Bridging Traditions: Mobilising Indigenous Knowledge and Marine Biodiversity Conservation to Support Learner Talk and Sense-Making in Grade 11 Life Sciences

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By

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Declaration of Originality

I Aswad Sibanda (22S7360) declare that this thesis has not been submitted for a degree in any other university apart from Rhodes University and I declare that it is my work, written in my own original words. It has only been submitted for master's degree at Rhodes University. Where I have cited the words or ideas of other researchers, these have been acknowledged using complete references according to the Departmental guidelines.

Signature:  Date: November 2024

Dedication

I dedicate this study to my beloved mother, Yanano, who left this world when I was just 10 years old, a little boy in Grade 4. Your absence created a void in my life that words can hardly express, and for many years, I found it hard to believe in myself. Yet, in my moments of doubt and loneliness, I held on to the memory of your love, and that sustained me. Though you are not physically here to witness this achievement, I feel your presence in every milestone I reach. This is as much yours as it is mine. In honour of your lasting impact, I have named my daughter after you, so your name and legacy will continue through the generations, cherished and honoured always.

A special dedication goes to my grandmother, Craidus Sibanda (Gogo Vena), the extraordinary woman who became my compass when I lost my way. You stepped in, raised me with tenderness and instilled in me the principles that have shaped the man I am today. Your resilience, wisdom, and strength built the foundation of this journey, and without your constant support, none of this would have been possible.

To these two remarkable women, I owe everything. You taught me the power of resilience, kindness and faith in the face of adversity. Your lessons live on in every decision I make and every success I achieve. May your souls continue to rest in eternal peace. This is for you, my eternal gratitude, wrapped in this thesis.

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Abstract

The Curriculum Assessment Policy and Statement (CAPS) document mandates that science teachers should integrate learners' Indigenous Knowledge (IK) into their classrooms. However, many South African teachers, like those in Namibia, seem to struggle with this integration due to insufficient pedagogical content knowledge, leading to minimal IK integration and hence poor science performance. This issue suggests that science curricula seem to lack clarity on integrating IK. It is against this backdrop that I was motivated to mobilise marine Indigenous Knowledge to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation.

A qualitative case study research design was used as it permits the grouping of detailed information essential to making sense of the anticipated responses of the participants. This study was informed by Vygotsky's sociocultural theory and Cultural-Historical Activity Theory (CHAT). It was conducted at a township school in the Eastern Cape, South Africa. Forty-five Grade 11 Life Sciences learners, two Indigenous Knowledge Custodians (IKCs) who grew up in marine environments and a local fisherman were participants in this study. Additionally, I asked one science teacher to be a critical friend. Data sets were gathered using a group activity, focus group interviews (sharing circles), observations (participatory and lesson observations), stimulated recall interviews and learners' reflections. The sociocultural theory was used as a lens to find out how learners learn through social interactions and how learning takes place in a sociocultural context. I augmented this theory with CHAT as an analytical framework. The CHAT provided an analytical lens to understand how community involvement and IKC interventions supported learner talk and sense making of the content and facilitated meaningful learning.

The main findings of the study revealed that during the IKCs' presentations, learners were able to identify science concepts embedded in the Indigenous Knowledge of marine biodiversity conservation. The findings further revealed that the presentations stimulated learner talk and improved sense making among learners regarding marine biodiversity conservation and related concepts. The study recommends that teachers should leverage IKCs' cultural heritage by inviting them into classrooms to make science more relevant, accessible and meaningful for learners.

Keywords: Life Sciences, marine biodiversity conservation, Indigenous Knowledge, learner talk, sense making, Sociocultural Theory, Cultural-Historical Activity Theory

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Abbreviations and/or Acronyms

CAPS: Curriculum Assessment Policy and Statement

CHAT: Cultural-Historical Activity Theory

DBE: Department of Basic Education

FGI: Focus Group Interviews

IK: Indigenous Knowledge

IKCs: Indigenous Knowledge Custodians

IKS: Indigenous Knowledge Systems

IWKL: Indigenous Ways of Knowing and Learning

MKO: More Knowledgeable Other

PCK: Pedagogical Content Knowledge

SCT: Sociocultural Theory

SRI: Stimulated Recall Interviews

TEK: Traditional Ecological Knowledge

TMESD: Transformation Model of Education for Sustainable Development

TIMSS: International Mathematics and Science Study

UK: United Kingdom

WS: Westernised Science

ZPD: Zone of Proximal Development

CHAPTER ONE: SITUATING THE STUDY

1.1 Introduction

The South African curriculum powered by the Curriculum Assessment Policy and Statement (CAPS) document recommends that a variety of teaching methods must be implemented including the use of Indigenous Knowledge (IK) (Department of Basic Education [DBE], 2011). Although it is one of the principles underpinning the curricula, literature has revealed that many science teachers in South Africa similarly to Namibia do not consider learners' IK when teaching. The current approaches seem to be aligned with the Westernised ways of teaching science. In this regard, Nyamukuti (2020) believes that policymakers and administrators who were taught under the Western system seem to be neglecting the promotion of the implementation of IK in science classrooms. It could be argued that the Western education they attained developed a colonial mindset that persists today (Nyamukuti, 2020; Shizha, 2013).

A deeper review of the above-mentioned concerns suggests that learners seem to be living in a world separated by a mountain (Tyeda, 2024) or a huge river (Godlo, 2024), incapable of connecting what they learn at home to what they are learning at school. Aikenhead and Jegede (1999) refer to this phenomenon as border crossing. As a result, some researchers have proposed revising the science curriculum to reflect African knowledge and identity (Aikenhead & Jegede, 1999; Kakambi, 2020; Mukwambo et al., 2014). According to Mutanho (2021), there has been an outcry to decolonise the curricula in many parts of the world, including the African curriculum. I agree with other scholars and Mutanho (2021), as I believe that the current curriculum needs to be critically examined, and its educational content and teaching methods revised.

This could suggest removing biases, stereotypes and perspectives that stem from colonial ideologies. The curriculum would be great if the curriculum writers would 'walk the talk' by valuing and integrating Indigenous ways of knowing, learning, and understanding the world into

the curriculum. This would mean recognising the importance of indigenous knowledge systems (IKS) and making sure that teachers are adequately trained and resourced with adequate materials (Ogunniyi, 2007). This involves acknowledging the concept of 'two-eyed-seeing' (Hatcher et al., 2017; Onwu & Mfundira, 2020) or 'two-ways-thinking' (Michie et al., 2023), which emphasises integrating multiple forms of knowledge. Michie et al. (2023) describe 'two-ways-thinking' as an approach that incorporates cross-disciplinary methods in the classroom, blending Indigenous and Western knowledge to enhance and diversify learning. On the other hand, 'two-eyed-seeing' means using the strengths of both Indigenous and Western perspectives, viewing Indigenous insights through one eye and Western knowledge through the other to achieve a comprehensive and informed perspective (Hatcher et al., 2017).

For instance, Seehawer (2018) noted that this call has necessitated the propagation of studies on integrating IK into science education. Extending on Mukwambo et al.'s (2014) seminal work, Seehawer (2018) believes that when indigenising curricula, policy needs to be more explicit on which topics to integrate what IK. Yet, the Curriculum Assessment Policy and Statement document and the textbooks recommended by the Department of Education hardly contain any specified IK. In addition, they do not encourage the use of available materials that learners and teachers can easily implement. This has resulted in other teachers, including myself, using examples that have no connection with learners' sociocultural backgrounds (Mavuru & Ramnarain, 2020; Vygotsky, 1978).

According to Taylor and Cameron (2016), most African countries, South Africa included, do not seem to value the knowledge and experience brought by African children to class. Their IK is regarded as inappropriate and of no value (Horthemke & Schafer, 2007). The danger, however, is that when learners' home and everyday experiences are not considered part of their learning process in science, a knowledge gap is created, resulting in learners being unable to relate to what they are taught. In contrast, if learners' home experiences are considered, a connection will be made between Westernised and Indigenous science which will close the gap of understanding among African Indigenous children (Aikenhead & Jedege, 1999; Nyamakuti, 2020). As alluded to earlier, Aikenhead and Jegede (1999) refer to this phenomenon as border crossing. However, Godlo (2024) argues that there are no borders in her area in the Eastern Cape in South Africa.

Instead, schools and the community are separated by rivers and hence she used the metaphor 'river crossing' in her study.

A plethora of studies have shown and observed that many African Indigenous children regard science as a very difficult subject (Aikenhead, 1996; Mutanho, 2021). This is largely because science in many African countries seems to be taught in a decontextualised manner (Gwekwerere, 2016); Mutanho, 2021). It is against this backdrop that the focus of this study was to mobilise marine IK to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation. The study was premised on the belief that learners' IK, which is part of their sociocultural background, might stimulate interest in learning and learner talk, making science relevant and thus making sense (Gwekwerere, 2016; Mavuru & Ramnarain, 2020). In addition, there is a belief that learners in township schools do not seem to engage in learner talk or argumentation, thus the need to mobilise IK. In this chapter, I present the study's context, problem statement, significance, methodology and my research interest in the topic.

1.2 Context of the Study

The Trends in International Mathematics and Science Study (TIMSS) report is an evaluation of the science and mathematics knowledge of learners worldwide that is conducted every four years (Liou & Hung, 2015). Reddy et al. (2015) noted that the TIMSS in 2011 showed that South African grades 7 and 8 learners failed both mathematics and science and were rated last out of all the 41 countries that participated. As confirmed in the TIMSS, learners with poor socioeconomic backgrounds perform poorly in science and mathematics (Howie, 2011).

I assume that the abstruse nature of teaching science that is European based contributed to these results as it is out of touch with learners' IK and culture. The TIMSS has a narrow focus on standardised assessments that overlook cultural diversity such as IK. In my view, it is biased against learners from disadvantaged socioeconomic backgrounds, emphasising academic success without considering critical thinking or real-world problem solving that is relevant to them. In this regard, the cultural-historical activity theory (CHAT) argues that these tensions highlight the need for an expansive learning approach (Vygotsky, 1978), where diverse knowledge systems (e.g., IK) are valued which promotes deeper learner engagement and understanding (Vygotsky, 1978).

The current European-based nature of teaching science is contrary to what is noted by the DBE (2011). For instance, the DBE (2011) stipulates that IK is one of the principles underpinning the curricula. Nyamakuti (2020) explains that this is the same case in Namibia. This, therefore, motivated this current study to mobilise marine IK to support learner talk and sense making of marine biodiversity conservation.

