts' into the classroom, which creates an opportunity to interrogate the learner's existing knowledge based on ideas, values, traditions, concepts and other aspects learned from the community. Social constructivism supports the impression that knowledge develops through shared experiences and social interaction (Akpad *et al*., 2020). The theory encourages the use of teaching activities that promotes active participation such as group work, brainstorming, case studies, research projects, problem-solving scenarios, dramatisation, and jigsaw among others (Dagar & Yadav, 2016).

The following principles or pedagogical goals guides learning under a constructivist environment. Teachers and learners should:

- Create opportunities for knowledge construction;
- Acknowledge learner's prior knowledge;
- Discourage competition and promote collaboration;
- Learning should be realistic and contextual;
- Learners must actively participant in their learning process;
- Learning is a social activity;
- Lessons should include a diversity of teaching techniques; and
- Use appropriate learning and assessment activities (Cholewinski, 2009; Dagar & Yadav, 2016; Akpad *et al.*, 2020).

Other major features underpinning Social constructivism encourage learners to identify learning opportunities, interrogate the new knowledge, integrate the new knowledge with prior-knowledge, and link their knowledge with their context (Dagar & Yadav, 2016). It also encourages learners to assume ownership of their learning experiences, share ideas, and use the acquired knowledge in their social environment (Nino, 2023). The study aims to identify whether IK can be used as a mediation tool to eliminate the space between the science content and the learners' social context. The implementation of principles supporting Social constructivism will encourage learner participation in the classroom, lessons will be centered

on realist and relevant contexts, lesson will be informed by learners' social context and knowledge gained can be linked and implemented by learners to solve social problems.

2.8.3. Application of Social Constructivism during teaching and learning practices

Social Constructivism is commonly described as a "learning theory" based on how learners' social contexts influence knowledge construction (Saleem, Kausar & Deeba, 2021). The theory promotes learner-centered activities that focus on the learner rather than focusing on the teacher (Akpan, *et. al.,* 2020). Therefore, there is limited literature that investigates how the theory influences teaching practices. Teachers assume the role of a mediator of learning in a constructivism classroom. The role of the teacher is to mediate the learning process and create a constructivist environment for all learners. Teachers can mediate a constructive learning environment through a selection of pedagogical strategies and activities associated with the theory of social constructivism (Powell & Kalina, 2009).

Teachers are required to prepare and present lessons that encourage self-discovery using pedagogical strategies that promote social interactions. Social constructivism promotes the use of problem-based activities, case studies, simulations, group discussions, research, and discovery-guided learning activities (Saleem *et. al.,* 2021). The theory encourages teachers to use multiple teaching methods to inspire discovery learning, integration of question and answer sessions, and promote dialectic interactions between learners (Powell & Kalina, 2009; Jha & Devi, 2014).

2.8.4. Limitations and strength of Social Constructivism

The theory of constructivism has had significant success and influence in the field of education; however it has also had its share of criticism (Shumba, Ndofirepo & Gwirayi, 2012). In criticising the theory of constructivism, Kirschener, Sweller and Clark (2006) stated that constructivism is a flawed epistemology that promotes unguided teaching techniques that requires minimal involvement from teachers such as group work and discussions. These teaching methods could result in learners being lost and frustrated during lessons, and resulting in misconceptions or

lesson objectives not being met (Alanazi, 2016). Other researchers critiqued that constructivism ignores individual learner development by focusing on group work and social development (Alanazi, 2016; Liu & Matthew, 2005). Classroom discussions are often dominated by learners performing above average, whereas learners performing below average remain in the shadow and unnoticed by teachers (Alanazi, 2016; Liu & Matthew, 2005).

Despite these criticisms, the theory continues to contribute positively towards understanding factors that influence a learning process. Those factors include advancing pedagogical approaches, encourage a classroom environment that promotes learning, teacher take a role of a mediator of learning through the use of learner-centered activities that promotes a positive teaching-learning environment. Some of the benefits associated with the theory of constructivism include that: (1) it offers information to improve knowledge systems; (2) it promotes the use of creative and adaptive teaching methods; and (3) it increases awareness on how learners conceptualise new knowledge (Shumba *et al.,* 2012).

Social constructivism is the most appropriate theory for the study as it addresses issues, concepts and ideas that relates to knowledge accumulated outside the classroom or within the social environment in which learners live. The theory also outlines the principles, ideas, teacher and learner roles, ideal teaching environment and other ideas that support a constructive learning environment. It creates a friendly environment that encourages sharing of knowledge and opinions during group activities. The aim of the study was to investigate how Life Sciences teachers incorporate IK in the classroom. Social constructivism and the literature review demonstrate that a teacher as a mediator of learning can use IK as a tool to simplify the science content into easily relatable content. This can be achieved by preparing lessons that integrates traditional and local knowledge that exists within a particular geographic area (De Beer & Whitlock, 2019).

2.9. Conclusion

Chapter two presented the literature review and the theoretical framework that guided the study. The literature review introduced IK and presented a comparative evaluation of IK and science to identify the synergies. The incorporation of IK in the science curriculum was analysed and the importance of the teachers PCK when teaching science content was evaluated. Social constructivism was presented as a theory that informed the study because it considers the learner's social and cultural context during a learning process. This included an analysis of key concepts such as the ZPD, mediator of learning and scaffolding as important concepts that supports the theory of constructivism. The purpose of the key concepts discussed above is to ensure that knowledge obtained in schools compliments the learner's context. Lastly the chapter presents strength and limitations of the Theory of Social constructivism and how it links to the study.

CHAPTER THREE

RESEARCH DESIGN & METHODOLOGY

3.1. Introduction

The Chapter three comprises of the research design and research methodology applied in the study. The study followed a qualitative research design and interpretivism as the research approach. Research participants were selected using purposive sampling method, focusing on five schools within the Bakenberg South Circuit. Data was collected using multiple techniques which included interviews with teachers, lesson observations and document analysis. The chapter also elaborates on how trustworthiness was achieved during different stages of the research. Lastly, the importance of ethical consideration and compliance applicable to the study is analysed.

3.2. Research design

A research design is a premeditated plan that informs all research process, which includes the collection, analysis and presentation of data (Lelissa, 2018). A research design is an overall-plan that ensures that research questions are appropriately answered and findings are credible and dependable (Asenahabi, 2019). This study was guided by a qualitative research design. Eyisi (2016) describes a qualitative research design as being commonly used in studies that focus on obtaining a better understanding of different social aspects, and also provides data that can be used to evaluate real life situations. Qualitative research has its origin from sociology, anthropology and humanities, and it focuses on exploring a situation as it occurs in its environment and the meaning individuals hold towards the phenomena (Asenahabi, 2019; Boru, 2018). Qualitative research design is ideal for investigating how people interpret the world around them and justification of real-life experiences (Cropley, 2023). Mohajan (2018) pointed that a qualitative research is suitable for the collecting and analysis of non-numerical data.

A qualitative design is applicable for this study as Indigenous Knowledge (IK) is classified as a social aspect due to its link to people's cultures, expressions, belief systems, insights and experiences (Grey, 2014; Lazarus & Jinadu, 2020). Islam (2013) defines IK as a body of knowledge emerging from multiple sources within social processes in a community. IK is built upon social interactions accumulated throughout generational experiences. Therefore, a qualitative research design provides an ideal plan towards understanding teachers' perceptions, knowledge, experiences and how they integrate IK in the Life Sciences classroom.

3.3. Research approach

Different studies have identified positivism and interpretivism as the leading paradigms or approaches that underpin research (Ryan, 2018; Starman, 2013). Positivism is generally used in qualitative studies and it is founded on the concept that "the truth and knowledge are subjective" (Ryan, 2018). Contrarily, interpretivism emphasises the significance of subjective experiences and personification of individuals' experiences (Starman, 2013). Interpretivism is commonly used in qualitative research studies (Ryan, 2018). The study followed interpretivism as its research approach. The use of interpretivism as a research approach focused on obtaining a better understanding of a phenomenon through social experiences, sharing of meaning, interactions and communication (Chowdhury, 2014; Miskon, Bandara & Fielt, 2015).

The objective for conducting the study was to obtain an enhanced interpretation on how Life Sciences teachers incorporate IK when teaching Environmental studies in grade 11. The study focused on the teachers' understanding and awareness towards IK, evidence of IK in the teacher's lesson plans and during lesson presentation. The research questions therefore centered on investigating the teacher's experiences, interactions and meaning held towards IK. The study also analysed elements which may affect the teacher's judgement to use or not use IK. The data was gathered using interviews, lesson observations conducted with five Life Sciences teachers and analysis of documents that informs teaching practices. The teacher's tertiary qualifications, teaching experiences, knowledge, perceptions, and training opportunities relating to IK were also analysed.

3.4. Research method

The study focused on a case of five schools and purposively sampled schools within the Bakenberg South Circuit, Mogalakwena district in Limpopo province. A case study was selected as the appropriate research method. A case study considers the complexity and uniqueness of an occurrence based on its multiple perspectives encountered in a real-life situation (Starman, 2013). Ebneyamini & Moghadam (2018) described a case study as "a realistic investigation that examines an occurrence within its real-life context, and the limitations between the occurrence and context are not clearly noticeable". A case study is a thorough and systematic method commonly applied in research that investigates individuals, groups of people, a community, institution or processes (Heale & Twycross, 2017). Case studies are frequently applied in qualitative research, especially in studies that investigate social sciences and human interactions (Rashid *et al*., 2019; Starman, 2013).

The study investigates how teachers incorporate IK in the classroom, while taking into consideration the unique context of the study. Therefore a descriptive case study was chosen for the study. A descriptive case study provides an opportunity to obtain an in-depth understanding of a phenomenon as it occurs in real-life context (Baxter & Jack, 2010; Hartman, Townsend & Jackson, 2019). It provides the researcher with the opportunity to present a holistic description of the data in a narrative form as it occurs (Pandey, 2019). A descriptive case study was chosen for the study as it creates an opportunity for the researcher to obtain an insight on the use of IK in the classroom through lesson observations and interviews with teachers.

The data collection methods commonly used during case studies includes document analysis, archival records, direct and indirect observations, interviews and analysis of physical artifacts (Campbell, 2015). In addition, Ellinger and McWhorter (2016) recommend using several data sources and applying data triangulation to establish trustworthiness when conducting qualitative research studies. Additional factors to consider when implementing a case study

includes that the study should aim to answer the “how” and “why” questions; the collected data cannot be altered to approve to reject the research hypothesis; the case study must consider contextual factors that may influence the phenomenon; and lastly there are no fixed limitations between the occurrence and the context being studied (Yin, 2003). The study presented a case of five Life Sciences teachers from five different schools in Bakenberg South circuit. The study followed Yin’s case study model demonstrated in Figure 3.1

1

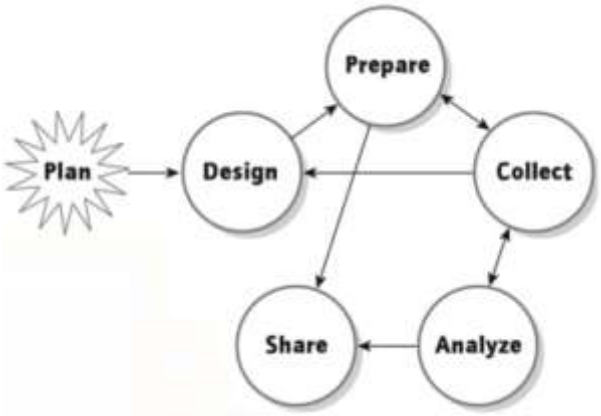

Figure 3.1: A case study model used in qualitative research (Yin, 2018)

1. Plan: The planning stage involves conducting a feasibility study which includes budget estimation and time frame, and identifying the need for the study;
2. Design: During the second stage the researcher selects an appropriate research design and research method(s);
3. Prepare: The third stage includes identification of research instruments that best suits the research needs and validation tests;
4. Collect: Data is collected following the research plan and data collection instruments identified in the third stage;
5. Analyse: Analysis of data leads to data reduction, data display and formulation of a theory or hypothesis.
6. Share: The sixth and final stage entails the writing process and conclusion of the research report (Yin, 2018).

3.4.1. Sampling procedure

The study employed a "purposive sampling method" to choose research participants. A purposive sampling method or judgment sampling is the opposite of a random sampling technique in such that it allows researchers to make deliberate choices on participants depending on their abilities or the research objectives (Doleres & Tongco, 2007). Purposive sampling is mostly applied in qualitative studies as it permits the researcher to make precise decisions about the sample size and participants. The study was conducted within the Bakenberg South circuit, under the Mogalakwena district in the Limpopo province. The circuit was purposively selected due to its location which is rural area (villages) of the Waterberg Biosphere Reserve and being surrounded by a large natural environment. Studies show that IK is associated with indigenous people as it contains important and unique knowledge endemic to a particular geographic area (Seehawer, 2018; Yohannes, 2018). Therefore, people living in rural communities surrounded by a natural environment are likely to integrate IK into their life styles. Five schools from Matopa cluster were purposively selected due to their accessibility, close proximity to one another and willingness to participate in the study.

3.4.2. Sample size

The Bakenberg South Circuit has 13 secondary schools. However the study only focused on schools within Matopa cluster. Each school received a letter requesting permission to conduct research and all schools approved through a formal letter. Only one Life Sciences teacher offering the subject in grade 11 when the study was conducted was selected from each school. The five participants are referred to as participant 1 to 5 throughout the research to maintain confidentiality. The table below displays academic qualifications and teaching experience of each participant:

Table 3.1: Participants' profiles

Participant	Gender	Age (years)	Qualifications	Teaching experience (years)
1	F	32	• Bachelor of Sciences Molecular Life Sciences • Post Graduate Certificate in Education (Senior phase & FET: Life Sciences & Natural Sciences)	5
2	F	28	• Masters of Agricultural studies • Post Graduate Certificate in Education (Senior phase & FET; Agricultural Sciences & Life Sciences)	2
3	M	58	• Advanced Certificate in Education (Life Sciences & Afrikaans)	34
4	F	27	• Bachelor of Sciences Agriculture • Post Graduate Certificate in Education (Senior phase & FET: Agricultural Sciences & Life Sciences)	9
5	F	46	• Advanced Certificate in Education (Life Sciences & English) • Diploma in Life Sciences Teaching	12

M-male; F-female

The participants profile demonstrate that all participants are qualified Life Sciences teachers with relevant teaching qualifications, sufficient number of teaching experiences and could be classified as subject specialists in teaching Life Sciences. According to the literature review, the teacher's qualifications and teaching experience directly influences the teachers' Pedagogical Content Knowledge (PCK) and perceptions towards a particular subject. PCK influences the

teachers' competence in delivering the subject content and it also influences the learner's overall achievement (Martina *et al.,* 2020).

3.5. Pilot study

A pilot study was administered at the sixth school in the Matopa cluster of the Bakenberg south circuit. The objective for conducting a pilot study was to evaluate interview and observation instruments for any error that may negatively affect the study, eliminate biasness and establish time frames for interviews and observations. The pilot study was conducted with the grade 11 Life Sciences teacher. The pilot study established minor error on the interview, mostly language or grammar. The interview instrument was then modified to eliminate errors and improve credibility of the results.

The following changes were made on the interview instrument: On question two and question three, "western science" was replaced with "classroom/ syllabus science". On question five the rating scale (0% to 100%) was included to avoid confusion and participant using different rating scales. The question that investigates the teachers' experience and training on the use of IK was initially one question; consequently it was later divided into two questions. Namely, question eight focused on knowledge and experience gained in college or university, and question nine focused on knowledge and experience obtained while working as a teacher. There were no modifications made on the document analysis and observation guideline.

3.6. Data collection

The data collection process is a critical phase of research due to its potential to negatively or positively influence the research quality and credibility. Choosing inappropriate data collection technique(s) could result in collecting insufficient and unreliable data, leading to the research question not being answered credibly (Kabir, 2016; Taherdoost, 2021). Data collection refers to a logical process of obtaining evidence that can be used to respond to the research questions (Kabir, 2016). There is a vast pool of data collection techniques, however, the technique(s)

selected for a specific study should be guided by the research questions (Parveen & Showkat, 2017).

Three data collection techniques were applied to gather data and these included both the primary and secondary data collection techniques. Using several data collection techniques produces results that are robust and credible when compared to a study that uses a single data collection technique (Davis, Golicic & Boerstler, 2011). Primary data is information collected by the researcher at first-hand experience or data collected for the first time (Parveen & Showkat, 2017). It is data that has not been published, modified, changed and it is regarded as valid, reliable and authentic when compared to secondary data (Kabir, 2017). The primary data was collected using semi-structured interviews and non-participatory observations. During interviews, the participant's responses were documented and later analysed in an attempt to draw a conclusion and answer research questions that relate to the participants' knowledge and perceptions towards IK. The lesson observations created an opportunity for the researcher to experience how participants teach and identify whether they integrate IK during their lessons or not.

Data was also collected through document analysis. Document analysis is classified as a secondary data which refers to data obtained from other sources or previous studies (Parveen & Showkat, 2017). Secondary data plays an important role in research as it provides background information of the topic from previous studies, and it serves as a baseline for the current study (Taherdoost, 2021). The use of secondary data is usually promoted due to its affordability and easy access in comparison to primary data. Secondary data is retrieved from sources of information including published books, articles, newspapers, government reports and a variety of internet sources. The secondary data was collected through the analysis of CAPS, grade 11 Life Sciences textbooks, and lesson plans prepared by each participant.

3.6.1. Semi-structured interviews

Interviews were carried out with five Life Sciences teachers. Interviews are generally applied in qualitative research studies as they encourage a dialogue between participants and researchers (DeJonckheere & Vaughn, 2019). A semi-structured interviews is usually guided by a flexible interview protocol and applies a combination of "closed- and open-ended questions" that allow follow-up questions that asks the 'why' or 'how' questions to encourage a conversation (Adams, 2015; DeJonckheere & Vaughn, 2019). Semi-structured interviews create opportunities to converse with participants in a relaxed setting. A Semi-structured Guideline was designed as a tool to collect data collection during interviews. Interview questions were asked randomly, however all questions were within the research scope (Parveen & Showkat, 2017). Follow-up question or clarity-seeking questions were asked to probe participants.

An Interview was conducted with each teacher at their particular schools. The duration of each interview was between 30 and 45 minutes. Interviews were audio recorded and notes written in a journal, transcripts were later reviewed during the data analysis process. Interview questions were divided into three sections based on the Interview guideline: Section A contained seven questions that investigated the teacher's knowledge and perception of IK; Section B comprised of four questions focusing on the teachers' experiences and training towards the use of IK; and Section C comprised of seven questions focusing on how the teachers uses IK in the classroom and opportunities to improve.

3.6.2. Non-participant Observation

A non-participant observation is a technique commonly used to collection data where the researcher observes a phenomenon and record information as the phenomena unfolds (Kumar, 2020). This involves observing an ongoing behavior or process while creating notes, videos or audio-recordings of the phenomenon (Bekwa, Olivier & van Niekerk, 2019). Observations are usually used as a tool to validate or verify data collected from other sources of data (Kumar, 2020). A non-participant observation limits the researcher's influence and manipulation of the behavior or phenomena being observed by recognising the researcher as an observer not taking

part in the study (Bekwa *et al.,* 2019). Kabir (2016) also suggested that a combination of interviews and observations as data collection techniques produce credible and authentic results. A combination of data collected using different techniques allows the researcher to triangulate, confirm, close gaps and develop a credible theory to answer the research questions.

Five lesson observations were conducted per teacher, resulting in a total of 25 lesson observations. The aim of conduction lesson observations was to observe how Life Sciences teachers integrate IK during lessons and to gain a first-hand experience as teaching takes place in the classroom (Parveen & Showkat, 2017). All observations took place during Life Sciences periods following the official school timetables. Data collected during lesson observations was audio recorded and documented in the journal, and later analysed to derive meaning. A lesson observation tool was designed and used as a guideline during observations.

3.6.3. Document analysis

Document analysis is generally applied in qualitative studies where the researcher analyses any official document relating to the research topic or research questions (Owen, 2014). Analysis of documents involves a logical process of assessing formal documents to generate evidence and meaning in relation to the research questions (Adosi, 2020; Bowen, 2017). According to Morgan (2021) any form of document that contains texts or visuals is a potential source of data, and this may include a variety of documents such as books, journals, articles, newspapers, government gazettes, institutional reports, films, videos and others.

It is common for researchers to intentionally or unintentionally interfere with data during interviews and observations (Morgan, 2021). However, document analysis can be used to clarify, challenge or support data collected through interviews and observation through data triangulation (Owen, 2014). In addition to conducting interviews and observations, the CAPS document, Life Sciences textbooks and lesson plans were reviewed to identify their influence on the incorporation of IK during lessons and identify opportunities of improve. Document

analysis was also intended to identify any form of IK that may have not overlooked during interviews and lesson observations. All documents that were analysed for this study were identified as documents that inform teaching practices on a daily basis. Documents were analysed using a Document Analysis Guideline.

- **Curriculum Assessment Policy Statement (CAPS)**

The CAPS document was designed by the DBE in 2011 as a component of the NRC. The DBE designed CAPS documents for all subjects taught from Grade R to 12. The purpose of implementing CAPS was to improve the execution of the NCS by replacing Subject Policy Statements, subject assessment guidelines and learning programme guidelines starting at Grade R to 12. The target group for the CAPS document is teachers as curriculum implementers.

Teachers use the CAPS document as a policy statement and guideline during lesson preparation and teaching. It provides teachers with important information such as what, when and how to teach each topic. The document outlines topics, specific learning outcomes, sequence and timeframes allocation for each topic, teaching approaches and minimum assessment activities required for each topic. The purpose of the CAPS document is to promote consistence in teaching and learning across the country in all learning areas, and to certify that all learners have equal opportunities to quality education regardless of their social and economic status, race and gender, physical or cognitive ability. The CAPS document intends to groom learners to "identify and solve problems through critical thinking; working successfully independently and with peers in their community; establish themselves professionally; explore opportunities presented by science and technology; and establish appreciation of the world as a connected systems" (DBE, 2011).

- **Grade 11 Life Sciences textbook**

The DBE provides public schools with textbooks for each subject. However, teachers have the opportunity to use additional textbooks or study guides which could add value towards the

teaching and learners process. The researcher obtained three grade 11 Life Sciences textbooks from research participants. Details of the textbooks are presented in Table 4.12 below.

Table 3.2: Description of three Life Sciences textbooks analysed

	Book tittle	Authors	Year of publication	Publisher
1	Solutions for all Life Sciences Grade 11	McKay I., Webb J., Marchant L., Freedman R., Simenson R., de Fontaine J. & van der Merwe C. D.	2016	Macmillian South Africa
2	Understanding Life Sciences Grade 11	Isaac T., Chetty S., Manganye H. T., Mpondwana N. L. & White L.	2012	Pulse Education Services
3	Nelson Mandela University Life Sciences	Munnik L. & Weisswange P. (editors)	2020	Department of Basic Education

Textbooks provide background information and subject content to ensure achievement of minimum requirements stipulated in the CAPS document. The target groups for textbooks are learners, teachers and parents. The textbooks outline the information and expertise that will assist learners towards becoming active partners in their learning experiences, develop necessary skill and knowledge towards becoming true scientists. Teachers are required to use textbooks, study guides and other teaching material aligned with CAPS document to assist learners towards being competent in the subject matter. Teachers use textbooks during lesson planning, lesson preparation and throughout the actual teaching and learning activities. All learning activities including assessment tasks are based on the content presented in the textbooks.

- **Lesson plans**

Teachers are required to familiarise themselves with the CAPS documents and textbooks prior to conducting any lesson. In addition, teachers are required to compile lesson plans in preparation to the actual teaching in the classroom. A Lesson plan is a draft or guiding tool used to transform the curriculum content from the CAPS document and textbook into a fun and educational activity. Lesson plans creates opportunities for teachers to plan their lessons in a creative, interactive and educative manner. It allows teachers an opportunity to organise resources and teaching materials on time, choose appropriate teaching method, time management, prepare assessment activities and learner activity that promotes effective learning.

The purpose of analysing lesson plans was to obtain a better understanding on whether teachers integrate IK during their lesson planning and preparation. A total of 25 lesson plans were collected and analysed. Data was collected using a Document Analysis Guideline. The incorporation of IK in the lesson plan has the potential to assist teachers during the strategic planning phase of the lesson.

3.7. Data analysis

The study applied a Grounded Theory Approach to examine the data. In the recent years, the theory has gained popularity in analysing qualitative data in education, psychology, health sciences and anthropology (Yazdani, Bayazidi & Afshari, 2023). The theory is considered a flexible analysis approach that follows a systematic process to formulate a theory or hypothesis based on collected data (Yu & Smith, 2021). A Grounded theory approach is commonly used to investigate social aspects, relationships, behaviors and processes (Noble & Mitchell, 2016). Analysing data using a Grounded Theory approach includes identification of codes and categories emerging from the collected data and discouraging the use of pre-existing concepts; codes are identified from notes and audio-recordings compiled during data collection; codes

are therefore used to formulate themes that will guide the development of a theory to respond the research questions (Yu & Smith, 2012).

Over the years the Grounded Theory approach has evolved into different forms and it is the researcher's responsibility to identify a suitable approach aligned to the research characteristics, and the relations between the researcher and research participants (Mills, Bonner & Francis, 2006). The Constructive Grounded Theory approach was recognised as the suitable form of Grounded theory to guide the study. A Constructive Grounded Theory approach permits the use of literature review and pre-defined categories (Charmaz, 2014). This approach also supports an analytical writing style that reflects the relationship between the participants' experiences, responses and analytical findings (Mills *et al.,* 2006). The data analysis process concludes with development of a hypothesis or theory derived from research findings. The hypothesis of theory developed must reflect the participants' experiences (Munhall, 2001).

Data analysis using a Grounded Theory approach can be divided into three stages illustrated on Figure 3.2:

1. The first stage is the 'open coding or initial coding' which involved "line by line" coding of the information. The coding process involves assembling, disintegrating and re-assembling data to identify codes that can be utilised to formulate categories (themes). Data collected from all five interviews was analysed simultaneously to identify similarities and differences;
2. The second stage is the 'axial coding or categorising'. In this stage the relationships between categories are evaluated and meaning is assigned to each themes. This process creates an opportunity to reflect on the results and analyse categories in relation to research questions;
3. The third and last stage is 'selective coding or analyses'. The last stage re-evaluates and confirms categories (themes) and their relationships. Categories are then analysed together to draw a conclusion towards developing a Grounded Theory (Gorra & Kornilaki, 2010; Hull, 2013; Noble & Mitchell, 2016).

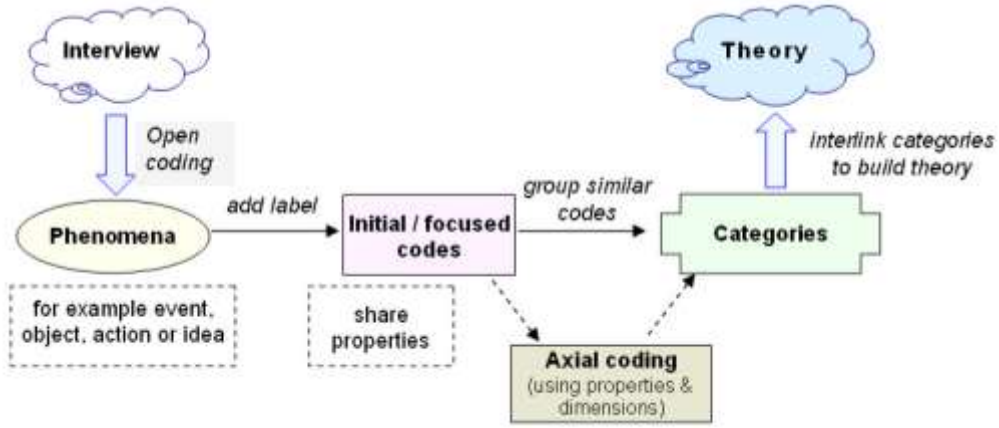

Figure 3.2: Stages of data analysis using a Grounded Theory approach (Gorra & Kornilaki, 2010).

The study implemented the Grounded Theory three stages of data analysis process discussed above. During the first stage, data collected during interviews and data collected during lesson observations was transcribed simultaneously following a "line by line" coding style guided by the Interview guideline and Lesson observation guideline. Transcription of the data included identification of codes prominent in the data. A hybrid coding approach that involved an integration of inductive and deductive coding was used. Deductive coding involves the use of pre-established codes and inductive coding approach involves identification of codes that emerge from the collected data. Pre-established codes were identified from research questions established in Chapter one. An "In-vivo coding" approach was applied to identify codes derived from words quoted from participant's words during interviews and lesson observations.

In the second stage categories were formulated from codes. Four categories (themes) were formulated as follows:

1. Knowledge of IK and integration in the classroom;
2. Perceptions towards IK;
3. Experience and training; and
4. Opportunities to integrate IK in the classroom.

The third and final stage involved analysis of results applying a fusion of thematic, discourse and content analysis methods. Data collected when analysing the Life Sciences CAPS document, textbooks and lesson plans was analysed using the content analysis method. A Grounded Theory was then developed to give a detailed explanation of how Life Sciences teacher integrate IK when teaching Environmental studies in grade 11.

3.8. Trustworthiness in qualitative research

A qualitative research generates opportunities for researchers to gather and interpret data based on people's knowledge and understandings through observation, interviews, narratives and story-telling (Stahl & King, 2020). This therefore prompts the need to evaluate the element of trust and transparency from the participants, researcher, data collection techniques and data analysis methods (Nowell, Norris, White & Moules, 2017). In qualitative research, trustworthiness is measured by evaluating of transferability, confirmability, credibility and dependability which is similar to conventional validity and reliability in quantitative studies (Nowell *et al.,* 2017). Trustworthiness is crucial in qualitative research as it minimises researcher's biasness (Gunawan, 2015). For the purpose of this research, trustworthiness was determined using the criteria developed by Lincoln and Guba (1985). The following discussion outlines protocols and procedures used to address components of trustworthiness throughout the study.

3.8.1. Credibility

Credibility is comparable to "internal validity" in quantitative studies (Nowell *et al.,* 2017). It addresses issues relating to how compatible the findings are in relation to reality. The elements of credibility in qualitative research are influenced by a number of factors which includes the methodology, methods of gathering data and analysis approach used. It evaluates the researcher's credibility to oversee the research process in an authentic manner (Bans-Akutey & Tiimub, 2021; Patton, 1999).

The process of “data triangulation” was applied to attain credibility in the results. “Data triangulation” is a process where multiple sources of data are used simultaneously to identify distinguishable or prominent patterns in the data (Stahl & King, 2020). Data triangulation is based on the principle that a single data collection technique does not provide adequate and reliable data to answer a research question or solve a problem. Using multiple data collection techniques provides different views of the same issue and mitigates weakness rising from each method through the strength of the other method (Bans-Akutey & Tiimub, 2021). Multiple data collection techniques were implemented which included document analysis, observations and interviews. Thus creating an opportunity to triangulate the data, maintain credibility of findings and ensure that data reflects reality.

3.8.2. Transferability

Transferability encompasses the level at which results may be replicated in similar backgrounds or environment (Korstjens & Moser, 2018). Transferability is equivalent to ‘external validity’ as it assesses the feasibility of replicating the research to a wider population (Shenton, 2004). The researcher ensures transferability judgment to potential researcher by providing an in depth explanation of the circumstances and procedures followed throughout the research process. This creates an opportunity for potential researchers to make informed judgement on whether to replicate the research in similar context (Korstjens & Moser, 2018). Transferability of the study was ensured through provision of a detailed background (context), information describing the case study, research methodology and protocols followed throughout the study.

3.8.3. Dependability

Dependability is commonly associated to “reliability” as it addresses issues relating to stability and consistency in the collected data while considering the study’s unique context (Korstjens & Moser, 2018; Shenton, 2004). Similar to “credibility”, the objective of achieving dependability is to minimise the researcher’s biasness and assumptions in the results (Stahl & King, 2020). The researcher achieves dependability through ensuring that all research processes are logically arranged, clearly documented and traceable (Nowell *et al.,* 2017). A comprehensive description

of the research design, research approach, sampling technique, sampling size and justification of data collection techniques is also included in Chapter three. In addition, an interview protocol, observation guidelines and document analysis guideline developed during the study to ensure consistency across all participants during data collection are attached as annexures.

3.8.4. Confirmability

Confirmability is propositional to "objectivity" as both evaluate authenticity of research findings and whether other scholars can obtain identical results implementing similar procedures (Korstjens & Moser, 2018; Shenton, 2004). Confirmability is concerned with confirming findings as true reflections of collected data and not creations of the researcher's imagination. Thus confirming that research findings reflects reality not the researcher's own creation. Lincoln and Guba (1989) articulated that confirmability is accomplished when credibility, dependability and transferability are all attained. Strategies implemented to achieve confirmability includes keeping records of important information and processes leading to justification of decisions that influenced the research processes such as the theoretical framework, methodology, data collection techniques, data analysis approach and other important decisions made throughout the study (Nowell *et al.,* 2017).

3.9. Ethical considerations

Ethical consideration refers to a code of conduct that informs the entire research process (Parveen & Showkat, 2017). Ethics in research are an essential element of research as they promote the well-being, dignity, protection and confidentiality of any information linked to the research participants (Akaranga & Makau, 2016). According to Leedy and Ormrod (2015) researchers should be aware and sensitive towards any potential harm participants may be exposed to during the study. This may include physical, emotional or psychological harm. Researchers must obtain consent from all participants and approval from relevant institutions concerned about the study (Maree, 2016). Ethical clearance certificates were attained from both the Limpopo Department of Education and The University of the Witwatersrand. The following ethical considerations were applied:

1. Participants were informed that participatory was voluntarily. They could decide to not take part or withdraw from participating without penalties;
2. Participants signed a written consent form after receiving an information sheet. Parents also signed a written consent form to acknowledge the learners presence in the classroom during lesson observations. Learners also signed assent forms after receiving information sheets;
3. Participant's details were kept confidential and anonymity was maintained between the researcher and participant. The study had five participants and each participant was assigned a code: Participant 1, 2, 3, 4 and 5 respectively;
4. Participants received continuous feedback throughout the study. Participants will be notified of the outcomes of the study once certified by the University;
5. Transcripts, audio-recordings and journal were preserved in a locked storeroom with limited access.

3.10. Conclusion

Chapter three entailed an in depth analysis of the applied research methodology. It described how information was collected using interviews, observations and document analysis. Document analysis focused on the Life Sciences CAPS document, three grade 11 Life Sciences textbooks and lesson plans. A Grounded theory was applied to analyse data presented in Chapter four, and a combination of thematic, discourse and content analysis approaches will guide the discussion in Chapter five. Chapter three also discussed how trustworthiness and ethical considerations were established through a variety of protocols and procedures implemented during the research.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1. Introduction

Chapter four reports on research finding derived from the collected data. It presents analysis of data from semi-structured interviews simultaneously with data collected from non-participant observation conducted during Life Sciences lessons. The chapter includes presentation of data collected from analysing the Curriculum Assessment Policy Statement (CAPS), three Life Sciences textbooks and participants' lesson plans. The presentation and evaluation of data was informed by the research questions outline in Chapter One. The primary research question investigated ways in which Life Sciences teachers can integrate Indigenous Knowledge (IK) to teach environmental studies in grade 11.