Given my 12 years of experience as a Life Sciences teacher in South Africa, I have experienced that the topic of biodiversity and conservation seems to be boring for learners. As a result, many learners are not interested in learning the chapter. This is also the case with my colleagues, as our discussions during moderation sessions highlight that the low performance on the topic yielded the same feeling. It could be argued that learners are not allowed to explore and make meaning of the concepts taught leading to their poor performance. I assume that my teaching pedagogy is not related to their life experiences (Gwekwerere, 2016), and as such, learners fail to connect the two.

The 2018 diagnostic report highlights learners' difficulties in structuring responses for the human impact essay, particularly on topics such as global warming and human impact on biodiversity (DBE, 2018). This is further supported by the 2023 Department of Education candidates' performance report, which showed that the pass rate in Life Sciences has remained steady but low over the past five years, with a higher percentage of learners obtaining 30 to 40 per cent in their final results (DBE, 2023). It seems as if the pass rate in Life Sciences has remained low and stagnant over the past years. I believe that environmental studies, including biodiversity, are major topics. This area constitutes 27% of Grade 12 Life Sciences Paper 1 and 53% of Grade 11 Life Sciences Paper 2 (DBE, 2011, p. 72). It is my contention, therefore, that if IK is implemented and encourages sense-making, the pass rate could improve.

Although the topic of biodiversity is relevant to learners' everyday lives (Kuhlane, 2011), as alluded to earlier, there seems to be a lack of relevant examples in textbooks and learning materials that are linked to learners' everyday life experiences (Gwekwerere, 2016). Instead, the examples that are used are more Westernised and do not consider learners who come from deep rural areas. For example, marine biodiversity conservation focuses on Western methods like implementing harsh laws and fines to make it impossible for marine resource harvesting. Yet, the textbook could give an example of a Zimbabwean culture that prevents people of a specific clan from eating a

plant or an animal that depicts that clan. This could be a very good example of biodiversity conservation. For example, if your clan is depicted as a fish, then all members of that clan are not allowed to eat fish. That could suggest that fish in that area would flourish as their consumption would be very low, leading to their conservation.

Another example is the isiXhosa culture, which contributes to marine biodiversity conservation. It was the traditional practice of setting aside 'no-take' areas, known as iNkomo or iMizizi, along the coastline. These areas were designated for protection and were not to be fished or exploited. This practice helped to preserve marine habitats and species by allowing ecosystems to recover and thrive without human interference. The Xhosa people have long recognised the importance of balancing resource use with environmental stewardship. Their cultural practices reflect a deep respect for marine life and its sustainability. Integrating this knowledge in the science classroom would allow learners to easily link Westernised Science (WS) and what I would call traditional science. Consequently, this link would promote learners' talk and sense making.

The integration of IK to mediate learning helps learners understand that science occurs in their daily life experiences and that they can connect it to what happens in the classroom (Gwekwerere, 2016). In this regard, the Life Sciences CAPS document, Specific AIM 3, states: "Life Sciences should allow learners to be exposed to the history of science and indigenous knowledge systems from other times and other cultures" (DBE, 2011, p. 17). However, as noted earlier, the CAPS document and the textbooks recommended by the Department of Education hardly contain any specified IK and no mention of available materials that could be easily found and used by learners and teachers.

It appears that the DBE deviates from the ideas of Shizha (2013). For instance, Shizha (2013) elaborates that for learners to have a better understanding in the classroom, educational practices should concede and accept cultural practices as they play a major role in learners' understanding. This has resulted in teachers, including myself, using examples that do not connect with learners' sociocultural backgrounds (Mavuru & Ramnarain, 2020).

Research has revealed that the diversity of learners' sociocultural backgrounds and hence cultural values may contribute in many ways towards a possible understanding of a subject (Kuhlane, 2011;

Nyamakuti, 2020). For instance, the study that was conducted in South Africa by Kuhlane (2011) on the benefits of integrating learners' prior everyday knowledge into teaching and learning revealed that the integration of IK enables meaningful learning for learners to better understand science concepts. Correspondingly, a study conducted by Nyamakuti (2020) in Namibia in a multicultural classroom showed that learners appreciated the benefits of integrating IK. They viewed IK as a mediational vehicle that joins prior knowledge to what is taught in the classroom. In addition, they were offered an opportunity to learn and understand broadly the topic of enzymes even though they all came from different sociocultural backgrounds (Mavuru & Ramnarain, 2020).

In the context of this study, for instance, under the topic of biodiversity conservation learners are expected to know the factors that can reduce the loss of biodiversity. For example, another Zimbabwean cultural practice that could fit here is the 'zviera' (taboos) concept. In this practice, specific mountains and forests are considered sacred and should not be exploited. This cultural practice can help learners understand the importance of sustainable practices and the conservation of natural resources, as it emphasises deep respect and responsibility for nature.

Learners could use this IK to acknowledge that this practice contributes largely to plant and animal conservation and thus biodiversity conservation. Glasson et al. (2010) concur with this practice, as they caution that the sustainability of ecosystems and cultural diversity in many developing African countries is in danger. As such, environmentalists are worried about the consistent loss of IK which plays an important role in maintaining biodiversity and ecological sustainability (Bowers, 2007; Glasson et al., 2010).

A plethora of literature has shown that many countries and educational curricula acknowledge the use of IK in teaching. However, they seem to lack enough content on IK or fail to elaborate on how it should be implemented. This is the case in South Africa and Namibia. Shizha (2007) elaborates that this kind of learning has detrimental effects on learners' performance as they cannot link their classroom experiences to their community experiences. According to Taylor and Cameron (2016), IK examples in the CAPS document are included as 'Activities' or 'Teacher Guidelines' and not as part of the science content. In this regard, Taylor and Cameron (2016) note that the CAPS document reflects some confusion concerning IK and its relationship with science learning. They further highlighted that there is inconsistency with the comprehensive and

interconnecting perspectives used in the CAPS texts. Asheela et al. (2021) concur with this literature since they argue that some teachers do not have the required IK.

The Cultural Historical Activity Theory (CHAT) argues that these contradictions reflect deeper tensions between Western science learning and IKS. For example, learners struggle to connect classroom content with their community experiences, as noted by Shizha (2007), because IK is not fully embedded into the teaching process. In this study, I used CHAT to hopefully resolve this contradiction by expanding the boundaries of science education when including IK as part of the scientific content itself, allowing for meaningful learner talk and sense making. The gap between teachers' lack of IK and their role in teaching it, highlighted by Asheela et al. (2021), represents another contradiction that needs to be addressed. Against this backdrop, this study sought to close this gap by mobilising marine IK to support learner talk and sense making of marine biodiversity conservation. This study thus recommends teacher training workshops and curriculum development that are linked to IK.

With my experience in teaching, I have come to realise that learners need to be at the centre of their learning process. This suggests that teachers need to consider learners' prior everyday knowledge in their science classrooms to promote meaningful learning lessons (Kambeyo, 2012). However, any misconceptions or alternate conceptions that come with such prior everyday knowledge need to be corrected or rectified, but not dismissed, as is often the case in most science classrooms. According to Liveve (2022), science teachers seem to struggle to integrate IK into their science lessons as they lack the pedagogical content knowledge (PCK) to do so. Hence, science teachers are encouraged to build on learning, including the prior everyday knowledge that learners bring to the classrooms and further value and implement the learners' life experiences as the focal point in learning and teaching (Gwekwerere, 2016).

I have observed that learners grasp new concepts better if a solid foundation from a previous grade is included. As such, I assumed that bringing IK into my science classes might curb the misunderstandings and misconceptions of the subject.

1.3 My Life History – Situating Myself in the Study

I was born and raised in Mashonaland East, Zimbabwe, surrounded by Indigenous practices rooted in the Shona culture. Our diet was largely plant-based, consisting of sadza (thick maize porridge), nyemba (black-eye pea), derere (okra), and other traditional crops like groundnuts and roundnuts. Growing up with my family was a blessing, as my parents instilled in me a deep respect for IK and the land. My mother taught me practical skills such as harvesting and preserving vegetables, drying michero (wild fruits), and preparing muramba (dried fish). My father, on the other hand, passed down skills like cattle herding, planting maize and finger millet and understanding zhizha (the seasonal cycles) that influenced our agricultural practices.

In our community, there was an intrinsic respect for nature, particularly for the rivers and wetlands that were vital to our way of life. While Zimbabwe is landlocked, we had a strong connection to water bodies, like rivers and dams, which provided us with fish and irrigation for crops during dry periods since we lived on a farm and survived by subsistence farming. My father used to say, "*Mvura itsime renyu rehupenyu*", meaning "Water is your well of life". This emphasised the importance of water conservation, but I did not understand that at that time. As a first-born child, I often accompanied him to these water sources, learning how to fish sustainably and understanding the importance of preserving aquatic life for future generations. This understanding formed part of what I later came to appreciate as IK related to aquatic biodiversity conservation.

After school, we played traditional games like nhodo, tsoro and pada, often alongside rivers or wetlands. My friends and I would sometimes spend the whole afternoon and weekend near these water sources, swimming and observing the fish and insects. These experiences shaped my understanding of ecology and IK, which I only realised after I enrolled for an MEd at Rhodes University.

We grew up being reminded that everything we do affects the environment one way or the other. In school, however, none of this rich, everyday knowledge made its way into my science lessons. Instead, the textbooks focused on Western examples of ecosystems, food chains and conservation practices, which had no link to my lived reality. Despite our deep interaction with local biodiversity, particularly aquatic life, our learning remained theoretical and separate from our

everyday life experiences as explained by Gwekwerere (2016) and other scholars. I believed that science was a foreign subject meant for naturally gifted learners. I memorised scientific facts without fully understanding them, and this created a barrier between my home experiences and my classroom experiences.

Reflecting on this now, I realise how much IK my father taught me and that the preservation techniques my mother used could have enhanced my understanding of biology. These practices carry scientific principles, such as sustainability, that are key in modern marine biodiversity conservation. Unfortunately, these ideas were never made clear during my schooling.

When I started teaching Grade 11 Life Sciences in South Africa, I found myself continuing the cycle of neglecting my learners' IK, despite the richness of their local experiences with nature and biodiversity. I taught solely from the prescribed CAPS document which has all its examples and textbooks soaked in Western science. This is despite CAPS recommending that a variety of teaching methods must be implemented including the use of IK (DBE, 2011). Like my teachers before me, I was not trained to integrate learners' IK into the science curriculum. This was even worse in my situation as I had a different sociocultural background than my learners and colleagues. This made me realise that my learners lost a lot of valuable IK that could have improved their grades.