The primary research question was divided into three sub-questions:

1. What are Life Sciences teachers' knowledge and perceptions towards the use of IK to teach environmental studies in a grade 11 classroom;
2. How do Life Sciences teachers use IK when teaching environmental studies in a grade 11 classroom; and
3. What guides teachers about the use of IK when teaching environmental studies in a grade 11 classroom"?

4.2. Organisation of data analysis

The study applied a combination of different data analysis methods. The data from interviews and observation was triangulated and examined using a combination of content analysis, discourse analysis and thematic analysis methods. Data collected from the CAPS document, textbooks and lesson plans was analysed using the content analysis method. Data collected during interviews was evaluated to answer the first sub-question. The discussion was guided by four categories that were derived

from the data. Data collected during interviews and observations was evaluated to response to the first and second sub-question. Data collection from document analysis was examined to respond to the third research sub-question.

4.3. Semi-structured interview and lesson observation results

A semi-structured interview was administered with participants in their respective schools. Interviews were conducted to build a profound conception of the teachers' awareness and knowledge of IK, exposure to training, availability of resources, and to understand how the incorporation of IK during lessons can be improved. Interviews were guided by the Interview Guideline to maintain consistency and avoid diverging from the research aim. Data collected during interviews was analysed using "interview transcripts" presented in table forms. Transcripts included all interview questions and participants' responses as demonstrated in Table 4.1: Participant 1's interview transcript. The participants' answers were later triangulated with data collected during lesson observations. This ensured that information provided by participants during interviews correlates with what transpired in the classroom during lessons.

4.3.1. Participant 1 summary of results

Table 4.1: Participant 1's interview transcript

Interview questions	Participant's answers
Knowledge and perception of IK	
1. How would you describe the term indigenous knowledge?	It is the knowledge passed on from people around you. The knowledge you obtain from people around you and the knowledge is enhanced when reading books
2. How would you differentiate IK from classroom/ syllabus science? What do you mean by "basics of life"?	IK provides the basics of life while science education provides scientific evidence for IK IK is the knowledge children obtain in the villages as

	they grow older. What they learn from others and from experiences such as survival skills
3. Are there similarities between IK and classroom/ syllabus science?	Yes. IK lays the foundation for all knowledge and science expands IK beyond what the learner already knows
4. What are the implications of these similarities and differences that you raised for the classroom?	Learners learn a lot at home and I think it would be easier to teach the science content while building on the knowledge that learners learned at home as their prior-knowledge
5. How would you rate your knowledge of IK (between 0% and 100%)? Why do you rate yourself at 50%?	50% I read a lot of books to improve my knowledge but I still believe that there is a lot I do not know. There is still more to be learned
6. Which examples of IK can you provide?	The traditional ways of brewing beer Traditional medicine such as application of aloe on wounds The use of cow dung to make fire, basically as fuel
7. Can IK be incorporated in a Life Sciences classroom?	Yes. Science validates knowledge learned from home. It assures learners that knowledge learned from home has a place in the classroom
Experience and training about the use of IK	
8. As a student, were there any module(s) that addresses IK at the university or college?	Yes. I studied Zoology at University. We had modules such as Bio-technology and Micro-biology that included aspects of IK but nothing that linked IK and teaching

Are you able to use that knowledge when teaching in the classroom?	*It does not link with what I teach in the classroom*
9. As a teacher, are there any training activities or workshops you have attended which contributed towards your knowledge of IK? Why do you think you have never received training?	No I do not know but maybe the department does not see the need
10. How has the training you received influenced how you use IK in the classroom?	I have not received any training
11. What can be done to improve your knowledge and use of IK? Any suggestions on how the training can be conducted?	The department must organise content workshops and training on how to make IK relevant in school Maybe training can focus on newly appointed teachers
Using IK in the classroom	
12. What does the CAPS document say about the use of IK in the classroom Have you read the CAPS document?	I do not know Yes but I do not recall learning about IK when reading the CAPS document
13. How do you bring/ incorporate IK in the classroom?	Using practical examples of IK that learners can relate to
14. Which examples of IK have you used when teaching environmental studies?	How methane gas can be used as a source of bio-gas
15. In which other topics, grade 11 Life Sciences, can IK be used?	Cellular respiration Anaerobic respiration

16. How do you think using IK could help learners?	IK can help learners to easily relate to the science content. It bridges the gap between knowledge learned from home and knowledge learned in the classroom
17. How do you assess learners using IK? Please explain why	I do not use it I think it is because I do not know how to do so. I have never considered using IK during assessment
18. What could be done to improve the usage of IK when teaching environmental studied in grade 11? Are you interested in learning more about IK?	Most teachers rely only on textbooks as their source of information. Only teachers who are interested in Science and IK consider using it. Teachers must research and read more about IK Yes I am interested. I would grab any opportunity to learn

Participant 1 classroom conditions

The participant's classroom had a total of 32 learners; 21 female and 12 male. The classroom was well organised and spacious with desks arranged in five rows. The sitting arrangement made provision for the teacher to walk in front and between rows when teaching. The classroom had no decorations or charts on the walls. The participant mostly used lecture as a teaching method and constantly asked learners questions to encourage participation during lessons. Participant 1 displayed good classroom management skills and encouraged learners to actively participate throughout the lesson.

Knowledge and perceptions towards IK

Participant 1 demonstrated moderate understanding of IK and rated her knowledge of IK at 50 percent. The participant was able to define IK; however, the participant was not able to clearly distinguish between IK and science. The participant was able to elaborate on how IK and

science are complimentary. According to the participant's response, IK lays a foundation for science: "*Learners learn a lot at home and I think it would be easier to teach the science content while building on the knowledge that learners learned at home as their prior-knowledge".* The participant also values the use of IK in the classroom: "*Science validates knowledge learned from home, and it assures learners that knowledge learned from home has a place in the classroom".* Participant 1 was able to provide examples of IK practiced within the community.

Experience and training on the use on IK

Participant 1 holds a Bachelor of Sciences in Molecular Biology and a Post Graduate Certificate in Education (Further Education and Training). The participant also has five years' working experience as a Life Sciences teacher. The participant accumulated the basic knowledge of IK from modules completed as a student in University. The participant identified the lack of training as one of the challenges leading towards the inability to integrate IK during Life Sciences lessons. The participant suggested that the Department of Basic Education (DBE) should organise content workshops for teachers to train them on how to use IK in the classroom.

The use of IK in the classroom

During the interview, participant 1 admitted to having limited knowledge of what the Life Sciences CAPS document state about the use of IK in the classroom. The participant explained that integrating IK during lessons can be achieved by using practical examples learners can relate to. A total of five observations were conducted with participant 1. Lessons observed during the study were prepared to teach the sub-topic "Interactions in the environment". Each lesson included one or two of the following activities: a verbal presentation prepared by the participant, question and answer sessions, and informal activities.

During the fouth lesson observation the participant was able to incorporate local examples when explaining the concept "predator-prey relationship". Such examples included dogs as predators and rabbits as prey, and humans as predators and impalas as prey. However, there

were a number of missed opportunities to integrate IK, such as accessing learners' prior knowledge at the beginning and throughout the lesson, integration of IK during informal assessments, and the use of pedagogical methods such as investigations and group discussions. During the interview, the participant also identified topics such as "cellular respiration" and "anaerobic respiration" as possible topics that provide opportunities to integrate IK. According to participant 1, "*IK helps learners to easily relate to the science content, and it bridges the gap between home knowledge and classroom knowledge".*

4.3.2. Participant 2 summary of results

Table 4.2: Participant 2's interview transcript

Interview questions	Participant's answers
Knowledge and perception of IK	
1. How would you describe the term indigenous knowledge?	*IK is the traditional ways of doing things*
2. How would you differentiate IK from classroom/ syllabus science?	*Science is the content taught in school and it is practical*
What do you mean when you say "science is practical?"	*Science focuses on things that we can see and prove practically. Like tested theories*
What about IK?	*IK is not taught in schools. It is based on what we learn at home*
3. Are there similarities between IK and classroom/ syllabus science?	*Both are knowledge accumulated over time*
4. What are the implications of these similarities and differences that you raised for the classroom?	*They influence each other. Some IK can be used in the classroom*
Can you elaborate on that?	*Depending on the subject and the topic, some IK can be used in the classroom*

Which subjects can integrate IK?	*Languages, creative arts, geography and life sciences*
5. How would you rate your knowledge of IK (between 0% and 100%)? Why do you rate yourself at 50%?	*50%* *There is a lot that I do not know. I believe my knowledge is average*
6. What are some of the knowledge that you consider as examples of IK in your community?	*Using horns for decoration, using cow dung to build a house or plaster the floor and using cow dung as fertiliser*
7. Do you think IK has a place in the Life Sciences classroom? Please elaborate Can IK be used when teaching life Sciences in the classroom?	*Yes, IK can lead to scientific research in University* *By linking science and IK when doing research* *Yes. But not with all topics*
Experience and training about the use of IK	
8. As a student, were there any module(s) that addresses IK at the university or college?	*No*
9. As a teacher, are there any training activities or workshops you have attended which contributed towards your knowledge of IK? Where did you gain the knowledge of IK?	*No* *I grow up in Venda and growing up in the villages requires basic knowledge of IK because that is how people survive in villages*
10. How has the training you received influenced how you use IK in the classroom?	*N/A*

11. What can be done to improve your knowledge and use of IK?	The department should organise workshops, training and short courses for teachers, and they should also invite local elders to facilitate the training
Use of IK in the classroom	
12. What does the CAPS document say about the use of IK in the classroom? Have you read the Life Sciences CAPS document?	*I do not know* *Yes I have but I don't remember reading anything relating to IK*
13. How do you bring/ incorporate IK in the classroom? Why do you not use IK in the classroom?	*I do not use IK in the classroom* *I don't know how to do it. I focus on what is provided in the textbook*
14. Which examples of IK have you used when teaching environmental studies?	*None*
15. In which other topics, grade 11 Life Sciences, can IK be used?	*I am not sure*
16. How do you think using IK could help learners?	*Using IK can help learners to understand the science content easily and quicker*
17. How do you assesse learners using IK?	*I do not know. It is difficult to integrate IK in the classroom*
18. What could be done to improve the use of IK in the classroom when teaching environmental studied in grade 11?	*Including topics such as how to produce value added goods such as the production of biltong, natural ways to preserve fruits and vegetables such as drying*

Participant 2 classroom conditions

The classroom arrangement was slightly similar to the classroom arrangement in Participant 1's classroom. The bottom sections of the windows were painted brown to reduce the amount of

sunlight entering the classroom. There were a total of 28 learners; 12 male and 16 female. Participant 2 used the lecture teaching style and mostly focused on content provided in the textbook with minimal efforts to encourage learner participation.

Knowledge and perceptions towards IK

Participant 2 demonstrated basic knowledge of IK and rated the knowledge at 50 percent. The participant defined IK as *"... the traditional ways of doing things".* The participant further described IK as knowledge not taught in school but learned from home, and described science as knowledge taught in school: The participant explained that IK and science are interlinked and the integration of IK in the classroom may lead to new scientific discoveries. Participant 2 provided examples of IK practiced in the local community that can be integrated in the Life Sciences classroom. Examples include the use of cow dung as building material to plaster house floors and the use of cow dung as fertiliser. Participant 2 was unable to recall any information or section in the Life Sciences' CAPS document that links IK with science. However, the participant affirmed to have read the CAPS document but do not recall information relating to IK.

Experience and training on the use of IK

Participant 2 holds a Masters degree in Agricultural Studies and a Post Graduate Certificate in Education (Further Education and Training). The participant has two years work experience as a Life Sciences teacher and has not attended any training addressing the integration of IK in the classroom. The participant further explained that none of the modules taught at university integrated IK. Participant 2 accumulated IK from knowledge and experiences acquired growing up in the rural village. The participant identified lack of training, both as a student and teacher, as directly linked to the inability to integrate IK in the classroom. The participant also suggested that the DBE should organise teacher's workshops on the use IK in the classroom: "*The department must organise workshops, training and short courses. They must also invite local elders to facilitate the training".*

The use of IK in the classroom

During the interview, participant 2 admitted to not being informed on what the Life Sciences CAPS document stipulates about the use of IK in the classroom, and the data corresponded with data collected during lesson observations. Five observations were conducted with participant 2; each observation was an hour long and aligned with the school timetable. There was no reference to IK during all lesson observed. The participant mainly relied on the textbook content. The participant would read the information in the textbook and explain the content in the learners' native language, Sepedi. The use of the learner native language was identified as a good practice as it assists learners towards understanding the science content easier.

The participant prepared lessons to teach the sub-topic "population size", which included concepts such as factors that influence the population growth, causes of fluctuations and techniques used to estimate population size. Only two activities were administered during the course of the observations and both activities were derived directly from the textbook. Teaching content directly from the textbook may indicate lack of preparation or lack of knowledge. The participant missed the opportunity to incorporate local examples and assign learners to investigate trends within their community. However, Participant 2 indicated that "*using IK can help learners to understand the science content easily and quicker"* and recommended that teachers should be trained on how to integrate IK during in the classroom.

4.3.3. Participant 3 summary results

Table 4.3: Participant 3's interview transcript

Interview questions	Participant's answers
Knowledge and perception of IK	
1. How would you describe the term indigenous knowledge?	*IK is knowledge that occurs in an area naturally or that has been there for many years, and it is knowledge that has not been brought from another place*

What is the source of such knowledge?	*It is almost like things that people know and understand about themselves and about their environment but no one taught them*
2. How would you differentiate IK from classroom/ syllabus science?	*IK and science are two different concepts. IK is knowledge from home and science is western knowledge*
Please explain your understanding of what western knowledge is?	*This is the knowledge that white people came with. There is knowledge that black people had from the olden days and then there is knowledge that we learned from white people*
3. Are there similarities between IK and classroom/ syllabus science?	*They are different with no similarities*
4. What are the implications of these similarities and differences that you raised for the classroom?	*It is difficult to use IK together with science concepts in the classroom because learners have a negative attitude towards IK. They undermine their own cultures and they do not value it because they think science is better. Learners recognise IK as old and outdated knowledge*
How can we bridge the gap?	*I really don't know because this a majority of this generation regards IK as witchcraft. They would rather buy medicine made from an aloe plant than to collect the plant itself from the mountains and use it*
5. How would you rate your knowledge of IK (between 0% and 100%)?	*Between 40% and 50%*

Why do you rate yourself at 40%?	*My knowledge of IK is not a lot. It is the generations that lived before us that had this knowledge*
6. What are some of the knowledge that you consider as examples of IK in your community? How is the moon used to predict rainfall?	*When people use the moon to determine the weather forecast such as predicting when they will receive the first summer rainfall, and the use of traditional medicine* *I honestly do not remember but I recall growing up adults would talk about it and their rainfall predictions were accurate*
7. Do you think IK has a place in the Life Sciences classroom?	*Yes, IK must be used as the foundation before introducing western education. IK is important*
Experience and training about the use of IK	
8. As a student, were there any module(s) that addresses IK at the university or college?	*No*
9. As a teacher, are there any training activities or workshops you have attended which contributed towards your knowledge of IK? Where did you gain the knowledge of IK?	*No* *I learned IK as a boy growing up in the villages. Most of the knowledge comes from our grandparents, they used to be good teachers*
10. How has the training you received influenced how you use IK in the classroom?	*N/A*
11. What can be done to improve your knowledge and use of IK?	*People who know IK should be encouraged to write books and those books must be part of the school curriculum*

Use of IK in the classroom	
12. What does the CAPS document say about the use of IK in the classroom? In which section of the CAPS document are the examples of IK included?	*It says IK must be used when teaching. CAPS give practical examples that can be used in the classroom* *The section that addresses the content*
13. How do you bring/ incorporate IK in the classroom?	*By using examples when teaching. I use relevant examples only*
14. Which examples of IK have you used when teaching environmental studies?	*The use of an African potato (Hypoxis hemerocallidea) in traditional medicine and the use of Mogaba (common name: wisteria tree, scientific name: Bolusanthus speciosus) to cure hypertension, high blood and sugar diabetes. I have also spoken about the use of cannabis (scientific name: Cannabis sativa) as a flue medicine*
15. In which other topics, grade 11 Life Sciences, can IK be used?	*In all topics*
16. How do you think using IK could help learners?	*It will be easy for learners to understand how nature functions without relying on western education. Learners will be able to link what they learn in the classroom with what they learn at home. It will also help them to understand science better*
17. How do you assesse learners using IK? What is the reason for not using it?	*I do not use it* *I don't know how IK can be used during assessment*

18. What could be done to improve the use of IK in the classroom when teaching environmental studied in grade 11?	*I think people who have the knowledge of IK should write books that can be used together with textbooks in the classroom*

Participant 3 classroom conditions

Participant 3's classroom setting was similar to the classroom arrangements observed in participant 1 and participant 2's classrooms. This is a standard classroom arrangement found in most public schools. Desks were arranged in rows with fewer learners in the classroom. The grade 11 class had a total of 16 learners; 7 male and 9 female. The sitting arrangement and the number of learners in the classroom also created opportunities for the teacher to regularly check learners' work and provide feedback during activities. The classroom did not have any charts or additional teaching materials, only a chalkboard mounted on the front wall.

Knowledge and perceptions towards IK

Participant 3 was well informed about IK. The participant defined IK as knowledge that naturally originates in a particular region, also known as local or community knowledge. The participant further identified IK as knowledge obtained from home and science as "western education" obtained in schools. This is the only participant that identified science as 'western knowledge" and also linked IK to prior colonialism.

Participant 3 advocated for the need to integrate IK with Life Sciences, however the participant also identified the learners' negative attitude towards IK as an obstacle: "*It is difficult to use IK together with science concepts in the classroom because learners have a negative attitude towards IK. They undermine their own cultures and they do not value it because they think science is better. Learners recognise IK as old and outdated knowledge".* The participant further supported that IK should be integrated into each lesson as a foundation that supports science taught in school. Participant 3 further provided examples of IK that can be used in the classroom when teaching environmental studies. According to the participant, IK can be integrated in all topics taught in grade 11 Life Sciences.