It was only when I enrolled in my MEd programme that I began to see the potential of integrating IK into science education. Marine biodiversity conservation, for example, in my situation, was enriched by local Indigenous practices, even though I grew up in the landlocked regions of Zimbabwe. Our knowledge of freshwater bodies, the careful management of fish stocks in rivers and dams, and the sustainable harvesting of aquatic plants have much in common with the global conservation goals taught in Life Sciences.

Through this study, I hoped to bridge the gap between IK and formal science education, making marine biodiversity conservation relevant and meaningful to my learners by drawing on the wisdom that has been passed down through generations in their communities (Kibirige & Van Rooyen, 2006). This motivated me to invite the Indigenous Knowledge Custodians (IKCs) to come and present their knowledge and experiences about marine biodiversity conservation. Learners

acted as co-researchers by gathering Indigenous Knowledge on marine biodiversity conservation, similarly to Mayana (2020).

1.4 My Positionality and Reflexivity

Bourke (2014) defines positionality as multiple identities of people for both researchers and participants which can impact the research process. According to Bertrand and Demps (2018), every researcher inherently carries assumptions and biases into their work, and their positions influence the interpretation and representation of the participants' voices. Similarly, Holmes (2020) explains that as a researcher one cannot separate oneself from the social reality one lives in and carry out studies objectively. As such, I hereby disclose how I may have influenced this study (Holmes, 2020)

As their teacher, the learners already knew me, and they might have considered me a more knowledgeable other (MKO) as reiterated by Vygotsky (1978). This may have caused an imbalance in the power gradient in my favour. Moreover, being a MEd student in this study, I might have been considered more knowledgeable. This might have been further exacerbated by the participants' knowledge that I am a senior marker for Life Sciences paper 2, and responsible for moderating other markers. To ameliorate this, I presented myself as a co-learner and made it clear that the purpose of this study was to generate something new and learn something that does not yet exist (Sannino et al., 2016).

Notwithstanding, being a Zimbabwean while the research participants were all isiXhosa speaking might have situated me as an outsider in this study. However, since I have been in South Africa for more than 10 years, similarly to Mutanho (2021), I have learned to speak isiXhosa. This was important as I found myself in a new social and cultural context where isiXhosa was the primary language of my learners and their families. This placed me in a unique position, where I initially felt like an outsider, particularly in the early years of my teaching career. This cultural breakthrough made me feel more like an insider within the community, fostering stronger relationships with my learners.

As a result, my learners always appreciated it whenever they heard me trying to speak isiXhosa and this made me an insider. Yet, despite learning isiXhosa, I recognise that there are still moments where my understanding of the language is limited, especially when it comes to deep cultural expressions used by my learners. I assume, therefore, that since our social and cultural backgrounds were different, I may struggle to understand the isiXhosa language used in the participants' responses (Galam, 2015). Thus, the critical friend who was South African and isiXhosa speaking helped me understand when I faced challenges. As such, I clarified that we were conducting the research together to additionally curb this problem and build strong relationships with my participants so that they understood my position very well.

Leaving for the United Kingdom (UK), England, certainly made me feel like an outsider again, especially after having worked hard to integrate into my South African community by learning isiXhosa. However, my time abroad sparked curiosity among my learners, who were eager to hear stories about life in the UK. This became a bridge rather than a barrier, as I shared experiences that highlighted differences and similarities between the UK and South Africa, particularly regarding environmental conservation and education. These conversations allowed us to connect local IK with global practices, making my time abroad a point of interest rather than division. Eventually, my learners saw that, despite my time overseas, I remained committed to their community and education.

On the other hand, reflexivity refers to the process of reflecting on and critically examining one's own role, biases and influence during the research process. It involves continuous self-awareness and acknowledgement of how personal and professional perspectives can affect the study. According to Finlay (2002, p. 532), reflexivity "requires critical self-reflection of the ways in which researchers' social background, assumptions, positioning and behaviour impact on the research process". In my study, I put reflexivity into practice by continuously reflecting on my dual position as both an insider and an outsider. I actively examined how my assumptions and cultural positioning shaped my interactions with participants and their responses. For instance, learning isiXhosa and integrating it into the local culture helped me build rapport with my learners, but I also acknowledged my limitations, especially when interpreting nuanced language. To

mitigate this, I collaborated with a critical friend who was fluent in isiXhosa, ensuring that my biases or misunderstandings were minimised.

Concurring, Holmes (2020) believes that reflexivity entails reflecting and acting throughout the research process. As such, I remained aware of learners' positionality and how my presence and perspectives may influence their responses and engagement. Similarly to Mutanho (2021) and Godlo (2024), I, therefore, advocated the use of clan names between myself and learners to level the power gradients. This was necessary for the participants to gain confidence and trust towards the researcher (Birhane et al., 2022). By addressing each other using clan names, a culturally significant practice, learners felt more empowered and comfortable participating in the research process. It fostered trust and reduced power dynamics, encouraging them to engage more openly and authentically with me as their teacher and researcher.

According to Birhane et al. (2022, p. 45), reflexivity "requires a deep understanding of how researchers' own identities and positions can shape the research process and outcomes". In this study, during the collaboration with IKCs, I recognised their cultural heritage and perspectives. As such, I was aware of my preconceptions about Indigenous Knowledge, and I was open to learning and adapting their methodologies to honour the contributions of IKCs. This helped both the IKCs and the learners to recognise that their culture is valued and appreciated at school by a non-South African.

As reiterated before, in all engagements I recommended using the isiXhosa language. I enjoyed the interactions as I felt appreciated by both learners and IKCs for trying to speak the language. By integrating reflexivity, the study hoped to authentically explore how IK influences Grade 11 learners' talk and sense making of marine biodiversity conservation.

1.5 Statement of the Problem

The traditional educational approaches that are Westernised often overlook the valuable insights offered by Indigenous Knowledge (Mazzocchi, 2006), even though IKS provide a holistic understanding of nature and can offer alternative perspectives on conservation practices in the context of this study. Integrating IK into the formal education system, particularly in subjects like

Life Sciences, can enhance learners' comprehension and appreciation of marine biodiversity conservation (Cajete, 2000). However, there is limited research on how IK influences learner talk and sense making in this context.

In the context of non-integration of IK, learners seem to find Life Sciences not interesting and difficult. According to my experiences and other colleagues, learners seem to struggle to understand science concepts when IK is not included. I assume that teachers are not well equipped with IK integration and thus lack sufficient strategies to implement their concepts. According to my understanding, this may result in teachers using strategies that are in contrast with the Indigenous ways of learning and thus have no link to learners' daily experiences (Gwekwerere, 2016). In this regard, Asheela et al. (2021) explain that the foundation of each stage of a learning procedure is the learner's existing knowledge, skills, interests and understanding, derived from prior experiences in school and out-of-school environments. This is supported by Mutanho (2021), as he reiterated that integrating IK into science education bridges a gap between 'science-in-society' and 'science-in-school'. However, Le Grange (2007) cautions that cognitive dissonance may occur initially when learners are exposed to two conflicting knowledge systems (Ogunniyi, 2007). In this case Westernised Science (WS) and IK. However, he later alludes that learners can develop a deeper understanding of both knowledge systems and find ways to integrate them meaningfully after the struggle (Le Grange, 2007).

Supporting this view, a plethora of literature highlights the significance of integrating learners' prior knowledge and experiences from diverse environments to enhance learning outcomes. For instance, Tina Grotzer from the Harvard Graduate School of Education discusses how connecting course material to learners' personal experiences can extend their understanding. By reflecting on how the matter relates to their own lives, learners are more likely to engage with and retain the information presented in class (Harvard Graduate School of Education, n.d.)

In the context of my study, learners seem to find it difficult to link biodiversity conservation with their daily life experiences which leads to poor performance in the topic and eventually the subject. I assume that my learners fail to understand science concepts because I do not use examples from their daily experiences (Gwekwerere, 2016). It is against this backdrop that I was motivated to explore the influence of IK on Grade 11 Life Sciences learners' talk and sense making of marine

biodiversity conservation. The study was based on the belief that learners' IK, which is part of their sociocultural background might stimulate interest in learning and make science relevant and thus make sense (Gwekwerere, 2016; Mavuru & Ramnarain, 2020).

1.6 Rationale and Significance of My Study

This is a formative interventionist study that mobilised marine IK to support Grade 11 Life Sciences learners' talk and sense making of marine biodiversity conservation. This was intended to make marine biodiversity conversation relevant and accessible to learners. This study sought to fill this gap by mobilising marine IK to support Grade 11 Life Sciences learners' talk and sense making regarding marine biodiversity conservation. By tapping into the cultural heritage and experiences of IKCs and using the sociocultural theory (SCT) and CHAT, this research hoped to provide insights into how IK can be effectively integrated into the curriculum. The learners who are the direct beneficiaries of the information were hoped to benefit significantly and make more sense by bringing their community into the classroom. It was hoped that the host school would benefit by improving the learners' grades when implementing the newly discovered strategy if the findings proved to be of importance and that the overall pass rate would increase.

The findings of this study were hoped to benefit me as a researcher and a Life Sciences teacher to improve my teaching methods in terms of integrating IK into the classroom, lesson preparation and learner sense making. In addition, it was hoped that the findings would be of relevance to the DBE so that they would propose some strategies to make it possible to integrate IK when mediating learning of biodiversity, particularly in the classroom. For instance, the DBE would consider having content-gap workshops for teachers in terms of IK based on the identified constraints and enablers of integrating IK when mediating learning of biodiversity conservation. In addition, it was hoped that other teachers would appreciate the findings and implement them to better their teaching practices. The strategies in this study could be used to integrate IK into the mediation of learning enabling learners to understand the subject better as both learners and teachers would be building on the learners' background knowledge (Hennessy et al., 2007). As the Life Sciences Curriculum Assessment Policy and Statement (CAPS)document (DBE, 2011, p. 5) puts it:

> Science should be taught in an integrated way to both enhance the subject and to clarify the relationship between the subject and society, that is indigenous knowledge systems that relate to a specific topic, related history of scientific discoveries and the applications of science in everyday life.

1.7 Research Goal

The main goal of this study was to mobilise marine IK to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation. To achieve this goal, the following research objectives and questions were addressed.

1.7.1 Research objectives

1. To establish what enables and/or constrains Grade 11 Life Sciences learners' talk and sense making of the topic of biodiversity conservation before the intervention.
2. To investigate if integrating IK into biodiversity conservation lessons shifts (or not) Grade 11 Life Sciences learners' talk and sense making.

1.7.2 Research questions

1. What enables and/or constrains Grade 11 Life Sciences learners' talk and sense making of biodiversity conservation before the intervention?
2. How do lessons on biodiversity conservation that integrate IK shift (or not) Grade 11 Life Sciences learners' talk and sense-making of this topic?

1.8 Theoretical and Analytical Framework

Merriam and Tisdell (2015) describe a theoretical framework as the foundational structure of a study. In this research, two theories were used: Vygotsky's (1978) sociocultural theory (SCT) and Engeström's (2001) CHAT. SCT helped explore how learners engaged with IKCs, focusing on social interactions and learning in a cultural context, especially as the IKCs shared their heritage of marine biodiversity conservation. CHAT, on the other hand, provided an analytical lens to understand how community involvement and IKC interventions supported learners in making sense of the content and facilitated meaningful learning.

1.8.1 Theoretical framework: Sociocultural theory

Sociocultural theory (SCT), as proposed by Vygotsky (1978), emphasises that learning is a social process driven by interactions between individuals, including adults and peers. Through these interactions, people construct meaning based on their social experiences. In the classroom, learners make sense of concepts by engaging with each other and their teachers. Vygotsky also highlights that individual development is deeply connected to social and cultural contexts. Supporting this, Mavhunga and Kibirige (2018) stress that meaningful learning occurs when it involves social interactions and culturally relevant materials. In addition, key components of SCT, like mediation of learning, social interactions, and the zone of proximal development (ZPD), demonstrate how learners internalise knowledge through guided participation in social activities.

1.8.2 Analytical framework: Cultural-historical activity theory

The CHAT assumes that human actions are complex, multi-layered and socially embedded. In this study, both the first and second generations of CHAT were applied. The first generation, derived from Vygotsky's SCT, focuses on the relationship between the subject, object and tools that mediate actions. Here, learners (subjects) interacted with the Indigenous Knowledge of marine biodiversity (object) using concepts and experiences shared by IKCs as tools. The goal was to understand how learners talk and make sense of marine biodiversity conservation when IK is integrated into the classroom.

The second generation of CHAT, as elaborated by Engeström (2001), examines collective activity systems where interactions between subjects, community, rules and tools shape outcomes. In this study, learners' sense making of marine biodiversity was influenced by the community (IKCs, teachers, and critical friend), rules (curriculum), and shared cultural experiences. The integration of IK was expected to shift learners' understanding and promote meaningful conversations and sense making about marine biodiversity conservation.

1.9 Data Gathering Methods

Different data gathering techniques were employed as a way of gathering rich data and thus assisting with the triangulation of data (Mill, 2011). The following data gathering methods were used to gather data in this study:

- group activity;
- focus group interviews (sharing circles);
- participatory and lesson observations;
- learners' reflections; and
- stimulated recall interviews.

1.10 Key Concepts Used in the Thesis

Biodiversity conservation, conceptions, dispositions, IK, learners' prior knowledge in science classrooms, learner talk, marine biodiversity conservation, and sense-making are the key concepts used in this thesis and are used consistently.

Biodiversity conservation

Biodiversity includes genes, species, and different kinds of ecosystems (Pimm, 2021). Ecosystems are forests, grasslands, deserts, ponds, and any other environment that sustains life. Similarly, Cardinale et al. (2012) define biodiversity as richness, evenness, and heterogenicity among life forms. According to Primack (2014), biodiversity conservation is the practice of protecting and managing the variety of life forms on Earth, including different species of plants, animals, and microorganisms, their genetic diversity, and the ecosystems they form. The goal of biodiversity conservation is to sustain the natural processes that support life, ensure the survival of diverse species, and maintain the ecological balance necessary for human well-being and the planet's health (Primack, 2014)

Marine Biodiversity Conservation

Marine biodiversity refers to the variety of life forms in the ocean, including species, ecosystems, and genetic diversity (Moberg & Folke, 1999). Marine ecosystems, like coral reefs and kelp forests, are crucial for supporting life and providing services such as food, carbon storage, and coastal protection. Halpern et al. (2015) emphasise that conserving marine biodiversity is vital for maintaining ecosystem health and sustainability. Marine biodiversity conservation aims to protect these ecosystems from overfishing, pollution, and climate change, ensuring the survival of species and the continued provision of essential services (UNEP, 2020).

Conceptions

Thompson (1992) averred that conceptions are mental arrangements that contain beliefs, concepts, meanings, propositions, mental images and others. According to Tsai and Kuo (2008), conceptions are views that learners have towards learning. Conceptions are key as they shape how learners understand, interpret, and make sense of new information, influencing both learning and the integration of diverse knowledge systems (Driver et al., 1994).

Dispositions

According to Atallah et al. (2003), learning can be influenced by both destructive and constructive attitudes. Such dispositions are associated with either positive or negative attitudes (Atallah et al. 2003). To Crick and Yu (2008), dispositions are a developmental tendency that develops over a long period.

Indigenous Knowledge

Indigenous knowledge (IK) is the knowledge gained by individuals as they live and work in their communities or society (Nyika, 2017). To Nyika, IK can be in the form of beliefs and norms and can comprise songs, local language, and even agricultural practices.

Learners' Prior Knowledge in Science Classrooms

Roschelle (1995) reasons that new knowledge begins with the selection of ideas from everyday experiences although it does not replace prior knowledge but instead re-uses it, resulting in prior knowledge being refined. According to Mutanho (2021), learners find it easier to understand concepts if the teacher develops ideas from the acknowledged to the unknown.

Learner talk

Learner talk refers to the verbal interactions and discussions among learners during the learning process (Mercer, 2000). It is key to understanding how learners construct knowledge, share ideas, and develop understanding through conversations (Alexander, 2008; Mercer, 2000). This type of communication includes asking questions, explaining concepts, debating perspectives, and reflecting on experiences. According to Mercer (2000), learner talk is essential for learners to articulate their thoughts, ask questions, and build on others' ideas. In this study, marine IK was mobilised to encourage learner talk and sense-making in Grade 11 Life Sciences, particularly during activities like group work, role play, and learner reflections, helping learners engage with marine biodiversity conservation.

Marine Biodiversity Conservation

Marine conservation is the practice of safeguarding and maintaining the world's oceans, aquatic life and ecosystems (Darrah, 2023). Darrah (2023) believes that marine conservation is a critical matter that affects both oceans and humans who depend on the aquatic environment for survival. The goal of marine biodiversity conservation is to sustain the natural processes that support marine life, ensure the survival of diverse marine species, and maintain the ecological balance necessary for the health of ocean ecosystems and human wellbeing (Sala & Knowlton, 2006)

Sense Making

Sense making as described by Weick et al. (2005), is a way of making circumstances comprehensible using clear and simple words. Nikodemus (2017) emphasises that sense making is when meaning materialises – a crucial part of linguistic conversation and communication. According to Maitlis and Christianson (2014), sense making involves organising and integrating

new knowledge with existing cognitive backgrounds to derive meaning. Sense making is critical in research as it helps learners construct reasonable explanations of data, events and experiences, thus guiding decision-making and actions (Maitlis & Christianson, 2014).

1.11 Thesis Outline

The study was conducted at Chigwe High School (pseudonym), a township school in the Eastern Cape, South Africa and consists of the following chapters.

Chapter One

Chapter One outlined the context of the study, the statement of the problem, the significance of the study, my positionality and the research goal and questions. An overview of the theoretical frames guiding the study and the proposed data collection methods were also highlighted as well as the chapter summary.

Chapter Two

In this chapter, the literature relevant to this study is presented, reflecting what has been researched and strengthening the importance of the study. In this chapter, the literature on the concepts of marine biodiversity conservation, IK, sense-making, learner talk, and prior knowledge is discussed.

Chapter Three

In this chapter, the conceptual, theoretical, and analytical frameworks that underpinned the study are discussed.

Chapter Four

This chapter deliberates on the methodology implemented in this study. The research paradigms, research method, research site, and sampling are discussed, followed by the data-generating techniques and procedures and the rationale behind their use, including data analysis. Lastly, the concerns of validity and trustworthiness and ethical considerations are presented.

Chapter Five

In this chapter, data generated from group activities is presented, analysed and discussed.

Chapter Six

In this chapter, data generated from the presentations by IKCs is presented, analysed and discussed.

Chapter Seven

In this chapter, data from the intervention lessons that integrated IK (videotaped lessons), participatory and lesson observations, focus group interviews, and data from stimulated recall interviews and learners' reflections are presented, analysed, and discussed.

Chapter Eight

A summary of the findings of the study is presented and analysed in alignment with the research questions. In addition, recommendations, limitations, possible areas of future research and reflections are provided as well as the conclusion.

1.12 Chapter Summary

This chapter introduced the study to the reader and described the background of the study as well as the problem statement which triggered the interest to conduct this research. The main goal of this study was to mobilise marine IK to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation. The context of this study, its significance, the research goal and questions were discussed. The methodology, data gathering techniques and theoretical and analytical frameworks that underpin this study were discussed. This included the sociocultural and CHAT theories. Lastly, the research goal and research question for this study were also set out. In the next chapter, I discuss the literature relevant to this study.

CHAPTER TWO: LITERATURE SYNTHESIS

2.1 Introduction

A literature review means positioning and reducing the studies around a subject (Creswell & Creswell, 2018). O'Leary (2014) similarly defines it as a review of a body of knowledge encompassing what has been found and methodological contributions. This study aimed to mobilise marine IK to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation. The aim was to make science accessible and relevant to learners by integrating learners' existing knowledge in science learning. As suggested by Aikenhead and Jegede (1999), it was hoped that the introduction of IK would remove the barriers preventing successful science learning for learners. In addition, it hoped to make learning accessible and interesting, especially by involving IKCs in their learning space.

In the previous chapter, I discussed the context of this study. In this chapter, I divulge the literature that informed the study, exploring the following concepts: biodiversity conservation, marine biodiversity conservation, learners' prior knowledge in science classrooms, IK, the benefits and challenges of integrating IK in science, the role of IKCs in science teaching and learning, conceptions, dispositions, learner talk and sense making.

2.2 The Knowledge Gap

While existing research has explored the integration of IK into educational settings and the benefits of Indigenous perspectives in biodiversity conservation (e.g., Davis & Rangel, 2018; McGregor, 2004), there seems to be limited empirical evidence on how marine IK specifically influences learner talk and sense making of marine biodiversity conservation. Most studies focus on general IK, or terrestrial ecosystems, without addressing the unique challenges and pedagogical strategies required for marine contexts. In addition, there is a gap in understanding how learners from diverse socioeconomic backgrounds, such as those from township schools, engage with and interpret

marine IK within the framework of their formal education (Berkes, 2018; Nakashima et al., 2012). This study sought to fill this gap by examining how marine IK can be effectively mobilised to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation.