Experience and training on the use of IK

Participant 3 holds an Advanced Certificate in Education, specialising in Life Sciences and Afrikaans, and has 34 years of experience working as a Life Sciences' teacher. The participant has not received any training on the use of IK both as a student and as a teacher. The participant accumulated IK from socialising with adults in the village as a young boy. The participant promotes and encourages knowledge sharing within communities and knowledgeable people in native communities should write books to preserve IK and integrate the knowledge in the school curriculums. The participant shared experiences and knowledge gained while growing up in the village. He further shared valuable knowledge gained such as learning efficient hunting strategies, survival strategies that includes identification of eatable plants and navigation techniques, and weather forecast.

The use of IK in the classroom

Participant 3 was the second teacher able to integrate IK during lesson observations. Participant 3 integrated examples of IK provided in the CAPS document and Life Sciences textbook during two observations. The classroom had fewer learners and therefore created opportunities for knowledge sharing between learners and the teacher. During the second observation when teaching the sub-topic "useful plants", the participant referred to examples of useful plants provided in the textbook such as the rooibos, devil's claw, African potato and *Hoodia*. The participant further requested learners to provide examples of medicinal plants used in their local area. Answers provided by learners included the use of kgopa (*Aloe vera*) to treat skin infections and wounds, mosehla (*Peltophorum africanum*) used to treat stomach diarrhea and stomach cramps, and mokgalo (*Ziziphus mucronata*) used during burial ceremonies.

During the fifth observation when teaching the sub-topic "alien plant invasion", the participant lead a discussion to identify alien plants growing in the local communities. The discussion also included reasons these plants were introduced in the area and their impact on the community and environment. Invasive alien plants growing in the local community such as guava, locally

known as moparela (*Psidium guajava)* that produces sweet fruits and the blue gum (*Eucalyptus*) commonly used as a flue medication were identified. During the interview, participant 3 suggested that IK can be integrated in all topics when teaching Life Sciences and that would help learners to relate to the science content easily: "*It will be easy for learners to understand how things function without relying on the western education. Learners will be able to link what they learn in the classroom with what they learn at home. It will also help them to understand the science content better".*

4.3.4. Participant 4 summary of results

Table 4.4: Participant 4's interview transcripts

Interview questions	Participant's answers
Knowledge and perception of IK	
1. How would you describe the term indigenous knowledge?	*I have no idea. I have never heard of it*
Do you think people in the olden days were knowledgeable?	*Yes. I think they were. They could even predict the amount of rainfall they will receive per season. They also had agricultural knowledge*
How would you explain that knowledge?	*I am not sure but I think IK it is traditional knowledge gained from elderly people. Elders teach young ones*
2. How would you differentiate IK from classroom/ syllabus science?	*IK and science is the same thing*
How are they the same? Please explain	*They are the same though I cannot explain how*
3. Are there similarities between IK and classroom/ syllabus science?	*Yes*
Please explain those similarities	*I don't know how to explain it but they are the*

	same
4. What are the implications of these similarities and differences that you raised for the classroom?	(*No answer provided)*
5. How would you rate your knowledge of IK (between 0% and 100%)? Why do you rate yourself at 30%?	*30%* *My knowledge on this topic is limited*
6. What are some of the knowledge that you consider as examples of IK in your community? Any other example?	*Using plants such as the gum tree (Eucalyptus mannifera) to cure flue* *I don't know*
7. Do you think IK has a place in the Life Sciences classroom?	*Yes (no further explanation provided)*
Experience and training about the use of IK	
8. As a student, were there any module(s) that addresses IK at the university or college?	*No*
9. As a teacher, are there any training activities or workshops you have attended which contributed towards your knowledge of IK?	*No*
10. How has the training you received influenced how you use IK in the classroom?	*N/A*
11. What can be done to improve your knowledge and use of IK?	*Teachers should research and read more about IK and the department should organise workshops for teacher*
Use of IK in the classroom	
12. What does the CAPS document say about the use of IK in the classroom? Have you read the Life Sciences CAPS document?	*I am not sure. Maybe* *Yes but not all of it*

13. How do you bring/ incorporate IK in the classroom? What is the reason for not using it?	*I do not usually use it* *When I am in the classroom I focus on what is provided in the textbook*
14. Which examples of IK have you used when teaching environmental studies?	*None*
15. In which other topics, grade 11 Life Sciences, can IK be used? Any other topic?	*Biodiversity* *I am only sure about biodiversity*
16. How do you think using IK could help learners?	*I do not see a need for it in the classroom*
17. How do you assesse learners using IK?	*I do not include it*
18. What could be done to improve the use of IK in the classroom when teaching environmental studied in grade 11?	*Teachers should focus on the science content when teaching in the classroom.*

Participant 4 classroom conditions

The classroom conditions were similar to those described in the previous classes. There was sufficient ventilation, light, the room was spacious and desks arranged in rows. There were a total of 28 learners; 15 male and 13 female. During lesson observations, participant 4's classroom was slightly louder when compared to classes observed with other participants. However, the participant was able to manage the class and continue teaching. The teaching material available in the classroom included the chalkboard, chalks, duster and textbooks.

Knowledge and perceptions towards IK

Participant 4 demonstrated an element of doubt and uncertainty when defining IK and throughout the interview. The interviewer had to ask probing questions to aid the participant towards understanding and defining IK. The participant thereafter defined IK as "... *traditional knowledge learned from elderly people*". The participant was unable to answer most questions or provided ambiguous answers. The participant identified a gum tree (*Eucalyptus mannifera*)

as a plant commonly used to cure flu. The participant rated her knowledge of IK at 30 percentages and recommended that teachers should read more to improve their IK.

Experience and training on the use of IK

Participant 4 holds a Bachelor of Science in Agricultural Sciences and a Post Graduate Certificate in Education (Further Education and Training). The participant has nine years of teaching experience and has not received training on the use of IK. In addition to reading toward improving teachers IK, participant 4 recommended that the DBE should organise workshops to improve the teachers' knowledge and skills to incorporate IK in the classroom: "*Teachers must research and read more about IK and the department should organise teacher workshops".* However, the participant does not promote the use of IK in the classroom.

The use of IK in the classroom

Participant 4 admitted to not using IK during the interview. Five lesson observations were conducted with participant 4 and none of the lessons integrated IK. Similar to other schools, lesson observations were guided by the school timetable and each lesson allocated an hour. Compared to other participants, participant 4's lessons were less organised; lessons started late or ended prematurely. Lessons observed covered the sub-topic "water availability and water quality".

The participant missed multiple opportunities to integrate IK through linking the lesson with local practices observed in the community, especially good practices that can be identified as indigenous or traditional practices. For examples, when teaching about the impact of fertilisers on water quality, learners can investigate local agricultural practices that negatively or positively influence the water quality, and indigenous practices used to minimise the negative impact. The participant also missed the opportunity to integrate IK during informal activities. According to Participant 4, teachers must focus only on teaching the science content and not integrate IK in the classroom. The participant does not value the use of IK during a science lesson.

4.3.5. Participant 5 summary of results

Table 4.5: Participant 5's interview transcript

Interview questions	Participant's answers
Knowledge and perception of IK	
1. How would you describe the term indigenous knowledge?	*It is the knowledge teachers use to assist learners and it helps learners with their day to day lives*
2. How would you differentiate IK from classroom/ syllabus science?	*They are the same*
3. Are there similarities between IK and classroom/ syllabus science?	*They are the same*
4. What are the implications of these similarities and differences that you raised for the classroom?	*Teachers can use IK to explain the content taught in the class and help learners understand better*
5. How would you rate your knowledge of IK (between 0% and 100%)? Why do you rate yourself at 50%?	*50%* *My knowledge is average*
6. What are some of the knowledge that you consider as examples of IK in your community? Please elaborate	*The effect of pollution on the environment* *Learners produce pollution when at home.* *They must learn about how to prevent that*
7. Do you think IK has a place in the Life Sciences classroom?	*Yes (no further explanation)*
Experience and training about the use of IK	
8. As a student, were there any module(s) that addresses IK at the university or college?	*No*
9. As a teacher, are there any training activities or workshops you have	*No*

attended which contributed towards your knowledge of IK?	
10. How has the training you received influenced how you use IK in the classroom?	N/A
11. What can be done to improve your knowledge and use of IK?	*Teachers must attend workshops on how to teach IK*
Use of IK in the classroom	
12. What does the CAPS document say about the use of IK in the classroom? Have you read the Life Sciences CAPS document?	*I do not know. I am not sure if it is included* *Yes I have but I don't remember if it talks about IK*
13. How do you bring/ incorporate IK in the classroom?	*I have never used it before*
14. Which examples of IK have you used when teaching environmental studies?	*None*
15. In which other topics, grade 11 Life Sciences, can IK be used?	*I am not sure*
16. How do you think using IK could help learners?	*It can help learners understand what we teach in the classroom better*
17. How do you assess learners using IK?	*I do not use it*
18. What could be done to improve the use of IK in the classroom when teaching environmental studied in grade 11?	*Teachers need to be trained about IK and how to use it in the classroom because it is important. We do not know how to use it*

Participant 5 classroom conditions

The classroom arrangement was similar to the arrangement described in Participant 1's classroom. The classroom was quiet, well organised and desks arranged in rows. The grade 11 classroom had a total of 17 learners; 9 male and 8 female. Lessons were interactive and participated through asking questions and sharing their knowledge.

Knowledge and perceptions towards IK

Participant 5 demonstrated limited knowledge of IK. The participant was unable to give a clear definition of IK and was unable to differentiate between IK and science. The participant's rating of IK at 50 percentages is questionable because the example of IK provided by the participant was irrelevant. The participant identified "... *the effects of pollution on the environment"* as an example of IK. The participant was also unable to link IK with the Life Sciences CAPS document, provide topics that can integrate IK, and identify examples ok IK that can be used in the classroom. The participant's lack of knowledge was reflected during lesson observations as none of the lessons observed integrated IK.

Experience and training on the use of IK

Participant 5 holds an Advanced Certificate in Education (Life Sciences and English) and a Diploma in teaching Life Sciences. The participant has been teaching Life Sciences in grade 10, 11 and 12 for the past 12 years. The participant also confirmed to not receiving training on the use of IK both as a student and as a teacher. Participant 5 recommended that teachers should be exposed to workshops that educate teachers on how to use IK.

The use of IK in the classroom

During the interview participant 5 confirmed to having limited knowledge of IK and also acknowledged to not using IK in the classroom. Five lesson observations were conducted during Life Sciences periods in grade 11. The participant demonstrated good classroom management and administered an activity at the end of each lesson. Each lesson started with marking of the assessment administered during the previous lesson and linking it with the next lesson. However, there was no evidence of IK during the teaching and learning process, and during assessments.

There were multiple opportunities missed to integrate IK. In one lesson the participant was teaching about the impact of alien plants towards food security. The participant could have drawn examples of alien plants found in the local area and discuss what impact they have towards food security. In another lesson about the "loss of wild varieties", the participant could

task learners to investigate different wild foods found in the areas and different methods used to preserve food practiced in the area. When teaching topics such as “food security”, activities could include investigations, group discussions, presentations, and inviting knowledgeable people to share their knowledge. Participant 5 suggested that teachers should be trained on how to use IK in the classroom as IK can help learners understand the science content.

4.4. Presentation of themes

The analysis of data presented in the participant’s interview transcripts was guided by the three stages of the Grounded Theory. In the first stage, data was transcribed using a “line-by-line” approach and the “In-vivo coding” approach was applied to identify codes or categories derived from words quoted from participant’s answers during interviews. The logical arrangement of the interview questions in the interview guideline also linked to the research questions: Therefore, resulting in a hybrid coding approach that involved a combination of deductive and inductive coding approaches. Pre-established codes were identified from research questions and used as a guideline to interpret codes identified from participant’s answers.

The second stage of data analysis involved classified of codes into categories and relationships between categories were established. Four categories (themes) were formulated as follows:

1. Knowledge of IK and its integration in the classroom;
2. Perceptions towards IK;
3. Experience and training;
4. Opportunities to integrate IK in the classroom.

Table 4.6 demonstrates how codes were formulated form interview questions: Question 11 investigated strategies that can be used to improve the teacher’s knowledge and use of IK. Table 4.6 therefore demonstrates how participant’s answers were recorded and codes derived. Codes derived from the participant’s answers were later analysed and discussed under the relevant theme(s). For example, codes derived from answers in question 11 presented in table 4.6 were discussed under theme three: experience and training towards the use of IK.

Table 4.6: An example on how codes were derived from participant's answers

	Participant's answers	Codes derived from answers
Participant 1	"The department must organise content workshops and training on how to make IK relevant in the classroom"	- Workshops - Training
Participant 2	"The department should organise workshops, training and short courses for teachers, and they should also invite local elders to facilitate the training "	- Workshops - Training
Participant 3	"People who know IK should be encouraged to write books. Those books must be part of the school curriculum"	- Write books
Participant 4	"Teachers should research and read more about IK and the department should organise workshops for teacher"	- Research and read - Workshops
Participant 5	"Teachers must attend workshops on how to teach IK"	- Workshops

4.4.1. Theme 1: Knowledge of IK and its integration in the classroom

The purpose of the study was to obtain awareness of the teacher's knowledge of IK and perceptions towards the incorporation of IK in school. The first interview question up to the seventh question assessed the teachers' knowledge of IK. Assessing whether teachers are able to differentiate between IK and science, provide examples of IK relevant to teaching Life Sciences, and their opinions on the incorporation of IK during lessons. Table 4.6 presents codes obtained from participant's answers when defining IK. Codes such as: local knowledge, traditional knowledge, natural and real life knowledge were identified. Defining IK as

'traditional knowledge' was the most common theme that appeared three times from the participant's answers.

Interview question 1: "How would you describe the term indigenous knowledge"?

Participant 1's answer: *"It is the knowledge passed on from people around you. The knowledge is enhanced when reading books"*

Participant 2's answer: *"IK is the traditional ways of doing things"*

Participant 3's answer: *"IK is knowledge that occurs in an area naturally or that has been there for many years, and it is knowledge that has not been brought from another place"*

Participant 4's answer: *"...IK is traditional knowledge gained from elderly people"*

Participant 5's answer: *"It is the knowledge teachers use to assist learners and it helps learners with their day to day lives"*

Table 4.7: Themes that emerged when participants defined IK

Emerging themes defining IK	Frequencies	Percentage (%)
1. Local	II	29
2. Traditional	III	43
3. Natural	I	14
4. Real-life	I	14

Codes that emerged from the participant's answers align with information discussed in Chapter two where IK is associated with traditions and cultural practices in a specific community or geographic area (Bamigboye, 2016; Govender *et al.,* 2013; Nnebuogor & Abimbola, 2019). Responses provided by participants also promotes that IK develops through shared rituals, trial and error, personal experiences, and wisdom preserved by local people as Magni (2017) alluded in the literature review.

During interviews, four participants were able to provide clear definitions of IK while participant 4 was only able to define IK after few prompting questions. Furthermore, four participants were able to provide relevant examples of IK practiced in their local communities while participant 5's example was not relevant to IK. Examples provided by participants include "*beer brewing, the use of cow dung as fuel*, *interpretation of the moon to determine weather forecast such as predicting the first summer rainfall, and the use of traditional medicine to treat various illnesses*".

Furthermore participants were asked questions that linked IK with Life Sciences content in grade 11. All participants asserted to have read the CAPS document: However, only participant 3 was able to demonstrate knowledge of what the CAPS document say about IK. According to participant 3, the CAPS document "... *says IK must be used when teaching. CAPS give practical examples that can be used in the classroom".* Participant 3 also acknowledged that IK can be integrated in all Life Sciences topics taught in grade 11. Participant 1, participant 2, participant 4 and participant 5 admitted to have read the CAPS document however could not recall what it stipulates about IK. Participant 1 was also able to identify two topics, cellular respiration and anaerobic respiration, as topics that can easily integrate IK. Participant 2, participant 4 and participant 5 were unable to link IK with the CAPS documents and were also unable to provide examples ok IK that can be integrated in the classroom.

During the interview, Participant 1 referred to how local people use cow dung as a source of bio- fuel as an example of IK. The example provided by Participant 1 can be used when teaching "solid waste disposal" and "Human impact on the environment". Participant 3 provided examples of useful indigenous plants with medicinal properties that are found in the local community as examples of IK that can be integrated when teaching topics such as "useful plants". Examples of useful plants in the local area included *lotsane* (African potato) use to treat bladder infections and diabetes, and *mogaba* (wisteria tree) to cure hypertension, high blood pressure and sugar diabetes, and the use of *patse* (cannabis) as a flue medicine. Participant 2, 4

and 5 acknowledged to not integrating IK during their lessons and they were unable to provide examples of IK that can be used in the classroom when teaching environmental studies.

Data collected during lesson observations concurred with data obtained during interviews. Out of 25 lesson observations conducted, five lessons per participant, only three lessons showed evidence of IK. Participant 1 was able to integrate IK during one lesson while participant 3 was able to integrate IK during two lessons. The data therefore demonstrated that teachers have a challenge towards integrating their knowledge of IK in the classroom. Participants were able to provide common examples of IK; however, they were not able to provide examples that can be integrated in the classroom.

Table 4.8: A summary of participant's knowledge of IK

	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5	Total number of participant achieved	Percentage (%)
Define &	√	√	√	√	√	5/5	100%
Differentiate IK from science	√	√	√	×	×	3/5	60%
Common examples of IK	√	√	√	√	×	4/5	80%
Linking CAPS with IK	√	×	√	×	×	2/5	40%
Examples of IK in the CAPS documents	√	×	√	×	×	2/5	40%
Identify topics that can integrate IK in grade 11	√	×	√	×	×	2/5	40%
Integration of IK during lessons	√	×	√	×	×	2/5	40%

Table 4.8 demonstrates that the teacher's knowledge of IK is a critical factor and plays a vital role towards incorporating IK in the classroom. Participant 1 and participant 3 demonstrated moderate knowledge of IK were able to integrate IK in the classroom; whereas participant 2, participant 4 and participant 5 demonstrated inadequate knowledge of IK were unable to integrate IK in the classroom. Teachers should have adequate content knowledge they to impart to learners (Guerriero, 2017; Obiekezie & Timothy, 2011). If teachers lack knowledge of IK it would be difficult to integrate and impart the knowledge to their learners (Putch, 2014).