2.3 Biodiversity Conservation

According to Primack (2014), biodiversity conservation is the practice of protecting and managing the variety of life forms on Earth, including different species of plants, animals and microorganisms; their genetic diversity; and the ecosystems they form. Biodiversity means the genes, species and the different kinds of ecosystems (Pimm, 2021). Ecosystems include forests, grasslands, deserts, ponds and any other environment that sustains life. Similarly, Cardinale et al. (2012) define biodiversity as the richness, evenness and heterogenicity among life forms. According to Pimm (2021), human actions destroy ecosystems and thus destroy genetic biodiversity. To my understanding, the rapid loss of biodiversity caused by humans – outpacing the ability of species to recover and replace those lost – represents a lack of conservation. Pimm (2021), similarly, defines it as how severely humans are not preserving biodiversity.

According to these scholars, biodiversity conservation is also responsible for the health and balance of the ecosystems. As mentioned earlier, humans disrupt these ecosystem networks faster than their natural recovery, and seemingly, the loss is accelerated by a lack of effective conservation (Pimm, 2021). It is vital to consider various conservation strategies as the survival of all living beings on Earth depends on a healthy biodiversity.

When biodiversity is conserved, tremendous benefits become available to humanity, such as food and fresh water, climate regulation and disease control **(**Cardinale et al., 2012**).** These authors also suggest that primary production, nutrient cycling and decomposition, among others, are ecosystem functions that may fail if biodiversity is not maintained. The biodiversity concept map, Figure 2.1, shows the importance of biodiversity conservation.

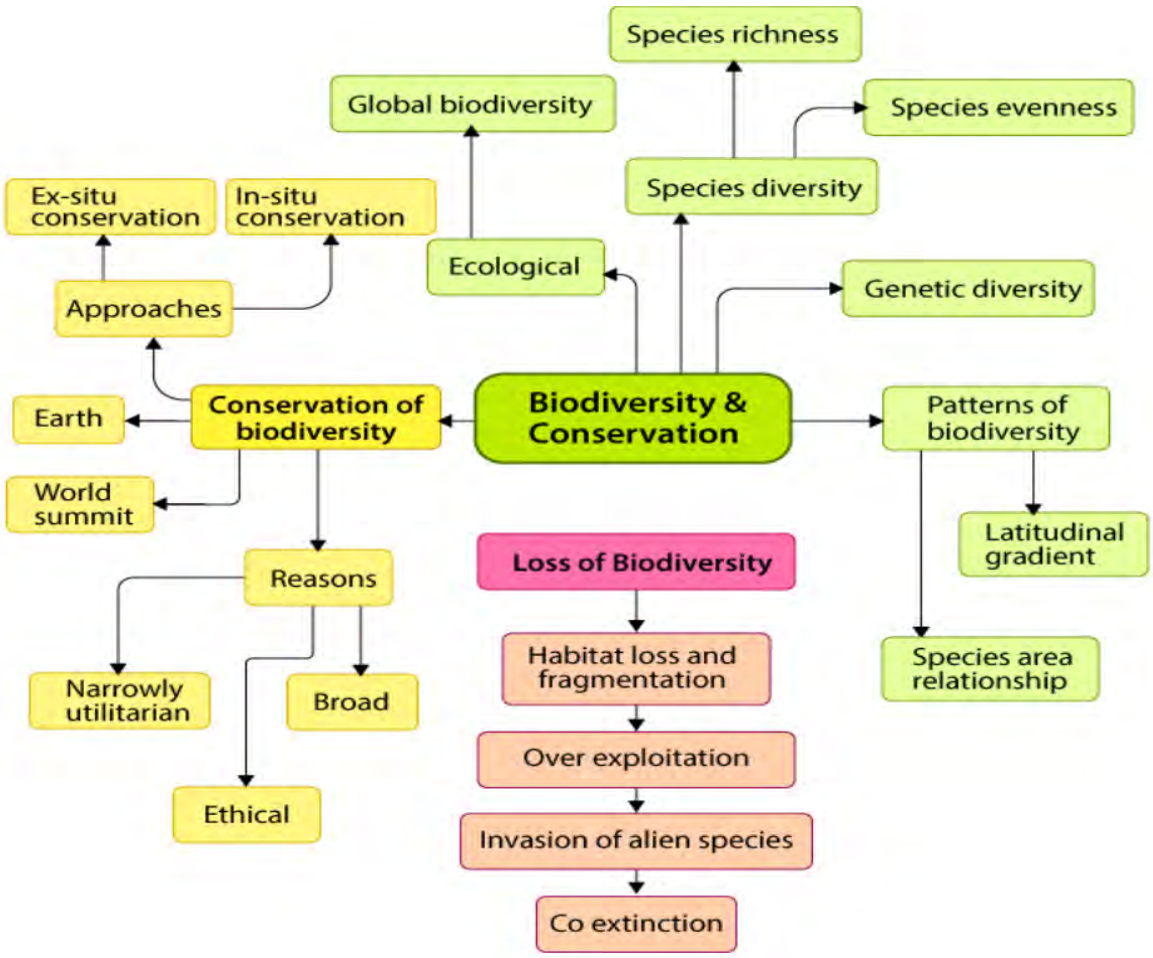


Figure 2.1: The biodiversity and concept conservation map (www.byjus.com/biology/biodiversity-conservation)

Figure 2.1 describes the benefits that biodiversity conservation can bring to society. Species richness and the index of biodiversity will drastically increase, making more food available to both humans and animals and extending to other benefits such as accessible medicinal drugs and revenue through ecotourism. Natural catastrophes can be followed by various forms of ecological succession, allowing the land and forests to become beautiful and vibrant again, all of which will reduce global warming.

In South Africa, Life Sciences is taught from grades 10 to 12, building on the biology section of natural sciences learned in grades 4 to 8. According to the Life Sciences CAPS document (DBE, 2011), one of the general aims of the South African curriculum is to use science to successfully show responsibility towards the environment. From Grade 10 to 12, four hours a week are allocated

to environmental studies and biodiversity (DBE, 2011). In my view, IKS, which are rooted in our cultural practices, may offer sustainable solutions to maintain biodiversity, thus, I was motivated to mobilise marine IK to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation.

2.4 Marine Biodiversity Conservation

Duffy (2003) defines marine biodiversity conservation as the practice of protecting and managing the variety of life forms in marine environments. These life forms include different species of fish, invertebrates, plants and microorganisms, and the genetic diversity and ecosystems they form (Duffy, 2003). According to Darrah (2023), marine conservation is the practice of safeguarding and maintaining the world's oceans, aquatic life and ecosystems. Darrah (2023) believes that marine conservation is a critical issue that affects both oceans and humans, who depend on the aquatic environment for survival. According to Sinay (2024), human activities have severely negatively impacted marine biodiversity and have become a major concern. Although climate change is a driving factor, unsustainable fishing practices, marine pollution, alien species and rising sea temperatures caused by human activities have become amplifying factors in the loss of marine species. Given the importance of marine ecosystems to both the environment and humans, there is an urgent need for conservation and restoration of marine biodiversity. Sinay (2024) believes that well-conserved marine biodiversity can prevent one species' extinction from causing wider negative impacts on a marine ecosystem.

In the context of this study, it was hoped that the learners' interactions with the IKCs would aid learners' talk and sense making of marine biodiversity conservation. This would then be a driving force in understanding the Westernised explanations provided by the Life Sciences textbooks. I thought that having the concepts explained in their native language by elders and local fishermen (some of whom may be the parents or relatives of learners) would help them link the knowledge to classroom practice and understand it better.

2.5 Learners' Prior Knowledge in Science Classrooms

Roschelle (1995) reasons that new knowledge begins with the selection of ideas from everyday experiences; it does not replace prior knowledge but instead re-uses it, resulting in prior knowledge being refined. According to Mutanho (2021), learners find it easier to understand concepts if the teacher develops ideas from the acknowledged to the unknown. Therefore, for learners to understand the learning objective, their prior knowledge of biodiversity conservation should be considered.

It should be noted that prior knowledge could refer to Indigenous or local knowledge. Kuhlane (2011) and Okanlawon (2017) view prior knowledge as the practices that learners obtain from their daily lives and preceding grades. Usually, learners connect their existing knowledge to the current knowledge being taught to make sense of their lessons. Kuhlane (2011) suggests that, since it is not possible to learn without prior knowledge, educators need to understand how prior knowledge affects learning to assist learners effectively. In the context of this study, prior knowledge refers to IK.

However, Taylor (1999) cautions that not all everyday information provides a suitable foundation for learning in the classroom. According to this scholar, if prior knowledge is not endorsed properly, misunderstandings may arise, making it irrelevant. In support of Taylor, Hodson (2009) also warns that not everything should be included in the curriculum under the banner of science.

In this study, learners were given questions about marine IK to research and present in class as a class activity. The purpose was to identify the level of IK related to marine biodiversity conservation possessed by learners To Dong et al. (2020), a learner would perform better when their prior knowledge is more comprehensive. In support of this, Mayana (2020) posits that integrating IK in science classrooms acknowledges the social identities of learners, and this can easily turn learning into a positive experience and contribute towards changing the attitudes of learners toward learning.

2.6 Indigenous Knowledge in Science Classrooms

Indigenous Knowledge (IK) is the knowledge gained by individuals as they live and work in their communities or society (Nyika, 2017). According to Nyika (2017), IK can be in the form of beliefs and norms and can comprise songs, local languages and even agricultural practices. Similarly, Kibirige and Van Rooyen (2006) define IK as an inheritance of knowledge and skills unique to a particular native culture, involving wisdom that has been advanced and passed on over generations. Mosimage and Onwu (2004) refer to IK as all-inclusive knowledge that covers technologies and practices that have been and are still used by Indigenous and local people for their existence, survival and environmental adaptations. According to Roschelle (1995), IK is embedded in Western science, and it can be used as prior knowledge to reduce learner challenges associated with WS. In this regard, Kibirige and Van Rooyen (2006) confirm that science teaching is improved when IK is used in the classroom as a preliminary point to discover concepts associated with WS.

Naidoo and Vithal (2014) highlighted three approaches to engaging IK in science lessons: the incorporationist approach, which brings selected IK into science by seeking how best IK fits into science; a separatist approach that holds IK side by side with scientific knowledge; and an integrationist approach that makes connections between IKS and science. Mayana (2020) and Taylor and Cameron (2016) concurred, the latter scholars terming the three perspectives of the relationship between IK and science education the inclusive, exclusive and intersecting perspectives. These perspectives are illustrated in Figure 2.2 below.