The data also demonstrates that participants' IK is a combination of Tacit Indigenous Knowledge (TIK) and Explicit Indigenous Knowledge (EIK). TIK can be defined as knowledge obtained through personal experiences and EIK is a combination of documented facts, laws and policies (Slade & Yoong, 2014). The participants' IK consists mainly of information obtained from their immediate community, mostly undocumented, through social interactions and personal experiences. However, the existing IK has potential to be documented, preserved and shared on different platforms. This aligns with the theory of social constructivism. One of the principles of social constructivism promotes that More Knowledgeable Others (MKO) should share their knowledge with those less knowledgeable (Fadeev, 2019). Traditional leaders, chiefs, healers and elders are identified as custodians of IK, therefore they should be encouraged to share their knowledge and write books to document the knowledge.

Data obtained from analysing the Life Sciences CAPS document revealed evidence of IK in three sections. The Life Sciences CAPS document integrates IK in the principles of the NSC curriculum, the "specific aims" of teaching Life Sciences and in the grade 11 content. Firstly, the sixth principle of the NSC promotes the value of IK and acknowledges the diverse heritage of the country as a critical component that underpins the South African constitution. Principle six of the NSC promotes the value of IKS: "*the sixth principle acknowledges the abundant culture and heritage in South Africa as a significant influencer to the country's values and constitution*". Therefore, identifying IK as one of the factors that influence many aspects in the country such policy development, governance, economy and social aspects. Secondly, the "Specific Aim 3" of

the CAPS document specifies the aim of teaching Life Sciences as to promote the learners comprehension on the value of science in their lives. The “Specific Aim 3” communicates the comprehension of applied Life Sciences in daily lives, including historical development of scientific advancements and its association with IKS *(DBE, 2011).*

The “Specific Aim 3” indicates that acquired knowledge must improve interpretations associated with IK and science. The goal of “Specific Aim 3” is to ensure that knowledge and skills obtained in the classroom adds value to the learners’ lives, promotes local knowledge and also considers the global community and its imperatives (Mvenene, 2017). The ‘Specific Aim 3” is critical as it aims to corrects the injustice identified by a study conducted by Mandikonza (2019) that investigated the incorporation of IK practices in science subjects. The study found that learners in poor and underprivileged societies struggle to recognise the connection between the knowledge learned at home and knowledge learned at school. Based on research, the CAPS curriculum has not achieved the set aim of incorporating IK in schools (Mavuso, Olawale & Mkosi, 2021). This study concurred with findings from Mavuso *et al.* (2021) as data collected from interviews and lesson observations demonstrated that participants were unable to link IK with the Life Sciences content, participants were not well informed on what the CAPS document aims to achieve in terms of IK, and therefore lacked knowledge and skills to integrate IK in the classroom.

Analysis of the CAPS document also revealed that the document does not provide a guideline or detailed information on how IK relates to science. Novice teachers or teachers that lack knowledge of IK would find it difficult to elaborate and engage learners with activities that investigate the connection between IK and science. Mandela (2023) also alluded that a majority of novice teachers are not well informed on how to integrate IK in the classroom. The administration of the ‘Specific Aim 3’ hinges on the teacher’s discretion, perceptions and knowledge of IK. There are no guiding principles or specific framework that guides the integrate IK in the classroom (Riffel, 2015). This study identified lack of teaching resources and guiding principles as one of the challenges that hinder the integration of IK in the science classroom.

Lastly, evidence of IK was found in the section that outlines the Life Sciences content taught in grade 11. The study only analysed sub-topics within the environmental sciences topic taught in term 3 and term 4. In this section IK is integrated into the content as examples that support science concepts. Analysis of the content revealed that examples of IK provided in the content section are vague and requires teachers to add additional information that link to their local context. Table 4.9 presents evidence of IK integrated in the sub-topics within the environmental sciences topic taught in grade 11.

Table 4.9: Analysis and evidence of IK in Life Sciences' CAPS document content (CAPS, 2011)

Topic & Sub-topic	**Evidence ok IK in content**
Strand 1: "Diversity, change and continuity"	
Biodiversity and classification of microorganisms	The use of traditional technologies to produce traditional beer, wine and cheese
Reproduction in plants (The significance of seeds)	The importance of indigenous seeds as a source of food
Strand 2: "Life processes in plants and animals"	
Animal nutrition (Homeostatic control)	Analysis of different diets influenced by different cultures, religion, personal and health choices. Those may include vegetarian, vegan and kosher
Energy transformation to sustain life (Anaerobic respiration)	The role of "anaerobic respiration" in industries such as during beer making
Strand 3: "Environmental studies"	
The human impact on the natural	Identification of local examples such as the

environment (Food security)	use of cow dung as fertilisers and pest controller to improve food production
Biodiversity loss	Exploring IKS and sustainable practices that protect the environment. Examples may include sustainable harvesting of indigenous plants
Management of solid waste	Cultivation of methane from the dumpsites for domestic heating and lighting in the households

Data obtained from the grade 11 Life Sciences CAPS document presents evidence of IK in different sections of the document. This therefore concludes that a majority of participants are not well informed or are not familiar with the CAPS document. During the interview, only participant 3 was informed on what the Life Sciences CAPS document stipulates about the integration of IK in the classroom.

Participants were asked to further elaborate on how they integrated IK during assessments. Interview question 17 asked: How do you assess learners using IK? According to the DBE, teachers are required to conduct assessments throughout the teaching and learning process (DBE, 2011). All participants admitted to not using IK during assessments. Participant 2 further identified lack of knowledge as the main obstacle towards integrating IK during assessments. Therefore teachers prefer using standardised assessment activities provided in the textbooks and study guides. This was evident during lesson observations: Though all teachers administered activities regularly, none of the activities integrated IK. The common practice amongst participants was to utilise activities provided from teaching resources obtained online or administer activities provided in the Life Sciences textbooks. The data revealed that teaching methods and assessments administered do not promote the principles of the theory of social constructivism that encourages the use of diverse teaching techniques and appropriate assessment activities. According to the theory of social constructivism, learning and teaching

activities should be realistic and contextual (Dagar & Yadav, 2016). A study conducted by William and Perrone (2018) argued for a need to evaluate assessment practices implemented in academic institutions to accommodate knowledge of culturally diverse learners. Strategies to integrate IK during assessment will be discussed in Chapter five.

The analysis of the Life Sciences CAPS document links directly to the analysis of the grade 11 Life Sciences textbooks. Three grade 11 Life Sciences textbooks obtained from participants were analysed. This study only focused on sub-topics within the knowledge strand "Environmental studies". The structure, presentation of topics, examples and assessment activities were similar in all three textbooks. The incorporation of IK was only evidence in the sub-topic "Loss of biodiversity" in all textbooks. The textbooks provide examples of indigenous medicinal plants that teachers can refer to when teaching about 'useful indigenous plants'. The information in the textbooks includes a short description, picture, historical background information, medical uses, threads and management actions to prevent overexploitation of the plant. The following examples of indigenous medicinal plants were discussed in each textbook. Those include the rooibos tea, devil's claw, *Hoodia* and the African potato:

a. Rooibos

The Rooibos (*Aspalathus liearis*) plant is an indigenous herbal plant commonly used to treat skin diseases, cancer, kidney stones, stomach cramps, headaches and the nervous tension. The herb is usually consumed as rooibos tea. The plantation of Rooibos tea has expanded into the Fynbos biome, threatening endemic biodiversity found in those areas, therefore advocating for a need to initiate strategic management actions to protect threatened species;

b. Devil's claw

The root of a devil's claw plant (*Harpagophytum procumbens*) is commonly used in traditional medicine to alleviate pain, fever and to assist with problems associated with digestion. Some of the strategies used to promote sustainable utilisation of the Devil's claw include replanting the primary root of the plant and physical distribution of seeds to increase the number of plants growing in an area;

c. Hoodia

Hoodia gordonii is a succulent plant historically used by the Khoisan communities and shared across generations as an appetite suppressant during long hunting trips. The plant is also found in various countries within the Southern African region such as Angola, Namibia and Botswana. Recent studies have identified the active compound in the leaves of the plant that can be used in the production of weight loss products;

d. African potato

The African potato (*Hypoxis hemerocallidea*) is a popular medical plant with extensive medical properties and high nutrient value. For many generations the African potato was been utilised by traditional healers and herbalists to cure various illnesses such as vomiting, dizziness, prostate cancer, arthritis and others. Recent studies identified the medicinal use of the plant when treating diseases such as tuberculosis, cancer and Human Immunodeficiency Virus (Isaac *et al.,* 2012; Mckay *et al.,* 2016; Munnik & Weisswange, 2020).

All three textbooks analysed presented opportunities for teachers to investigate and learn more about IK and identify topics that can integrate IK. The textbooks also provide examples of IK and assessment activities that can integrate IK. For example, when teaching about 'the significance of seeds' under Biodiversity, a teacher can task learners to conduct an investigation and collect eatable indigenous seeds in their local community. This activity may assist learners towards building a connection between the science topics in school and knowledge gained at home. All three textbooks do not provide a specific guideline on the incorporation of IK; however they provide fewer examples on certain topics. It is the teachers' responsibility to identify practical examples that link with specific content or topics to be taught.

Teachers have the opportunity to identify appropriate teaching strategies and assessment tasks that integrates IK. Similar to information obtained in the Life CAPS document, the integration of IK using examples requires the teacher to add information to what the textbook provides to

ensure that learners can relate to the examples: Therefore, supporting the view that the teachers' perception and knowledge of IK plays is critical towards the integration of IK in the classroom.

Additionally, a total of twenty five lesson plans, five from each participant, were assessed for evidence of IK. Only lesson plans prepared for lessons observed as part of the study were analysed. The lesson plans collected were presented using a variety of templates. However, all lesson plan templates included a lesson topic, objectives, duration, resources, content to be taught, teaching method, learner activities and assessment activities. From a total of 25 lesson plans analysed only one lesson plan from Participant 3 contained elements of IK. Participant 3's second lesson plan incorporated examples of useful indigenous plants derived directly from the textbook and later integrated during the lesson in the classroom. In total, only three lesson plans out of 25 lesson plans, 12 percent, integrated elements of IK.

Participant 3's fifth lesson also integrated examples of useful alien plants found in the local community though these examples were not evident in the fifth lesson plan. Participant 1's second lesson observation also integrated examples of local animals when introducing the sub-topic "predator-prey relationship" to the learners. However, these examples were not integrated in participant 1's second lesson plan. There was no evidence of IK in lesson plans prepared by participant 2, participant 4 and participant 5. Mpofu *et al.* (2014) associated the inability of teachers to integrate IK during lesson with challenges posed by the curriculum content taught in schools: The curriculum taught in schools is dominated by western philosophies and therefore limits the integration of IK to bits that fit into the existing science syllabus.

4.4.2. Theme 2: Perceptions towards IK

The following discussion focuses on analysing participants' perceptions towards the use of IK in the classroom. The interview question 7 examined participants' perceptions towards IK and its relevance in the classroom, while the interview question 16 investigated how participants think

IK could help learners in the classroom. Participants' responses to the questions revealed that four participants expressed a positive attitude towards IK and its incorporation in the classroom; however, only three participants were able to justify their responses. Participant 1, participant 2 and participant 3 acknowledged that integration of IK during lessons could promote a better understanding of the science content and establish a relationship between the science content and the learners' context. Participant 5 was unable to justify or support the promotion of IK while participant 4 does not promote the use of IK in the classroom. The data corresponds with a study conducted by Mandlela (2023) that concluded that 66% of teachers promoted the integration of IK in the classroom.

The data obtained from interviews align with findings from a study conducted by Mandikonza (2019) which recommends that knowledge should develop from context to concepts. This implies that teachers should consider the learners' social context, access their prior knowledge and therefore introduce science concepts based on what learners know. The science content taught in schools should develop from the learner's social context and integrate new science concepts into what the learners already knows. The answers provided by three participants supported Mandikonza's (2019) observation and also promotes the principle of the theory of social constructivism which promotes learning as a social activity.

4.4.3. Theme 3: Experiences and training on the use of IK

Participants indicated that they have not participated in any training which addressed IK while working as teachers for the DBE. Only Participant 1 confirmed to learning about IK when studying a Bachelor of Sciences in Molecular Life Sciences at university. The participant further clarified that IK was integrated into two modules, namely bio-technology and microbiology, however the knowledge gained did not relate to the use of IK in the classroom. Participant 2, 3, 4 and 5 did not recall any module that integrated IK at university or college during their studies. The data therefore revealed that participants did not acquire knowledge or skill on the use of IK in the classroom from universities or at work; Modules offered at different tertiary institutions

did not integrate IK and the DBE does not organise training on the integration of IK in the classroom.

Interview question 8: ***As a student, were there any module(s) that addresses IK at the university or college?***

Participant 1's answer: *"Yes. I studied Zoology at University. We had modules such as Bio-technology and Micro-biology that included aspects of IK but nothing that linked IK and teaching"*

Participant 2's answer: *"No"*

Participant 3's answer: *"No"*

Participant 4's answer: *"No"*

Participant 5's answer: *"No"*

Participant 3 has been employed as a Life Sciences teacher by the DBE for the past 34 years and does not recall any training or workshop that addressed the incorporation of IK in school. The data supports results from previous studies that lack of training among teachers could be the result of lack of instructive policies, training and implementation of western models on South African schools (Mavuso, Olawale & Mkosi, 2021). Research has demonstrated that a majority of teachers in non-western countries lack pedagogical knowledge and subject knowledge to effectively incorporate IK and science. These phenomena results from training institutions implementing a curriculum based entirely on "scientific mode of inquiry" (Oguniiyi, 2004; Angaama *et al.,* 2016; Mandlela, 2023). There is limited capacity amongst teachers and subject specialists due to limited or no training on the use of IK in the classroom.

4.4.4. Theme 4: Opportunities to integrate IK in the classroom

Based on the collected data, only two out of five participants were able to integrate IK during lesson observations. However, the data also indicates that only three of twenty five (twelve percent) lesson presentations integrated IK and one of twenty five (four percent) lesson plans

incorporated IK. There were a number of missed opportunities that participants could have utilised to integrate IK during lesson planning, lesson presentations and assessment activities.

Lesson plans

A lesson plan provides multiple opportunities to integrate IK. This is an important document compiled by teachers in preparation to teaching in the classroom. Lesson plans are prepared days or weeks prior to the actual lesson. Therefore creating opportunities for teachers to plan ahead of time and collect necessary information. A lesson plan is divided into numerous sections which may include the lesson topic, learning outcomes, duration, resources, teaching methods, learners' activities and assessments.

IK can be integrated in the learning outcomes through outlining what learners are expected to know when the lesson concludes. Outcomes such as identification of indigenous fruits in the local area, or differentiate between alien and indigenous plants growing in the local area could be integrated in the lesson plan. Learning outcomes should connect the Life Sciences content with local knowledge. IK can also be integrated into lesson plans during the lesson introduction through accessing learners' prior knowledge, create an environment where learners can share their knowledge and actively participate during lessons.

IK can also be integrated into learning and assessment activities. Teachers are required to identify suitable teaching strategies and assessment activities that promote learning and encourage learner participation. The theory of social constructivism identifies teachers as mediators who facilitate the learning process. The theory promotes pedagogical strategies that encourage learner-self-discoveries and social interactions. Teachers can integrate IK through the use of problem-based activities, case studies, simulations, group discussions, investigations, and other discovery-guided learning activities (Saleem *et. al.,* 2021). Those activities should be indicated on the lesson plan. The theory of constructivism also encourages the use multiple teaching strategies, question and answer sessions, and promotes dialog between learners (Powell & Kalina, 2009; Jha & Devi, 2014).

Information in the lesson should be evident in the classroom. For examples, lesson introductions could include a question and answer session where teachers assess learners' prior knowledge, knowledge gaps, address misconceptions and facilitate knowledge sharing. Assessment of learning could include activities such as simulations, discussions and investigations that encourage interactions between learners and their environment. Additional missed opportunities to integrate IK are evident in the Life Sciences textbooks. Textbooks reviewed for the study offered minimum information on the integration of IK in the classroom. Therefore there is a need and opportunity to update textbooks to include more information, pedagogical strategies and assessment activities that integrates IK.

Results of the study demonstrate that teachers who are more informed are likely to incorporate IK in the classroom. This confirms that IK can be incorporated during Life Sciences' lessons when teaching environmental studies, provided that teachers are knowledgeable and equipped with skills to prepare lessons that integrate IK. The results concur with Da Silva, Pereira and Amorin (2023) findings that concluded that integration of IK in schools is achievable, however emphasised on the teachers' opinion of the situation as an important factor when engaging in intercultural dialogues such as IK.

4.5. Conclusion

Chapter Four contains results obtained from data collected through interviews with five Life Sciences teachers, 25 lesson observations, analyses of the Life Sciences CAPS document, three grade 11 Life Sciences' textbooks and 25 lesson plans. Data collected during interviews and data collected during observations were transcribed using a "line-by-line" coding strategy. Both deductive and inductive coding approaches were used to identify codes which lead to formulation of five categories (themes) that guided the presentation of data. The next chapter will discuss the findings and formulate a conclusion.

CHAPTER FIVE

DISCUSSION OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

5.1 Introduction

Chapter five outlines the findings, recommendations and the conclusion established on results demonstrated in Chapter four. The discussion highlights the teachers' knowledge and opinions towards Indigenous Knowledge (IK) and the incorporation of IK during lessons when teaching environmental studies in grade 11. The chapter also discusses findings on documents that guide teachers during lesson preparation and classroom practices. Furthermore, the chapter provides the limitations and recommendations of the study.

5.2 Discussion of findings

The results presented in Chapter four revealed that participants demonstrated basic knowledge of IK at varying degrees: all participants were able to define IK, three out of five able to differentiate IK and science, and three out of five promote the integration of IK in the classroom. Four participants were able to provide local examples of IK, however only two participants were able to integrate IK when teaching in the classroom. Only three out of 25 lesson observations integrated IK and one out of 25 lesson plans contained IK. Results demonstrated that participants were unable to integrate their basic knowledge of IK with the Life Sciences content taught in the classroom. However, results further demonstrated that three out of five participants, 66 percent, promote the use of IK in the classroom. Key findings discussed in the next section indicate a paradigm shift in the teacher's knowledge and perceptions towards IK, and acknowledgement of the need to incorporate IK in school.

5.2.1. Key finding 1: The knowledge and perceptions towards IK differ among teachers

The study established that Life Sciences teachers had varying levels of knowledge of IK. Though all participants were able to define IK, only three participants were able to differentiate between IK and science; four participants were able to provide local examples of IK, however only two participants were able to provide examples of IK that can be used in a Life Sciences

classroom when teaching environmental studies in grade 11. Furthermore, only three participants were able to identify topics that could integrate IK. Participants had basic knowledge of IK acquired from their local communities and therefore were unable to link IK and the science content. Similarly, Dziva *et al.* (2011) also concluded that a majority of teachers in non-western countries have limited knowledge of IKS and therefore are unable to incorporate IK in the classroom. Results presented in this study demonstrated that 80% of the participants were able to provide basic knowledge of IK however not relevant to teaching Life Sciences. This could reflect a paradigm shift in the teacher's knowledge of IK, where teachers are now informed and knowledgeable about IK. However, there are challenges that hinder teachers from further developing their knowledge and integration IK during lessons. Those challenges will be discussed later in the chapter.

Four out of five participants were optimistic concerning the utilisation of IK in a Life Sciences classroom. They also acknowledged that the incorporation of IK during lessons could improve the learner's understanding of science concepts and help learners link the new knowledge with their everyday lives. A study conducted by Abah, Mashebe and Denuga (2015) found that many Black learners are experiencing a challenge of 'border-crossing' between their home lives and school. The gap disconnecting the learner's home and school knowledge has the potential to negatively influence their academic performance. The participants' opinions about the integration of IK in the classroom indicate that the incorporation of IK into science topics will create opportunities to close the gap and link science with what learner's learn at home.

Only one participant demonstrated limited knowledge of IK and did not encourage the incorporation of IK when teaching. Participant 4 suggested that Life Sciences teachers should only teach science concepts and not association IK with science. This is a concern as according to Shizha (2012) the teachers' beliefs, perceptions and knowledge about a subject or specific content influences the teachers' practices in the classroom. Therefore, this implies that participant 4 is unlikely to integrate IK when teaching Life Sciences or any other subject.

In Chapter two, a study conducted by Mazzocchi (2018), and a study conducted by Naidoo and Vithal (2014) suggested that majority of science teachers in non-western countries perceive science as superior knowledge to IK. However, key findings from this study demonstrated that 80% of the teachers valued IK and promote its integration during science education. Participants stated that IK could present the missing link between home knowledge and school knowledge. These findings concur with Dlamini and Ndzinisa (2021) study that was conducted with 110 primary school Science teachers in Swaziland. Dlamini and Ndzinisa (2021)'s study presented that teachers are informed on the value of using IK in a science classroom. This may therefore conclude that there is gradual change in the teacher's perceptions towards the use of IK and teachers are willing to integrate IK in the classroom provided they are well informed of the topic.

However, these results could not be generalised or considered a representation of all Life Sciences teachers as perceptions of teachers based in urban areas may differ from perceptions of teachers based in rural areas. Mavuru and Makhunga (2020) identified a trend where teachers based in multi-racial schools question the integration of IK during lessons, stating the likelihood to create confusion amongst learners, whereas teachers from township schools demonstrated appreciation, awareness and enthusiastic towards the integrate IK in the classroom.

The learners' negative attitude towards IK was identified as one of the barriers towards integration of IK in the classroom. Participant 2 explained that most learners value science as superior knowledge than IK. They classified IK as old, outdated knowledge and not relevant to the current era. The integration of IK with science will create opportunities to demonstrate the value of IK and IKS that exist within communities and create environmental awareness.

5.2.2. Key finding 2: Teachers lack skills to integrate IK in the classroom

The finding of the study demonstrated that Life Sciences teachers lack relevant skills, knowledge and resources that could stimulate the incorporation of IK in the classroom.

Although teachers have an understanding of IK and acknowledge the significant role it could play when used in the classroom, they have not receive any training or assistance from the Department of Basic Education (DBE). Participant 2 has been employed by DBE as a Life Sciences teacher for the past 34 years while participant 5 has 12 years of work experience as a Life Sciences teacher. Based on participant 2 and participant 5's experiences we can therefore conclude that the DBE has not conducted training or provide teachers with teaching resource to promote the use of IK in the classroom.

This conclusion is aligned with findings of a study conducted by Mavuru and Makhunga (2020) that concluded that the DBE encourages the use of IK when teaching Life Sciences, however there are no efforts or initiatives implemented to assist teachers in advancing their skills and knowledge of instructional strategies that may be implemented to incorporate IK in various Life Sciences topics. Only one participant recalls learning about IK in university as a student while other participants have not been trained on how to align IK with science topics when teaching Life Sciences. Mavuso *et al.* (2021) alluded that lack of informative textbooks and teaching materials that support the integration of IK in the classroom remains one of the obstacles for teachers.

5.2.3. Key finding 3: Teachers do not incorporate IK in the classroom

The research findings demonstrated that 40% of participants, two out of five teachers, were able to integrate IK when teaching Life Sciences in grade 11. This finding was established from results obtained from interviews and lesson observations. A total of 25 lesson observations were conducted and only three lesson integrated IK: Participant 1 integrated IK during one lesson observation, while participant 3 integrated IK during two lesson observations. There was no evidence IK during lesson observations conducted with participant 2, participant 4 and participant 5. Results obtained from analysis of lesson plans revealed that only participant 3 was able to integrate IK into a lesson plan. A total of 25 lesson plans were assessed and only one lesson plan, four percent, had evidence of IK.

This therefore supports the notion that teachers do not have relevant skills, resources and teaching materials to guide the integration of IK into the science curriculum (Seehawer, 2018). The findings concur with the conclusion presented by Jumba and Mwiti (2022) in a study conducted with 65 teachers in Kenya. Their study demonstrated that 36% of the participants (teachers) were knowledgeable of IKS, and therefore the incorporation of IK in the curriculum would not be feasible. Jumba and Mwiti (2022) recommended that the DBE should provide teachers with skills, information and resources to ensure successful integration of IK during lessons.

5.2.4. Key finding 4: There is limited information guiding teachers on the integration of IK in the classroom

The Life Sciences CAPS document and the grade 11 Life Sciences textbooks provided minimum guidance on the use of IK. Firstly, IK is included in the Life Sciences' CAPS document as the sixth principle that underpins the NSC curriculum. The CAPS sixth principle promotes the value of IK and recognises the country's diverse heritage as an important component towards promoting equal access to education for all. However, the document does not provide detailed guidelines on how the DBE intents to achieve the sixth principle.

Secondly, the 'Specific Aim 3' in the Life Sciences CAPS document advocates for the value and relevance of science in the learner's lives, and the link between science and IK. However, the document presents limited information on how to integrate IK and science, or how science fits into the learner's lives. There are no guidelines or activities that could guide teachers on how to achieve the 'Specific Aim 3'. Lastly, IK is also included in the section of the document that outlined the grade 11 content. However, IK is only integrated as examples that support the science content in specific topics, and similar examples are reflected in the grade 11 Life Sciences textbooks.

Documents analysed for this study do not supply adequate information on how teachers should integrate IK during lesson planning and lesson presentation. Therefore, the use of IK relies

mainly on the teacher's knowledge and perceptions. It is the teachers' responsibility to seek local knowledge, prepare lesson and activities that integrates IK found in their local area. This requires teachers to be life-long learners and always seek opportunities to cultivate their PCK. However, the documents create opportunities to explore opportunities to improve the accommodation of IK in the classroom. Teachers should prepare lessons that require learners to share knowledge, group discussions or investigations that explore IK in the communities. Teachers therefore become mediators of learning and implement a learner-centered approach to create interactive, fun and informative lessons.

5.2.5. Key finding 5: There are multiple opportunities to improve the use of IK in the classroom

The study presented multiples opportunities that could be used to integrate IK when teaching Life Sciences in grade 11. IK can be integrated during lesson planning and preparation, lesson presentations and assessment activities. Lesson plans are prepared prior to the actual lesson. This provides an opportunity for teachers to familiarise themselves with the topic, research additional information and prepare teaching resources. Proper preparation will ensure that teachers are well prepared to teach, lessons link with the learners' context and lessons encourage active participation.

Results presented in this study demonstrate that a majority of teacher use lecture is the sole or dominant teaching method in the classroom. Lectures minimise interaction, and do not promote learner participation and knowledge sharing. The theory of social constructivism encourages the use of multiple teaching methods to promote participation, and encourage social and dialectic interactions between learners (Jha & Devi, 2014). The theory also promotes the use of problem-based activities, group discussions, investigations and discovery-guided learning activities (Saleen *et al.,* 2021). Therefore teachers should carefully consider the teaching method and activities used during a lesson as some activities could easily integrate IK than others. The following discussion outlines opportunities and strategies that can be

implemented to integrate IK into Environmental studies during lesson planning and presentation in grade 11:

Integration of IK during lesson planning and presentation using local examples

Sub-topic: Population ecology (Interactions in the environment)

- When teaching about the "predator-prey relationships", teachers can integrate indigenous hunting strategies into the lesson. The lesson can include how the local hunting strategies have negatively or positively influenced the predator-prey populations (wild animals) in the local area. The lesson could also integrate the consequences of the exponential population growth (humans as predator) and the negative impact linked to advanced hunting strategies on the prey population.

Sub-topic: Loss of biodiversity

- The teacher can integrate examples of locally poached or over utilised species of animals and plants, possible causes of poaching, indigenous practices to prevent local extinction and promote sustainable utilisation of resources.

Integration of IK using appropriate teaching strategies

Sub-topic: "Human impact on the environment"

- Teachers can invite knowledgeable people from local communities to share their understanding and experiences about the devastating effects of climate change on farming practices in the local area.

- Teachers can also organise a day visit to a local nature reserve or cultural site to learn about the differences between indigenous hunting methods and poaching, importance of biodiversity and the impact of biodiversity loss on the ecosystem, etc.

Integration of IK through appropriate assessment activities

Sub-topic: Food security (loss of wild varieties of crop plants)

- Learners can conduct an investigation about indigenous seeds used as source of food. The task can include a collection of different eatable seeds, classifying seeds into indigenous or exotic, wild seeds or crops. The research findings could be presented with peers or groups in the classroom.

Sub-topic: Solid waste disposal

- Learners can demonstrate different indigenous uses of cow dung (examples may include the use of cow dung as fertilisers, insects repellent, building material and as a source of fuel).

Additional approaches that teachers can adopt towards improving the incorporation of IK in the classroom may also include:

1. Integration of learner's prior knowledge into the classroom;
2. Construction of knowledge from the known (IK) to the unknown (science concepts);
3. Use of local languages and familiar vocabulary to explain science concepts;
4. Integration of familiar artifacts and local examples to elaborate science concepts;
5. Create opportunities for learners to experience learning through exhibits, performances, story-telling, posters;
6. Promote group discussions and presentations;
7. Assignments that allow learners to express their knowledge verbally;
8. Investigations and research tasks that promotes community engagement (Dziva *et al*., 2010; Mavuso *et al,* 2021; William & Perrone, 2018).

Table 5.1 presents an example of a lesson plan that integrate IK when teaching about 'food security' and Table 5.2 presents an example of a lesson plan that integrates IK when teaching about 'the atmosphere and climate change' in grade 11. The second row of the table contains information obtained from CAPS and the third row of the table contains IK that links to the topic and assessment activities that integrates IK. The third row also contains possible benefits for learners when IK is successfully used to complement science concepts in the classroom. Therefore, these lesson plans demonstrate opportunities that can be explored to integrate IK when teaching Environmental studies and other topics in grade 11.

Table 5.1: First lesson plan demonstrating the integration of IK in a lesson

<table>
<tr><th colspan="3">Grade 11 – Term 4
Topic: “Environmental studies”
Sub-topic: “Human impact on the environment”</th></tr>
<tr><td colspan="2">Content:
• Food security
- “Rapidly expanding population growth;
- Effects of droughts and floods caused by climate change;
- The use of incorrect farming practices such as monoculture;
- The negative impact of insecticides;
- The need for fertilisers after soil erosion;
- Introduction of alien plants and reduction of agricultural land;
- The loss of wild species and its impact on the gene pools;
- Genetically modified foods;
- The impact of wastage on the environment”</td><td>CAPS suggested assessment activities:
• “A practical observation of an example of the human impact on the environment in the local area;
• Submission of a written report”</td></tr>
<tr><td>Integration of Indigenous knowledge:
• “Indigenous farming methods used in the community (compare past and current practices);
• The use of cow dung as fertilisers and insecticide;
• Indigenous food endemic to the area”</td><td>Possible assessment activities:
• “Investigating indigenous farming practices in the local community;
• Discussion of the learners’ prior knowledge, relating their knowledge the content;
• Discussion of indigenous farming practices versus modern farming practices and their contribution towards food security;
• Collection and display of indigenous food found in the local community”</td><td>Possible benefits for learners:
• “Practical application of knowledge
• Environmental awareness
• Awareness of different knowledges systems
• Creation learning opportunities that are relevant and relating to learners’ lives
• Closing the gap between school science and IKS
• Community involvement
• Learning becomes relevant to the learner’s lives”</td></tr>
</table>

Table 5.2: Second lesson plan demonstrating the integration of IK in a lesson

<table>
<tr><td colspan="3">Grade 11 – Term 4
Topic: “Environmental studies”
Sub-topic: “Human impact on the environment”</td></tr>
<tr><td colspan="2">Content:
• The atmosphere and climate change
- “The impact of carbon dioxide, methane gas and other GHG;
- Understanding the concept of ‘carbon footprint’ and measures to reduce individual’s carbon footprint;
- The negative consequences of deforestation;
- Greenhouse gas effects and its link to global warming;
- The causes and effects of Ozone depletion”</td><td>CAPS suggested assessment activities:
• “A practical observation that involves an example of the human impact on the environment in the local area;
• Submission of a written report ”</td></tr>
<tr><td>Integration of Indigenous knowledge:
• “Changes in local weather patterns (compare past and present experiences);
• Indigenous techniques used to predict seasonal rain and weather forecast;
• Indigenous practices that reduces the carbon footprint;
• Indigenous practices that prevents deforestation”</td><td>Possible assessment activities:
• “Investigating indigenous practices to ‘make rain’ in the local community; or investigating indigenous practices to predict weather forecast;
• Group discussion or debates relating to the content discussed during the lesson (e.g. indigenous versus scientific practices)”</td><td>Possible benefits for learners:
• “Practical application of knowledge
• Environmental awareness
• Awareness of different knowledges systems
• Linking lessons to the learners’ daily lives
• Making science lesson relevant, fun and memorable
• Community involvement
• Learning becomes relevant to the learner’s lives”</td></tr>
</table>

5.3. Implications of the study

The study carries implication for Life Sciences teachers and the DBE. It is evident that there is a need for change in how teachers approach the use of IK during lesson preparation and teaching. Teachers need to adapt to the constantly changing dynamics in the classroom and become life-long learners. Teachers should seek opportunity to gain knowledge and advance their PCK. Teachers have to participate in learning and teaching platforms where teachers share ideas and experiences, and enroll for courses or qualifications that improve their subject knowledge and teaching practices.

The DBE should develop teaching materials that will train and educate teachers on how to incorporate IK during lessons. The DBE should further organise regular training workshops where teachers can share knowledge, ideas and experiences on how they use IK in the classroom. Equipping teachers with knowledge, skills and teaching resources will increase their confidence in engaging learners in discussions that addresses IK.

5.4. Limitations of the study

The study presented a few limitations which should be considered when reviewing the findings and contributions. Time was the biggest limiting factor during data collection. The study investigated how teachers use IK when teaching ‘environmental studies’ in grade 11. The Life Sciences CAPS provides a schedule and timeframes on when each topic should be taught. As a result the ‘environmental studies' topics are only taught in term 3 and term 4 of the school calendar. The data was collected during times when teachers’ attention was divided between completing the syllabus, overseeing revision and study time, and making arrangements for the final examination.

The study also had a reasonably small sample. The study presented a case of five Life Sciences teachers from the Bakenberg South Circuit in the Mogalakwena District. All schools were purposively nominated owing to their accessibility and enthusiasm to partake in the study. Participating schools were situated within rural villages surrounded by indigenous communities.

Consequently, the findings should not be extrapolated to represent the views and perceptions of teachers on a larger scale. Therefore, comparable studies should be conducted in different locations in the country to compare the results, especially with teachers in schools located in urban areas.

5.5. Recommendations

The integration of IK to teach Life Sciences is a challenge which requires collaboration from different stakeholders including the DBE, Institutions of Higher Education, curriculum and policy developers, teachers and community leaders. The following discussion presents recommends based on the findings.