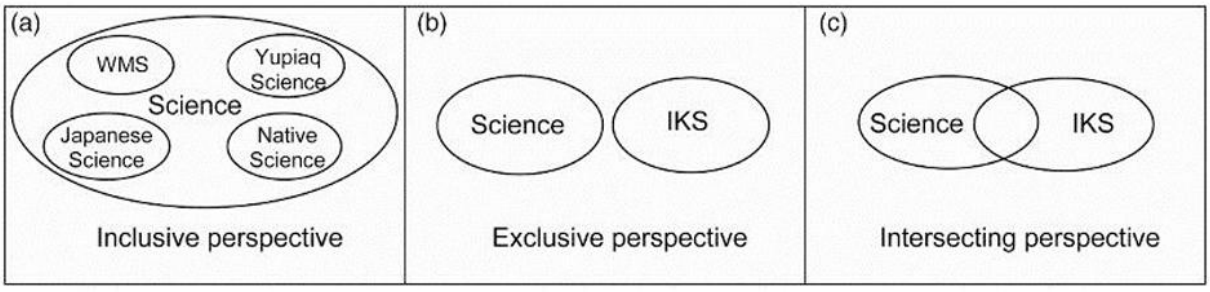


Figure 2.2: Three perspectives of the relationship between science and IKS (Adapted from Taylor & Cameron, 2016, p. 36)

Taylor and Cameron (2016) argue that there is no single way to think about science, as science is the knowledge and understanding of nature; they believe that all knowledge is rooted in a particular worldview with beliefs about the world. They further argue that the three perspectives acknowledge IK as a valid and useful way of knowing and grasping knowledge. Many scholars believe that the social identities of learners are acknowledged when IK is taken into consideration in the science classroom (de Beer & Whitlock, 2009; Mavuru & Ramnarain, 2020).

Taylor and Cameron (2016) describe the inclusive perspective as one where science is seen as an overarching domain that encompasses various forms of knowledge, including IK. In this view, IK is considered subordinate to WS, with the primary role of IK being to promote the learning of WS. The dominant characteristic of this perspective is the superiority of WS over IK. However, my study introduces new insights by focusing on how IK influences learners' talk and sense making, rather than just examining the relationship between IK and WS.

The exclusive perspective treats science and IKS as entirely separate and distinct domains, with no overlap or intersection between them. Taylor and Cameron (2016) identify this view as one that regards IK and WS as ontologically and epistemologically different, advocating for their treatment as separate entities in the curriculum. They argue that the most appropriate form of knowledge should be selected based on the relevance of the situation at hand.

Taylor and Cameron (2016) suggest that while IK and WS may differ in their ontology and epistemology, there are significant commonalities between them. They argue that educators should emphasise the knowledge that exists at the intersection of IK and science, that is, applying the intersecting perspective. Similarly, Mutanho (2021) contends that both the scientific and non-scientific aspects of IK are valuable in a science lesson because they spark interest. Therefore, the focus should be on the commonalities rather than the differences between these knowledge systems.

As far as Govender (2014) is concerned, learners become motivated to learn science when IK is integrated into science classrooms. In support of this, Mukwambo et al. (2014) reiterate that the integration of IK into classrooms helps to decolonise and Africanise science education. It should be noted, however, that teachers should be cultural knowledge brokers to successfully integrate IK

into their teaching (Cooper, 1999, 2014; Simasiku, 2022; Wyatt et al., 2017). In addition, Kibirige and Van Rooyen (2006) argue that matters may arise for dissemination across cultures since it is difficult to share IK among members of different cultures.

As mentioned previously, Hodson (2009) warned that not everything should be included in the curriculum under the banner of science, and similarly, Mukwambo et al. (2014) cautioned that proper examination of IK should be done before it is used in teaching and learning so that inconsistencies and misconceptions are pointed out and/or eliminated. According to Shizha (2007), integrating IK into science lessons is not an easy task, as there might be challenges regarding teachers' attitudes and pedagogical knowledge. This is exacerbated by the fact that IK is not documented despite it being vital in understanding and sense making in science.

Michie et al. (2022) argue that the most effective way to create an inclusive science curriculum is by incorporating the pedagogy of indigenous ways of knowing and learning (IWKL), which introduced the concept of a 'two-eyed-seeing' approach. They believe this helps to bridge the gap between Western and Indigenous perspectives. This approach intentionally and respectfully integrates different ways of knowing, allowing learners to view science through one eye with the strengths of IK and through the other eye with the strengths of Western knowledge (Taylor & Cameron, 2016).

Also, Michie et al. (2023) discuss the concept of 'two-ways-thinking' as an approach to integrate IK with Western educational perspectives. This idea is like two-eyed-seeing (Hatcher et al., 2009), which encourages viewing the world through both Indigenous and Western lenses to create a more holistic understanding as alluded to above. In two-ways-thinking, cross-disciplinary learning is promoted, especially by incorporating Indigenous perspectives. The goal is to use an integrated approach that enriches learning by combining diverse ways of knowing, fostering a more inclusive and expansive educational experience. Michie et al. (2023) believe that the concept of 'two-ways-thinking' is useful in subjects like science. They argue that IK can deepen understanding by offering alternative viewpoints and experiences on natural phenomena (Michie et al., 2023).

The CAPS document defines IK as knowledge stored within different communities that can be passed from generation to generation. In this study, the Indigenous Knowledge Custodians

interacted with the learners as they discussed the marine biodiversity strategies that they practised and are still practising. As explained by Handayani et al. (2018), this is referred to as cultural sustainability, as the knowledge – besides assisting in learners' understanding of science concepts – will also trickle down to future generations. The same practices may be used to sustainably develop marine ecosystems in years to come by current and future generations.

Based on my experience as a Life Sciences teacher, I have learned that learners understand new knowledge quite easily if examples common to them are integrated as part of the lesson. If IK is ignored, learners will not have a solid foundation to develop Westernised knowledge concepts. Since IK is an all-inclusive knowledge, the involvement of elders and a local fisherman hoped to close the existing gap between IK and WS.

2.7 Benefits of Integrating IK into the science classroom

Nyika (2017), Shizha (2007) and many other scholars have supported the integration of IK in classrooms and the incorporation of IK in the science curriculum. In their view, IK makes learning easy and fun for learners as they connect WS to their IK. Mushayikwa and Ogunniyi (2011) believe that the integration of IK is a vehicle for discussing the interaction between Western and Indigenous worldviews. Shizha (2009) believes that when IK is integrated into learning, learning becomes relevant and learners will respond well to the new knowledge.

Mavuru and Ramnarain (2020) emphasise that integrating learners' cultural customs and values into science lessons and class proceedings could enhance learner performance since learners will be involved in familiar activities. In my view, learners will successfully learn using IK and WS only if they successfully link and move their understanding from IK to WS. Similarly to Mutanho (2021), as a science teacher, I believe that learners need both knowledges to successfully understand the Westernised curriculum. Aikenhead and Jegede (1999) support the above as they contend that learners successfully move from IK to WS just like crossing a physical barrier from one place to another.

As mentioned earlier, scholars like Taylor and Cameron (2016) observe that there is no single way to think about science, as science is the knowledge and understanding of nature. In support, Michie

et al. (2022) introduced the concept of a two-eyed seeing approach, which they believe helps bridge the gap between Western and Indigenous perspectives. In this study, the inclusion of these two knowledges allowed learners to view science through one eye with the strengths of IK and through the other eye with the strengths of Western knowledge. From my perspective, this helped to foster learner talk and sense making. However, I believe that teachers need to recognise and understand the two knowledge systems before bringing them to the science class. They also need to know how to integrate them, and thus there is a need to find strategies for combining the two knowledges in science teaching. This echoes Mukwambo et al. (2014), who believe that IK needs to be properly examined before it is used so that there is a chance to expose any misconceptions that might come to the fore or be embedded in it.

In this study, learners experienced retrodictive learning (Chikamori et al., 2019), as the IKCs shared their cultural knowledge of marine biodiversity and made it accessible to the learners. As the IKCs shared their cultural knowledge on marine biodiversity conservation, learners could tie the concept to their prior knowledge to understand the scientific concept of biodiversity conservation. According to Chikamori et al. (2019), learners go through a retrodictive learning process by learning current knowledge by connecting it to what they know from the past.

2.8 Challenges of Integrating IK in the Science Classroom

Although a variety of scholars believe that IK integration has proven to be good for learning and easily connecting background knowledge and WS, it also has its shortcomings. Taylor (1999) cautions that not all everyday information provides a suitable foundation for learning in the classroom. According to him, if prior knowledge is not endorsed properly, misunderstandings may arise, and it becomes irrelevant. Mukwambo et al. (2014) also stress that IK needs to be properly examined before it is used so that there is no possibility of exposing any misconceptions that might be embedded in it.

In my own life experiences, many people in my culture undervalue IK, seeing it as less important or entrenched in myths, when in fact only a fraction of it is. Southerland (2000) thinks that forcing all forms of knowledge about nature and naturally occurring events into concepts of science sets no boundaries for the limits of science.

As a Life Sciences teacher who has had the privilege of teaching learners from diverse sociocultural backgrounds, I believe that integrating IK can be challenging in the sense that different cohorts of learners might have different IK, some of which the teacher may also not have. In that case, it might be difficult for the teacher to connect with the cultures and IK of all learners to make learning inclusive. In my opinion, learners who come from the same tribe or have a similar cultural background to the teacher might benefit more, while others might be left unsatisfied.

In support of this, Nyamakuti (2020) contended that teachers must be culturally sensitive and should get to know and respect learners' cultures to influence their conduct in class. She further highlighted that learners may hold back from asking questions since this is perceived as disrespectful to elders in some cultures. In the case of this study, the elders were the teachers and IKCs. To prevent this possibility, I followed Nyamakuti's (2020) approach in her study and urged my learners to be active and participate freely in class.

Nyika (2017) explains that IK is unique to a culture or society. This means that IK is unique knowledge intertwined with a certain culture and is not shared with other cultures. This knowledge is influenced by geographical and environmental factors that have an impact on certain communities' ways of living. In the context of this study, non-Xhosa-speaking learners may be disadvantaged as the custodians of the IK have their knowledge deeply rooted in the isiXhosa culture.