5.5.1. The Department of Basic Education

The DBE should take a leading role in the initiative to integrate IK in all subjects taught in schools. According to Tsindoli (2018) a large proportion of teachers in non-western countries are not educated on how to implement a curriculum that integrates IK. A large number of teachers lack knowledge of IKS and lack knowledge on how to incorporate it when teaching. Therefore, the DBE should develop training programmes and workshops to capacitate teachers with knowledge, skills and resources that will encourage the integration IK in the classroom. Workshops will help create awareness, provide knowledge, skills and teaching strategies that could improve the teacher's confidence to integrate IK during lesson planning, select appropriate teaching approach and integration of IK in assessment activities. The DBE should also initiate a programme(s) that develop teaching materials that will guide teachers during lesson planning and when teaching in the classroom.

5.5.2. Institutions of Higher Education

The study recommends that universities and colleges that offer teaching qualifications should amend the content to incorporate IK in an attempt to prepare novice teachers with awareness, information, skills and resources that can be used link IK with science concepts. Universities and colleges should ensure that novice teachers are informed of the importance of incorporating IK

in their lessons plans and lesson presentations. An alternative to amending existing modules, universities and colleges should develop a separate module that introduces the element of IK in all teaching qualifies.

5.5.3. Teacher's professional development

Teachers should be encouraged to adopt a culture of being a life-long learner to expand their knowledge on different topics taught in Life Sciences, including expansion of knowledge of IKS. Teachers should be encouraged to enroll for additional qualifications or short courses that will improve their knowledge of the subjects they teach. Enrolling for further studies will not only equip teachers with knowledge but also provide opportunities to participate in discussion that address recent studies and current affairs in their field of expertise. Teachers should also be encouraged to socialise with local people to accumulate local knowledge from knowledgeable people in the communities in an attempt to close the gap and address existing challenges.

5.5.4. Policy and curriculum development

The study recommends that policy makers and curriculum developers should evaluate documents that inform the educational activities in schools. Important documents available to teachers such as CAPS, textbooks and teacher's guide should include guidelines on the uses of IK when teaching different topics. The revised documents could include examples of IK, learner activities, assessment activities and other strategies that promote the incorporation of IK.

5.5.5. Additional resources to supplement the textbook

The DBE should provide teachers with additional resources that align IK with the science content taught in school. Additional resources may include teacher's guidelines with teaching strategies, assessment activities and examples of IK and other information that promotes the use of IK in the classroom.

5.5.6. Community partnership and development

Community elders, chiefs, indunas, headmen, diviners, spiritualists and herbalists are recognised as keepers of knowledge in the communities (Govender *et al.,* 2013; Nnebuogor & Abimbola, 2019). These people have a vast accumulation of knowledge that is easily lost when those individuals die. The department should support such people to write books that can be published and used as tools to integrate IK in the curriculum. This initiative will promote knowledge sharing, preservation of IK, awareness among young people and community development.

The DBE should also develop a relationship with knowledgeable people within communities and promote the collaboration between knowledgeable others and teachers during the training workshops. Teachers should organise field trips with learners to visit cultural or heritage sites that offers indigenous education. A partnership between community elders, traditional experts and Life Science teachers could advance the incorporation of IK in schools by integrating knowledge from different sources (Mazvuso *et al.,* 2021).

5.5.7. Future research

1. Similar studies should be conducted in different areas of the country, especially with participants teaching in schools located in urban areas, to compare the results with studies conducted in rural areas.
2. Further research in 'Institutions of Higher Education' should encourage scholars towards developing a framework that will inform the integration of IK in different curriculums taught in schools.

5.6. Conclusion

The study investigated how Life Sciences teachers integrate IK to teach environmental studies in grade 11. This was a case of five schools in 'Bakenberg South Circuit' in 'Mogalakwena District', Limpopo Province. The research participants were five Life Sciences teachers, one teacher from each participating school, teaching Life Sciences in grade 11. The study was

guided by the Theory of social constructive and data was obtained through interviews, observation and document analysis.

An interview guideline and observation guideline were used to collected data that answered question about the participant's knowledge and perceptions about IK. Results from the interviews were triangulated with results from the lesson observations. The results revealed that the knowledge of IK differs among teachers: however all teachers demonstrated moderate knowledge of IK and only one teacher did not advocate for the incorporation of IK during science lessons. A lesson observation guideline was used to collect data that provided evidence regarding the use of IK during science lessons. Results demonstrated that four out of five teachers do not use IK during their lesson and data collected from analysis of lesson plans confirmed the results. A document analysis guideline also guided exploration of the CAPS document and textbooks. The results obtained displayed that there is limited information that guides teachers on the incorporation of IK during lesson preparing and when teaching.

Therefore, the study recommends that teachers should seek opportunities to learn and advance their PCK, invest in personal development and enroll for qualifications that advance their subject knowledge. The study further advocates for the DBE to organise workshops that will equip teachers with knowledge, skills and teaching resources that will promote the introduction of IK in a science classroom. The advancement of IK in a Life Sciences classroom has the potential to bridge the existing gap and connect school knowledge with home knowledge. Knowledge construction should start from "what is known" (IK) and gradually develop into "the unknown" (science concepts). Therefore, learners may be able to conceptualise the science concepts and implement the new knowledge in their everyday lives.

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ANNEXURE A: LDBE Permission to Conduct Research

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

CONFIDENTIAL

Ref: 2/2/2 Enq: Makola MC Tel No: 015 290 9448 E-mail:MakolaMC@edu.limpopo.gov.za

Thoka MB
Private Bag 3
WITS
2050

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH

1. The above bears reference.
2. The Department wishes to inform you that your request to conduct research has been approved. Topic of the research proposal: **"AN INVESTIGATION OF USE OF INDIGENOUSE KNOWLEDGE TO TEACH 'ENVIRONMENTAL STUDIES AT GRADE 11 : CASE STUDY OF SCHOOL IN BAKENBERG SOUTH CIRCUIT ,LIMPOPO PROVINCE "**
3. The following conditions should be considered:

3.1 The research should not have any financial implications for Limpopo Department of Education.

3.2 Arrangements should be made with the Circuit Office and the School concerned.

3.3 The conduct of research should not in anyhow disrupt the academic programs at the schools.

3.4 The research should not be conducted during the time of Examinations especially the fourth term.

3.5 During the study, applicable research ethics should be adhered to; in particular the principle of voluntary participation (the people involved should be respected).

3.6 Upon completion of research study, the researcher shall share the final product of the research with the Department.

Cnr 113 Biccard & 24 Excelsior Street, POLOKWANE, 0700, Private Bag X 9489, Polokwane, 0700
Tel:015 290 7600/ 7702 Fax 086 218 0560

4 Furthermore, you are expected to produce this letter at Schools/ Offices where you intend conducting your research as an evidence that you are permitted to conduct the research.

5 The department appreciates the contribution that you wish to make and wishes you success in your investigation.

Best wishes.

22/09/2022

Mashaba KM **Date**

DDG: CORPORATE SERVICES

Cnr 113 Biccard & 24 Excelsior Street, POLOKWANE, 0700, Private Bag X 9489, Polokwane, 0700
Tel:015 290 7600/ 7702 Fax 086 218 0560

ANNEXTURE B: The University of Witwatersrand Ethics Clearance Certificate

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

Research Office

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

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER: H22/07/46**
PROJECT TITLE	An investigation of use of Indigenous Knowledge to teach 'Environmental Studies' at grade 11: A case of schools in Bakenberg South Circuit, Limpopo Province
INVESTIGATOR(S)	Ms M Thoka
SCHOOL/DEPARTMENT	Wits School of Education/
DATE CONSIDERED	22 July 2022
DECISION OF THE COMMITTEE	Approved Risk Level: Minimal
EXPIRY DATE	06 September 2025

DATE 16 November 2022 **CHAIRPERSON** (Professor J Watermeyer)

cc: Supervisor : Professor C Mandikonza

DECLARATION OF INVESTIGATOR(S)

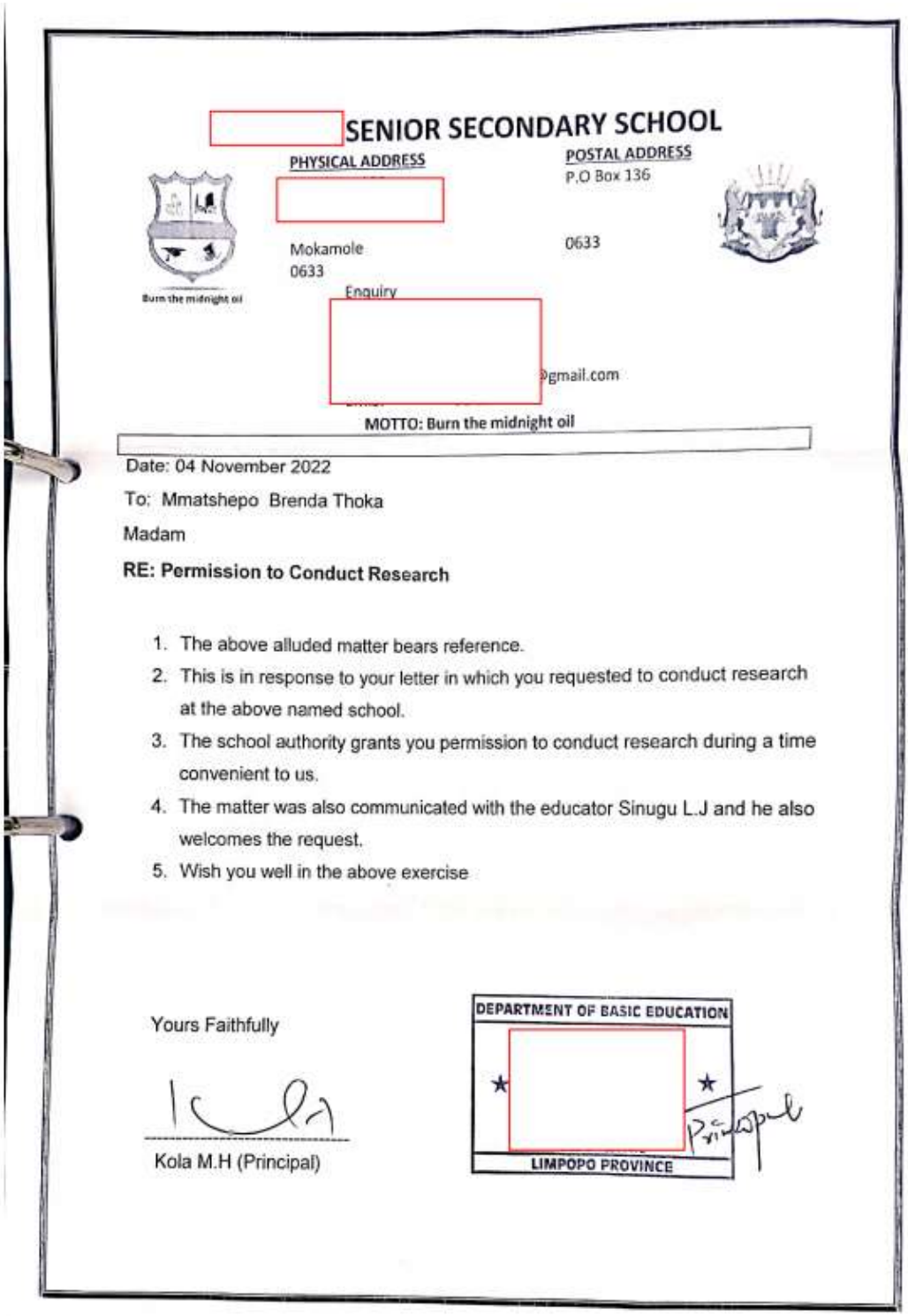
To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University. Unreported changes to the application may invalidate the clearance given by the HREC (Non-Medical)

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to submit an amendment of the protocol to the Committee. **I agree to completion of a regular progress report. For Minimal and Low studies, this is due annually on 31 December. For Medium and High Risk studies, this is due twice annually on 30 June and 31 December.**

Signature 10 / 09 / 2022 Date

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

ANNEXURE C: School One's Permission Letter to conduct Research



[redacted] SENIOR SECONDARY SCHOOL

PHYSICAL ADDRESS

[redacted]

Mokamole
0633

POSTAL ADDRESS
P.O Box 136

0633

Burn the midnight oil

Enquiry [redacted]

[redacted]@gmail.com

MOTTO: Burn the midnight oil

Date: 04 November 2022

To: Mmatshepo Brenda Thoka

Madam

RE: Permission to Conduct Research

1. The above alluded matter bears reference.
2. This is in response to your letter in which you requested to conduct research at the above named school.
3. The school authority grants you permission to conduct research during a time convenient to us.
4. The matter was also communicated with the educator Sinugu L.J and he also welcomes the request.
5. Wish you well in the above exercise

Yours Faithfully

Kola M.H (Principal)

DEPARTMENT OF BASIC EDUCATION

[redacted]

Principal

LIMPOPO PROVINCE

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ANNEXTURE D: School Two's Permission Letter to conduct Research

[redacted] SEC SCHOOL

HARD WORK PAYS
THE WARMTH OF THE NATION

PHYSICAL ADDRESS
[redacted]
Mokamole, 0633

Enquiry: [redacted]
Cell: [redacted]59
Email: [redacted]mail.com
Emis: [redacted]

27 October 2022

Dear Sir/ Madam

LETTER OF PERMISSION TO CONDUCT RESEARCH AT [redacted] SECONDARY SCHOOL

I, Marakalla L.C, the school principal at [redacted]dary School give permission to Mmatshepo Brenda Thoka, student at the University of Witwatersrand to conduct research at our school. This letter serves as an acknowledgement that the school has been fully informed about the research titled **"An investigation of use of indigenous knowledge to teach environmental studies at grade 11: a case of school in the Bakenburg South Circuit, Limpopo Province"**, and I am aware that the data collected will form part of the student's report for her Masters dissertation.

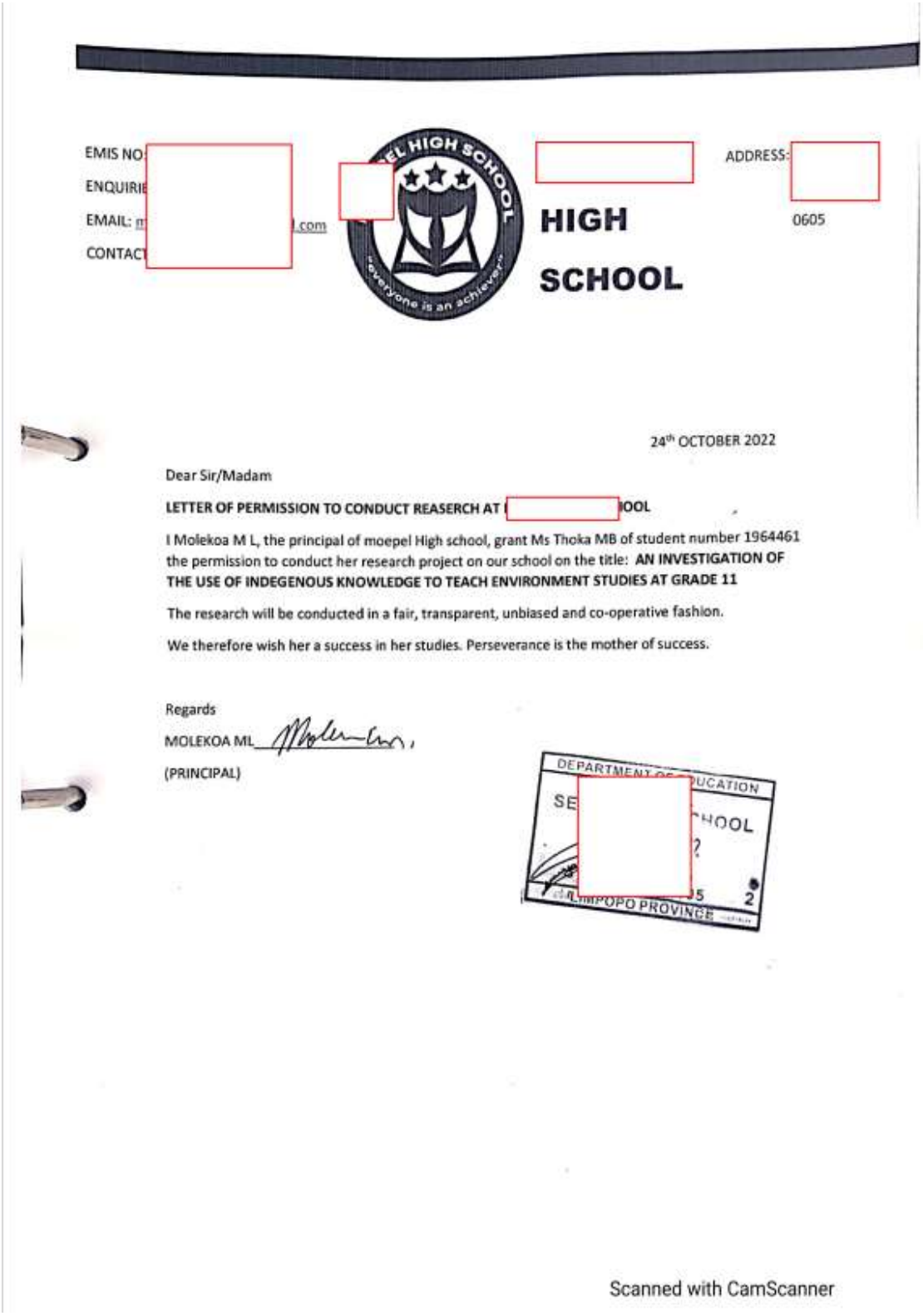
We wish Ms Thoka all the success in her studies.

DEPARTMENT OF EDUCATION
[redacted]OOL
LIMPOPO PROVINCE

Yours Faithfully,

Marakalla L. C

ANNEXTURE E: School Three's Permission Letter to conduct Research



EMIS NO:

ENQUIRIE

EMAIL: m .com

CONTACT

ADDRESS:

0605

HIGH SCHOOL

24th OCTOBER 2022

Dear Sir/Madam

LETTER OF PERMISSION TO CONDUCT REASERCH AT OOL

I Molekoa M L, the principal of moepel High school, grant Ms Thoka MB of student number 1964461 the permission to conduct her research project on our school on the title: **AN INVESTIGATION OF THE USE OF INDEGENOUS KNOWLEDGE TO TEACH ENVIRONMENT STUDIES AT GRADE 11**

The research will be conducted in a fair, transparent, unbiased and co-operative fashion.