Nyamakuti (2020) observes that many Namibian schools are multicultural and learners' IKs differ from each other. This is because of globalisation and economic migration, which has seen people of many different origins in various parts of the country. Nyamakuti (2020) highlighted that it could be a challenge for teachers to teach or use examples of the IK of some learners and ignore others. I believe that integrating IK into the science classroom requires sensitivity to the diverse cultural backgrounds of learners. Focusing on one group's IK while neglecting others may lead to feelings of exclusion, complicating the teacher's role in fostering an inclusive learning environment.

According to Snively and Corsiglia (2008), many science teachers view IK as significant but not worthy of being integrated into science lessons. This becomes a major drawback because learners

bring a variety of ideas and experiences from their cultural backgrounds, but teachers are not ready to integrate this vital knowledge as they assume that WS is better and brings "real" science into the classroom. In support, Horsthemke and Schafer (2007) discuss several challenges regarding the integration of IK into the classroom. They argue that one of the significant challenges is the epistemological difference between IKS and WS. They contend that IK is often local, communal, and orally transmitted, which contrasts with the universal, individualistic, and formal nature of WS (Horsthemke & Schafer, 2007). This difference creates challenges in assessing and validating IK in a formal educational setting.

Hart (2010) contends that integrating IK is not the only vehicle for learning but integrating IK and WS brings many ways of learning into the classroom, which may yield better understanding for learners. Concerning this, Seehawer and Breidlid (2021) identify several challenges to integrating IK into the classroom. One significant challenge they highlight is the marginalisation of IK in education systems that are dominated by Western knowledge frameworks. This marginalisation is linked to the colonial legacy that has historically privileged Western knowledge systems, making it difficult for IK to be seen as equally valid. Although they advocate integrating both knowledge systems, they stress that effective teaching and assessment methods are essential for successful implementation (Seehawer & Breidlid, 2021). For example, IK may involve oral traditions, experiential learning, and community-based knowledge, which can be difficult to incorporate in conventional classroom practices and standardised assessments (Seehawer & Breidlid, 2021). They also suggest that IK and WS should be compartmentalised according to specific subjects to ensure relevance.

2.9 Community Elders

Community elders are the custodians of the IK. This study would not have been possible without the contribution of community elders and the local fishermen. To contextualise their learning, learners had to collaborate with community elders by listening actively and discussing specific practices of marine biodiversity conservation. They thus helped the learners realise how science is tangled with Indigenous practices. Inviting Indigenous elders to designate traditional ways of doing things allowed learners to realise that science can be done anytime and everywhere. It is

significant for learners to see that science exists in our daily lives and outside the classroom environment (Luehmann, 2009).

Wyatt et al. (2017) and other scholars refer to Indigenous leaders as cultural knowledge brokers. As alluded to earlier, this concept involves recognising 'two-eyed-seeing' (Hatcher et al., 2017; Onwu & Mfundira, 2020) or 'two-ways-thinking' (Michie et al., 2023), which emphasises integrating multiple forms of knowledge. These scholars posit that these methods of integrating IK and WS in educational settings involve learning to see from one eye with the strengths of IK and from the other eye with the strengths of Western knowledge, bringing both perspectives together for a fuller understanding. In this study, I engaged with IKCs and learners, which had a fundamental impact on learners making the connection from community culture to school culture.

During this study, for instance, the IKCs shared the cultural heritage of marine biodiversity conservation to make learning about biodiversity accessible to learners. While the IKCs shared their cultural heritage, learners were afforded an opportunity to link the concepts to their prior knowledge (linking the past) to understand the concept of marine biodiversity conservation (thinking of the present), as reiterated by Chikamori et al. (2019). Chikamori et al. (2019) state that learners deliberately connect their present knowledge, learned in previous learning experiences, to what they already know from the past. Moreover, when learners comprehend the concept of marine conservation from 'retroductive learning', they will go through a retrodictive learning process. Learners will likely understand most of what is related to marine biodiversity and will be encouraged to make use of their IK to help them understand and make sense of marine conservation in the future. Similarly to Nyamakuti's (2020) study, this process is summarised below in Figure 2.3.

This diagram is relevant to my study as it imagines the integration of IK into the Grade 11 Life Sciences curriculum, promoting a holistic approach to marine biodiversity conservation. It illustrates 'retroductive learning', where learners connect past cultural beliefs, present conservation practices and future sustainability. This aligns with my research goal of mobilising IK to support learner talk and sense making of marine biodiversity conservation. In this study, this was possible through learners' social interactions with IKCs. The emphasis on the learner's active

role and the involvement of IKCs highlights the potential of IK to facilitate meaningful learning and bridge the gap between traditional knowledge and modern science education.

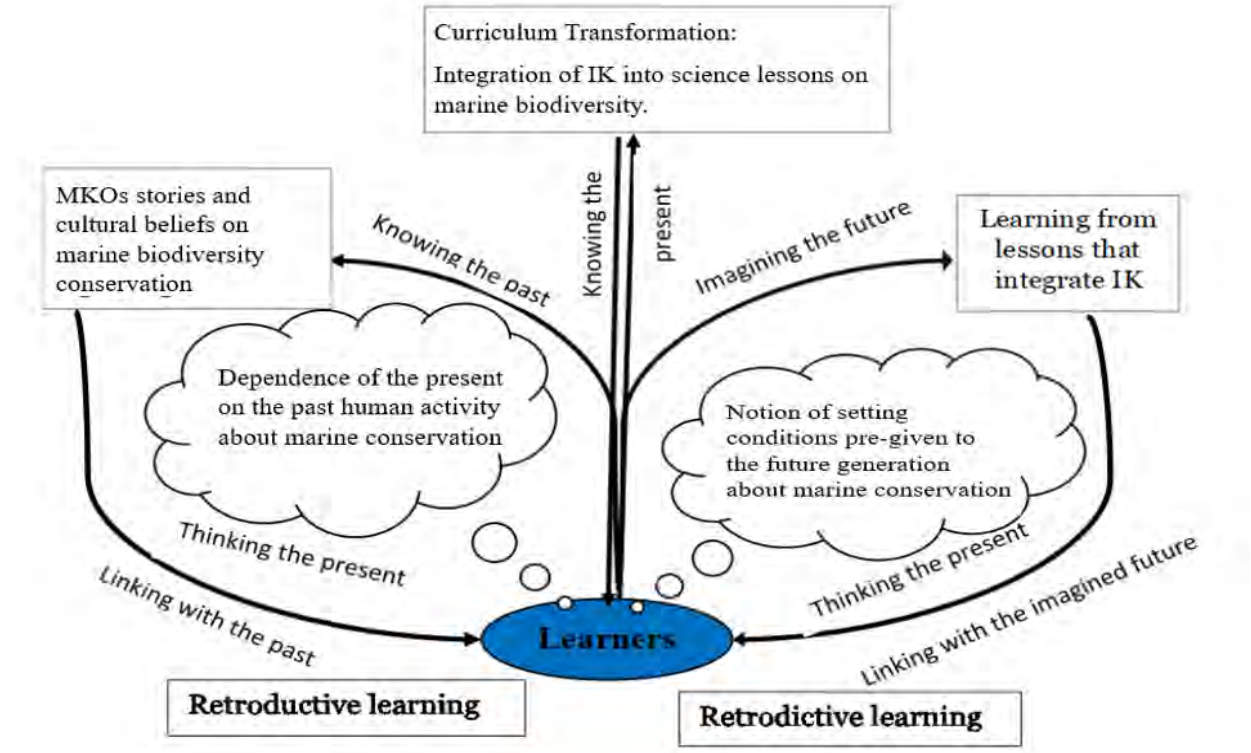


Figure 2.3: The role of integrating IK into the science classroom (Adapted from Chikamori et al., 2019, p. 9)

For this study, IKCs were invited because they are experienced and instrumental in IK, and they carry the history of their cultural practices and traditions. The IKCs provided me with the necessary tools and confidence to integrate IK into science learning. Many scholars, including Mayana (2020) and Mutanho (2021), contend that involving elders is vital to learners and teachers.

The above diagram serves as a visual representation of my study's theoretical and practical goals, illustrating how IK can be integrated into science education to foster meaningful learning and engagement among Grade 11 Life Sciences learners.

2.10 Conceptions

Thompson (1992) avers that conceptions are mental arrangements that contain beliefs, concepts, meanings, propositions, mental images and more. According to Tsai and Kuo (2008), conceptions are views that learners have towards learning. Atallah et al. (2010) theorise that conceptions are the views that learners hold concerning a subject and what they consider makes sense and is vital for them to learn. This echoes well with Chan (2011), who believes that conceptions are an understanding of the knowledge and changes in individual opinions through learning. Richardson (2011) observes that there are two types of conception approaches: the deep approach and the surface approach. In his argument, learners construct meaningful thoughts in a deep approach, whereas evidence is used in the surface approach (Richardson, 2011). In this study, the intention was to expose the learners to various cultural beliefs and local knowledge about marine biodiversity conservation and explore whether such exposure would have any influence on their conceptions of science. Several research studies show that concepts are related to dispositions (Mayana, 2020), which are discussed next.

2.11 Dispositions

According to Atallah et al. (2003), learning can be influenced by both destructive and constructive attitudes. Such dispositions are associated with either positive or negative attitudes (Atallah et al., 2003). To Crick and Yu (2008), dispositions are a developmental tendency that evolves over a long period. In this period of development, it can be fully developed and yet be enhanced, provided the learner has great endurance. In support of this literature, Graven (2012) also believes that dispositions are influenced by the shift to act in a certain way in different situations. Literature supports the idea that dispositions can be learned and can develop through interactions with the greater world as well as through exposure to social environments (Crick & Yu, 2008; Graven 2012).

This resonates well with my study, as learners were expected to develop and change through interactions with the IKCs, peers, a critical friend, and me. This study also explored whether there was a shift in learners' dispositions when integrating IK in the teaching of marine biodiversity conservation. In this study, I had hoped that IK integration in marine conservation would

contribute towards the learners' dispositions towards science lessons. It was also hoped that learners would show greater interest in learning as what is taught is related to their sociocultural setting (Mavuru & Ramnarain, 2020).

2.12 Learner Talk

Kim et al. (2018) review the importance of learner talk as a critical aspect of active learning and knowledge construction in the classroom. They stress that when learners engage in meaningful dialogue, they can better process and internalise scientific concepts. In this study, I hoped to develop learners' talk on marine biodiversity conservation through role play, group discussions and interactions with IKCs. Learner talk, according to Kim et al. (2018), fosters collaborative learning environments where learners express their understanding, negotiate meanings, ask questions and build on each other's ideas. The study hoped that through structured conversations, learners can clarify their thinking, confront misconceptions, and develop deeper conceptual understanding (Kim et al., 2018). The presentations by IKCs were done in isiXhosa, and the idea was to foster understanding and engagement. Thus, learner talk and sense-making were expected to shift. Mavuru and Ramnarain (2020) assert that using the home language helps learners who lack confidence in English to talk and construct their understanding of scientific concepts.