We therefore wish her a success in her studies. Perseverance is the mother of success.

Regards

MOLEKOA ML

(PRINCIPAL)

DEPARTMENT OF EDUCATION

SCHOOL

LIMPOPO PROVINCE

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ANNEXURE F: School Four's Permission Letter to conduct Research

MOGLAKWENA DISTRICT

NO:

ENQ

079

BAKENBERG SOUTH CIRCUIT EMIS

MOKOPANE

060

To whom it may concern

University of Witwatersrand

Wits School of Education

ScienceEducation

PERMISSION TO CONDUCT RESEARCH

It is with pleasure to inform you that the SGB and the principal of the above mentioned school do permit you to conduct research as you requested. And we also hope that your working with educators and learners of this school will be of help to your studies.

Kind regards

Maluleke M.P

Principal

ANNEXTURE G: School Five's Permission Letter to conduct Research

[redacted] SECONDARY SCHOOL

ENQUIRY: [redacted]
CELL NO: 0[redacted]
Email: sesh[redacted]

[redacted]
MOKAMOLE
0633

EMIS: [redacted]

26/10/2022

Ref No. 14/2022
Dear Sir/Madam

RE-GRANTING PERMISSION TO CONDUCT RESEARCH AT SESHOATLHA SEC SCHOOL

1. The above matter refers.
2. The above mention school grant Mmatshepo Brenda Thoka permission to conduct research at our school
3. The matter was also discussed with [redacted] the Life Sciences educator at our school.
4. We hope Brenda will be able to get what she is looking for, and will be helped in her endeavour to complete her research.

Thanking you in anticipation

Yours faithfully
Rankapole JM (Principal)

Signature:.....

Date: 26/10/2022

DEPARTMENT [redacted] TION
P[redacted], MOKAMOLE,0633
LIMPOPO PROVINCE

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ANNEXURE H: Participants' Information Sheet for Teachers

PARTICIPANT INFORMATION SHEET FOR TEACHERS

An investigation of use of Indigenous Knowledge to teach 'Environmental Studies' at grade 11: A case of schools in Bakenberg South Circuit, Limpopo Province.

Dear Sir / Madam

My name is Mmatshepo Brenda Thoka. I am a Masters student, 1964461, at the University of the Witwatersrand, Johannesburg. My supervisor is Dr Caleb Mandikonza. I am conducting a research study about **how Life Sciences teachers use Indigenous Knowledge (IK) in the classroom** when teaching Environmental Studies in grade 11. The study will investigate the teachers' perceptions about IK, examples used in the classroom and existing opportunities of using IK when teaching environmental studies. The study title is **"An investigation of use of Indigenous Knowledge to teach 'Environmental Studies' at grade 11: A case of schools in Bakenberg South Circuit, Limpopo Province"**.

I am inviting you to take part in a semi-structured interview and five observations. Interviews will take place at your school and observations will also take place in your classroom during the period that you will be teaching the topic. The researcher will make arrangements with you in time and considers your availability. During the interview, you will be asked questions that relates to your experience and views about the research topic in order for the researcher to have a better understanding of your perceptions, knowledge, exposure, training, and resources you have access to with regards to IK, and how the use of IK can be improved. The interview will last approximately 20 to 40 minutes or as long as you would like to talk about your experience.

With your permission, I would like to audio record and write down field notes during the interview. Both the audio-recording and field notes will be used during data analysis at the later stage. At the end of the study, the research data, including consent forms, interview transcripts, field notes and your contact details, will be kept in locked filling cabinets, stored in a password-protected university computer and also backed up online. The data will only be deleted after 10 years and only the researcher will have access to the data.

All the information you give us will be kept strictly confidential. The audio-recording of your interview will be identified by a code assigned to each participant. The audio-recordings will be transcribed, and identifying details such as places and people's names will be removed from the transcripts. We will use quotes from the interviews in the write-up of the study and we will ensure that no one can be identified from these quotes.

If you decide to take part in the research study, it should be because you want to volunteer. You do not have to answer any questions if you do not want to and you can stop being in the study at any time. You will not get any direct benefits if you choose to join the research study. You will not lose any services, benefits or rights you would normally have if you decide not to join. Taking part in the research study will not cost you anything. You will not be paid for being in this research study. The risks for this research study are no more than what happens in everyday life. However, if you feel uncomfortable, you can stop the interview at any time, without giving a reason. You can also ask for your data to be removed from the study and destroyed.

This research study will be written up as part of the Masters Research thesis and submitted for examination. The results will also be submitted for publication in an academic journal and presented at conferences. If you would like to receive a summary of this report, I will be happy to send it to you.

If you have any questions during or afterwards about this research study, feel free to contact me or my supervisor on the details listed below. If you have any concerns or complaints about the ethical procedures of this research study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical), telephone +27(0) 11 717 1408, email hrecnon-medical@wits.ac.za.

ANNEXURE H

Researcher:
Mmatshepo Brenda Thoka, 1964461@students.wits.ac.za, +27(0) 78 633 5212

Supervisor:
Dr Caleb Mandikonza, caleb.mandikonza@wits.ac.za, +27(0) 11 717 3260

ANNEXURE I: Participants' Information Sheet for Parents

PARTICIPANT INFORMATION SHEET FOR PARENTS

An investigation of use of Indigenous Knowledge to teach 'Environmental Studies' at grade 11: A case of schools in Bakenberg South Circuit, Limpopo Province.

Dear Parent/ Guardian

My name is Mmatshepo Brenda Thoka. I am a Masters student, 1964461, at the University of the Witwatersrand, Johannesburg. My supervisor is Dr Caleb Mandikonza. I am conducting a research study about **how Life Sciences teachers use Indigenous Knowledge (IK) in the classroom** when teaching Environmental Studies in grade 11. The study will investigate the teachers' perceptions about IK, examples used in the classroom and existing opportunities of using IK when teaching environmental studies. The study title is **"An investigation of use of Indigenous Knowledge to teach 'Environmental Studies' at grade 11: A case of schools in Bakenberg South Circuit, Limpopo Province"**.

Part of my data collection technique, I will be conducting five observations where I will observe Life Sciences teachers while they teach in the classroom. Learners will be present in the classroom when the teacher observations are being conducted but learners are NOT participants. The purpose of the observations is to observe how teachers use IK when teaching in the classroom. Each observation will take place during Life Sciences lessons and the duration of the observation will be determined by the duration of the lesson.

With your permission, I would like to audio record and write down field notes during the lesson observation. Both the audio-recording and field notes will be used during data analysis at the later stage. At the end of the study, the research data, including consent forms and field notes will be kept in locked filling cabinets, stored in a password-protected university computer and also backed up online. The data will be deleted after 10 years and only the researcher will have access to the data. All the information collected will be kept strictly confidential. You will not get any direct benefits if you choose to allow your child to be part of the research study. Taking part in the research study will not cost you anything and you will not be paid for being in this research study. The risks for this research study are no more than what happens in everyday life.

This research study will be written up as part of the Masters Research thesis and submitted for examination. The results will also be submitted for publication in an academic journal and presented at conferences. If you would like to receive a summary of this report, I will be happy to send it to you.

If you have any questions during or afterwards about this research study, feel free to contact me or my supervisor on the details listed below. If you have any concerns or complaints about the ethical procedures of this research study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical), telephone +27(0) 11 717 1408, email hrecnon-medical@wits.ac.za.

Researcher:
Mmatshepo Brenda Thoka, 1964461@students.wits.ac.za, +27(0) 78 633 5212

Supervisor:
Dr Caleb Mandikonza, caleb.mandikonza@wits.ac.za, +27(0) 11 717 3260

ANNEXURE J1: Teachers' Consent Form – Interview

Consent Form for Teachers - Interview

An investigation of use of Indigenous Knowledge to teach 'Environmental Studies' at grade 11: A case of schools in Bakenberg South Circuit, Limpopo Province.

Name of researcher: Mmatshepo Brenda Thoka (1964461)

I, _____, voluntarily give consent in taking part in the interview conducted by the researcher for this research project. The research focus and methodology to be used has been explained to me through the Participant Information Sheet and by the researcher and I have read and understood what my participation will involve. I agree to the following (Please circle the relevant options below):

The research study was explained to me. I understand what this study is about.	YES	NO
I understand that I volunteer to take part in the interview, and I can withdraw from participating at any stage of the research.	YES	NO
I agree that the interview may be audio recorded.	YES	NO
I agree that direct quotations from my interview answers recorded by the researcher may be used by the researcher in their research report.	YES	NO
I agree that my personal information (my name will not be used by the researcher in their research report) will not be shared with other people.	YES	NO
I agree that other researchers may use the information I provide in my answers recorded by the researcher (depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on.	YES	NO

Signature: _____ **Signature:** _____

Participant' name: _____ **Researcher' name:** _____

Date: _____ **Date:** _____

ANNEXURE J2: Teachers' Consent Form – Lesson observation

Consent Form for Teachers - Observation

An investigation of use of Indigenous Knowledge to teach 'Environmental Studies' at grade 11: A case of schools in Bakenberg South Circuit, Limpopo Province.

Name of researcher: Mmatshepo Brenda Thoka (1964461)

I, _____, voluntarily give consent in taking part in the observation conducted by the researcher for this research project. The research focus and methodology to be used has been explained to me through the Participant Information Sheet and by the researcher and I have read and understood what my participation will involve. I agree to the following (Please circle the relevant options below):

The research study was explained to me. I understand what this study is about.	YES	NO
I understand that I volunteer to take part in the observation, and I can withdraw from participating at any stage of the research.	YES	NO
I agree that the observation may be audio recorded.	YES	NO
I agree that direct quotations from my participation during the observation made by the researcher may be used by the researcher in their research report.	YES	NO
I agree that my personal information (my name will not be used by the researcher in their research report) will not be shared with other people.	YES	NO
I agree that other researchers may use the information I recorded during the observation (depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on.	YES	NO

Signature: _____ **Signature:** _____

Participant' name: _____ **Researcher' name:** _____

Date: _____ **Date:** _____

ANNEXURE K: Parents' Consent Form

Consent Form for Parents

An investigation of use of Indigenous Knowledge to teach 'Environmental Studies' at grade 11: A case of schools in Bakenberg South Circuit, Limpopo Province.

Name of researcher: Mmatshepo Brenda Thoka (1964461)

I, _____, **parent/ guardian of** _____ give permission to the above mentioned learner to be present in the classroom when this research study takes place. I understand that participation in this research study is voluntarily. The research focus and methodology to be used has been explained to me through the Participant Information Sheet and I have read and understood the role of learners in the study. I agree to the following (Please circle the relevant options below):

I have received sufficient information about the research study. I understand what this study is about.	YES	NO
I understand that taking part during the research is voluntarily.	YES	NO
I agree that the observation may be audio recorded.	YES	NO
I agree that data collected during observation by the researcher may be used in the research report.	YES	NO
I agree that no personal information will be collected (learner's name will not be used by the researcher in their research report).	YES	NO
I agree that other researchers may use the information collected during the observation (depending on their own ethics clearance being obtained) but the learner's name and any personal information will not be used or passed on.	YES	NO

Researchers' name: _____ **Parent/ guardian's name:** _____

Signature: _____ **Signature:** _____

Date: _____ **Date:** _____

ANNEXURE L: Learners' Assent Form

ASSENT FORM FOR LEARNERS

An investigation of use of Indigenous Knowledge to teach 'Environmental Studies' at grade 11: A case of schools in Bakenberg South Circuit, Limpopo Province.

Name of researcher: Mmatshepo Brenda Thoka (1964461)

I, _____, voluntarily agree to be in the classroom when this research project is conducted. The research focus and methodology to be used has been explained to me through the Participant Information Sheet and by the researcher. I have read and understood that I am NOT a research participant but I will only be present in the classroom when the observations take place. Only the teacher will be the research participant. I agree to the following (Please circle the relevant options below):

The research study was explained to me. I understand what this study is about.	YES	NO
I understand that I can volunteer to take part in the study, and I can withdraw from participating at any stage of the research.	YES	NO
I agree that the observation may be audio recorded.	YES	NO
I agree that the observation made by the researcher may be used by the researcher in their research report.	YES	NO
I agree that my participation will remain anonymous (my name will not be used by the researcher in their research report).	YES	NO
I agree that other researchers may use the information obtained during the observation made by the researcher but my name and any personal information will not be used or passed on.	YES	NO

Signature: _____ **Signature:** _____

Learner's name: _____ **Researcher's name:** _____

Date: _____ **Date:** _____

ANNEXURE M: Semi-structured Interview Guideline

SEMI-STRUCTURED INTERVIEW GUIDE

An investigation of use of Indigenous Knowledge to teach 'Environmental Studies' at grade 11: A case of schools in Bakenberg South Circuit, Limpopo Province.

The following questions will serve as a guideline during the semi-structured interview, other questions will arise during the interview from participant's responses. The researcher will use follow-up questions, probing questions and interpreting questions to get more details and correct interpretation of the interviewee's responses during the interview.

The guide has two sections: The first section will provide the participants' biographical data and the second section provides topic related information which will help in answering the research questions. The interview should not take more than approximately 30 to 40 minutes. You are allowed to stop the interview at any point when you do not feel comfortable. There is no right or wrong answer and **you Do Not need** to provide your name during the interview.

SECTION A: BIOGRAPHICAL DATA

i. **Sex** (Male, female or other)
ii. **Age group** (20-29; 30-39; 40-49; 50-59 or above 60)
iii. **Highest qualification** (BEd degree, Honours, Masters, Doctral or others)
iv. **Teaching experience** (0-4; 5-9; 10-14; 15-19; 20-24; 25-30; >30 years)

SECTION B: KNOWLEDGE, PERCEPTIONS & USE OF IK

Knowledge and perception of IK

1. How would you describe the term indigenous knowledge?
2. How would you differentiate IK from classroom/ syllabus science?
3. Are there similarities between IK and classroom/ syllabus science?
4. What are the implications of these similarities and differences that you raised for the classroom?
5. How would you rate your knowledge of IK (between 0% and 100%)?
6. What are some of the knowledge that you consider as examples of IK in your community?
7. Do you think IK has a place in the Life Sciences classroom?

Experience and training about the use of IK

8. As a student, were there any module(s) that addresses IK at the university or college?
9. As a teacher, are there any training activities or workshops you have attended which contributed towards your knowledge of IK?
10. How has the training you received influenced how you use IK in the classroom?
11. What can be done to improve your knowledge and use of IK?

Use of IK in the classroom

12. What does the CAPS document say about the use of IK in the classroom?
13. How do you bring/ incorporate IK in the classroom?
14. Which examples of IK have you used when teaching environmental studies?
15. In which other topics, grade 11 Life Sciences, can IK be used?
16. How do you think using IK could help learners?
17. have you assessed learners using IK? Do you have any examples of how you assessed the concepts using that you can share with me? What are your views on the effectiveness of this approach?

APPENDIX H

18. What could be done to improve the use of IK in the classroom when teaching environmental studied in grade 11?

ANNEXURE N: Non-participant Observation Guideline

Lesson Observation Guideline

An investigation of use of Indigenous Knowledge to teach 'Environmental Studies' at grade 11: A case of schools in Bakenberg South Circuit, Limpopo Province.

SECTION A: BACKGROUND INFORMATION

Date_____ Start time_____ End time_____

Observer_____ Announced observation (Y/ N) _____ Observation NO_____

Years of teaching_____ Teaching qualification(s) _____

School/ class description _____

Lesson topic _____

SECTION B: LESSON OBSERVATION – CONTEXT

Number of learners _____

Ethnicity _____

Brief description of the lesson observed, classroom setting arrangement and any relevant details about the teacher and learners.

_____
_____
_____
_____
_____

SECTION C: LESSON OBSERVATION – CONTENT

1. Lesson introduction

_____
_____
_____

2. Lesson body

_____
_____
_____

3. Lesson conclusion

_____
_____
_____

SECTION D: Reflections on the lesson'

How do teacher accesses learners' prior knowledge and pre-conceptions?

_____
_____
_____

How do teacher encourages learners to share their knowledge and opinion?

_____
_____
_____

How does the lesson links and relevant to topic

_____
_____
_____

How do teacher links lesson content with IK

_____
_____
_____

How do teacher uses local examples to explain the content

_____
_____
_____

How do learner assessment activity incorporates IK

_____
_____
_____

How do teacher uses IK in assessment?

_____
_____
_____

What are the opportunities of using IK identified in this class?

_____
_____
_____
_____
_____

ANNEXURE O: Document Analysis Guideline

Document Analysis Guideline

An investigation of use of Indigenous Knowledge to teach 'Environmental Studies' at grade 11: A case of schools in Bakenberg South Circuit, Limpopo Province.

(Textbooks, lesson plans, CAPS Document, any other resources used)

SECTION A: BACKGROUND INFORMATION

1. What is the purpose of the document?
2. Who is the target group of the document?

SECTION B: DOCUMENT POLICY ANALYSIS

3. What is the purpose of the document?
4. How is the document used/intended to be used?
5. What are the expected outcomes of the document?

SECTION C: PRACTICE IMPLEMENTATION AND IMPACT

6. Which section(s) of the document acknowledges IK?
7. What influence does the document have on the use of IK in the classroom (How does it help the teacher to mediate the use of IK)?
8. Does the document outlines a guideline on the use of IK in the classroom when teaching environmental studies at grade 11?
9. What examples of IK are found in the document that can be used in the classroom when teaching environmental studies at grade 11?
10. What opportunities exist in the document that can be used to improve the use of IK in the classroom when teaching environmental studies at grade 11?