2.13 Sense Making

Sense-making, as described by Weick et al. (2005), is a way of making circumstances comprehensible in clear and simple words. Nikodemus (2017) emphasises that sense-making is when meaning materialises, which is a crucial part of linguistic conversation and communication. To Vygotsky (1978), language is a mediational cultural tool for sense making. According to Weick et al. (2005), sense-making involves changing circumstances into a situation that is understood explicitly in words. Similarly, Ash (2004) highlights that reflective scientific sense making creates a platform for discussion to take place while carrying out certain tasks, and he argues that sense making occurs during socialisation and is retrospective.

In the context of my study, the two elders who grew up in marine environments and local fishermen were the knowledge bearers. Therefore, in this study, the wisdom, skills and knowledge they

brought with regard to marine biodiversity were used to support learners to make sense of the concept of marine biodiversity conservation. In addition, the presentations by the community leaders were consolidated in the form of an exemplar lesson to ensure that there was sense making among learners. All presentations were presented in the local languages, as Msimanga and Lelliot (2014) and Mavuru and Ramnarain (2017) posited that home language helps learners to understand and make sense of scientific concepts.

2.14 Chapter Summary

In this chapter, I discussed the literature relevant to this study. Firstly, I started the chapter by discussing the gaps in knowledge of the integration of IK in the teaching of marine biodiversity conservation. I also provided a brief description of the concept of biodiversity, a definition of local or IK, the significance and challenges of integrating IK in the science classroom, and the role of IKCs in science lessons. In the next chapter, I discuss the theoretical frameworks used in this study.

CHAPTER THREE: THEORETICAL FRAMEWORKS

3.1 Introduction

Merriam and Tisdell (2015) define a theoretical framework as the structure, the scaffolding and the frame of a study. To Bertram and Christiansen (2020), a theoretical framework provides a feasible explanation for why things happen and is used to frame the study. The focus of this study was to mobilise marine IK to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation. This resonates with the requirements of the South African curriculum that IK of learners be recognised in their learning of science. Accordingly, Mavuru and Ramnarain (2020) noted that if learning is related to learners' sociocultural background it will be interesting and related to what they already know. This was supported by Mutanho (2021), as he reiterated that integrating IK into science education bridges a gap between 'science-in-society' and 'science-in-school'.

This study was informed by two theories, namely, Vygotsky's (1978) sociocultural theory (SCT) and the CHAT. In this study, SCT was used to explore the relevance of integrating Indigenous Knowledge in science as the learners interacted with the IKCs who were sharing their cultural heritage of marine biodiversity conservation using local language to explain. Thus, it acted as a theoretical framework lens to find out how learners learn through social interactions and how learning takes place in a social-cultural context. It was augmented with Engeström's (2001) CHAT as an analytical framework to see the relevance of community in the process of making and interpreting meaning, thus sense making and understanding how the intervention of IKCs facilitates learning.

3.2 Theoretical Framework: Vygotsky's Sociocultural Theory

The theoretical framework informing this study is Vygotsky's (1978) sociocultural theory. Sociocultural theory (SCT) states that learning is a product of social interactions involving adults

and peers (Vygotsky, 1978). Vygotsky (1978) describes SCT as a social process whereby people interact with each other and construct meaning through their social experiences. According to Vygotsky (1978), everything is learned in two stages, firstly, through contact with others and then by being added to the individual's mental structure. He further argues that effective learning lies in the social interactions between individuals and their peers (Vygotsky, 1978). According to Shizha (2013), school knowledge must express social desires, concerns and sociocultural needs for socioeconomic development. This means that the knowledge from school should be aligned with learners' experiences, and these should be branded by their sociocultural worldview (Shizha, 2013). In this regard, for meaningful and successful learning, the learners' language acts as a border crossing (Aikenhead & Jegede, 1999). In support, Taber (2020) explains that learners come to school with some form of local knowledge from home, so when they learn science, they cross cultural borders.

For instance, in the classroom situation, learners should interact among themselves and their teachers to make sense of and construct the meaning of the concepts being taught. In agreement with Vygotsky, John-Steiner and Mahn (1996) explain that an individual's development relies on the diffused experiences of others. In support, Mavhunga and Kibirige (2018) allude that meaningful learning takes place when people learn through social interactions and with materials from their sociocultural background. This means that learning does not take place in isolation; for Vygotsky (1978), individual development cannot be understood without reference to the social and cultural contexts within which the individual is embedded. Concurring, Stott (2016) states that interactions with others support mental functioning and processes from the social to the individual level. In this study, through group activities, discussions, and reflections, I intended for learners to internalise the learned knowledge (Eun, 2008). Concurring with the above-mentioned literature, my study focused on learners who were also regarded as co-researchers, as they were asked to find information on IK about the topic of marine biodiversity conservation, similarly to Mayana (2020).

Vygotsky's sociocultural theory's main components are the mediation of learning, culture and language, social interactions and the ZPD (Oakley, 2004). I will now discuss each of these below as they were used in this study.

3.2.1 Mediation of learning

The idea of mediation refers to two interconnected ideas that are fundamental for a sociocultural understanding of human cognition and development (Vygotsky, 1978). To Boblett (2012), mediation refers to a process by which individuals interact with learners from the social and cultural environment. Vygotsky suggests that in the learning process, experts use tools to mediate learning. These tools could be materials, cultural artefacts or humans within a social environment (Vygotsky, 1978) that serve the purpose of conveying abstract concepts to the concrete level. In the context of this study, the wisdom, skills and knowledge brought by IKCs were used as a cultural tool to mediate learning of the concepts of marine biodiversity conservation. The study allowed space for interactions between the IKCs, a critical friend, the learners and me. As such, the critical friend and I acted as guides and interpreted the events to learners. The use of IsiXhosa enriched learner engagement, facilitating dialogue with IK custodians who mediated discussions and encouraged cultural knowledge sharing. This was influenced by Vygotsky (1978), who highlights that language is a vital cultural apparatus and human medium for communication. In this, he posits that speech and language can be a tool used to master human surroundings.

3.2.2 Culture and language

Culture is an important social factor not to be ignored in the analysis of gender relations (Chikunda & Chikunda, 2015). It plays an important role in persuading and shaping development (Vygotsky, 1978). Woolfolk et al. (2008) believe that all high order mental processes such as reasoning and problem solving are mediated by psychological tools such as signs, symbols and language. In the context of this study, the use of IK was a response to cultural tools that mediated thinking. As IK is transmitted orally (Kibirige & Van Rooyen, 2006), learners are believed to have learnt culture and language from their parents and immediate surrounding society. This knowledge will then hopefully form a foundation for cognitive learning that draws from their own life experiences. Hence, the invitation of elders and a fisherman who may be experienced in their culture (MKO) (Vygotsky, 1978) to integrate IK. This theory was used as a lens to understand how the integration of IK influences the learners' learning and sense making. The use of isiXhosa (local language) increased the learners' participation in the presentation, as they spoke freely since the presentation was done in their local language.

3.2.3 Social interactions

Vygotsky (1978) believes that learning takes place through social interactions with peers or knowledgeable others (parents, teachers or other learners). In this study, it was intended that when the IKCs, learners, a critical friend and I integrated IK, the learners would freely contribute to learning experiences among themselves. In the context of this study, the classroom was a social unit that consisted of learners, a teacher, a critical friend and IKCs. Our interactions were intended to allow learners to make sense of marine biodiversity conservation as informed by Mavuru and Ramnarain (2020) on how learning takes place in a sociocultural context. According to Berg (2009), integrating IK into science lessons facilitated the understanding of WS in the class, as IK served as a point of departure for the learners. The study was not only interested in what the IKCs would bring to the interactions but also in what learners would bring and how the interactions would shift (or not) their talk and sense making of the concept of marine biodiversity conservation.

3.2.4 Zone of proximal development

According to Vygotsky (1978), the zone of proximal development (ZPD) is defined as the distance between the actual development level as determined through independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. Vygotsky believes that a child reaches their ZPD through guidance and interaction with others in a classroom. Nevertheless, Stott (2016) contends that there is an assumption that only learners benefit in the ZPD which is not the case; rather, all participants benefit including the teacher. Thus, in this study, it was intended that we might all benefit. Learning that is mediated within the ZPD can lead to cognitive development and acquisition of higher levels of psychological functions, which may be the ability to analyse, evaluate and synthesise information or situations (Zohar & Dori, 2003). In this study, the focus group interviews (sharing circles) and stimulated recall interviews were good examples that caused the stimulation of high order thinking skills that the participants acquired. In addition, in the context of this study, learners engaged within their ZPDs by participating in the presentation by the community members when demonstrating the IK of marine biodiversity conservation.

Vygotsky (1978) puts forward the idea that when a learner is at their ZPD for a particular task, supporting them in the most effective way will help them progress to achieve the task at hand. He avers that the assistance can be removed once the learner becomes confident, and the learner may continue to work effectively and independently. Figure 3.1 below shows Vygotsky's (1978) ZPD diagram.

Figure 3.1: Shows Vygotsky's (1978) ZPD (https://iece.weebly.com/vygotsky.html)

Ismail et al. (2017, p. 155) illustrated the ZPD diagrammatically as shown in Figure 3.2 below. I use this diagram to support my argument on ZPD like Mutanho (2021). In this study, my role as the teacher was to provide scaffolding by breaking down complex tasks into manageable parts, offering hints, asking guiding questions and giving feedback. In addition, it meant modelling problem-solving strategies and gradually reducing support as the learners became more competent. The idea of scaffolding by Vygotsky (1978) was supported by Rojas-Drummond et al. (2013), who defined scaffolding as the temporary support and gradual withdrawal and transferring of responsibility to learners to promote the eventual appropriation of knowledge and abilities and self-regulation.

My critical friend offered constructive feedback to encourage reflection and improvement. It was intended that learners would see different perspectives and refine their understanding. In addition,

it was believed that these conversations could help learners articulate their thoughts, question assumptions and explore new ideas. The IKCs' involvement intended to provide culturally relevant examples and context, making learning more meaningful and applicable. This included sharing traditional ecological knowledge and practices related to marine biodiversity conservation. Consequently, learners' peer interactions intended to shift from their current understanding to their ZPD. In summary, the role of the teacher, a critical friend and IKCs was to give instructional support to the learner to stretch their understanding from that which they already knew to that which they could know or do with support (Mutanho, 2021).

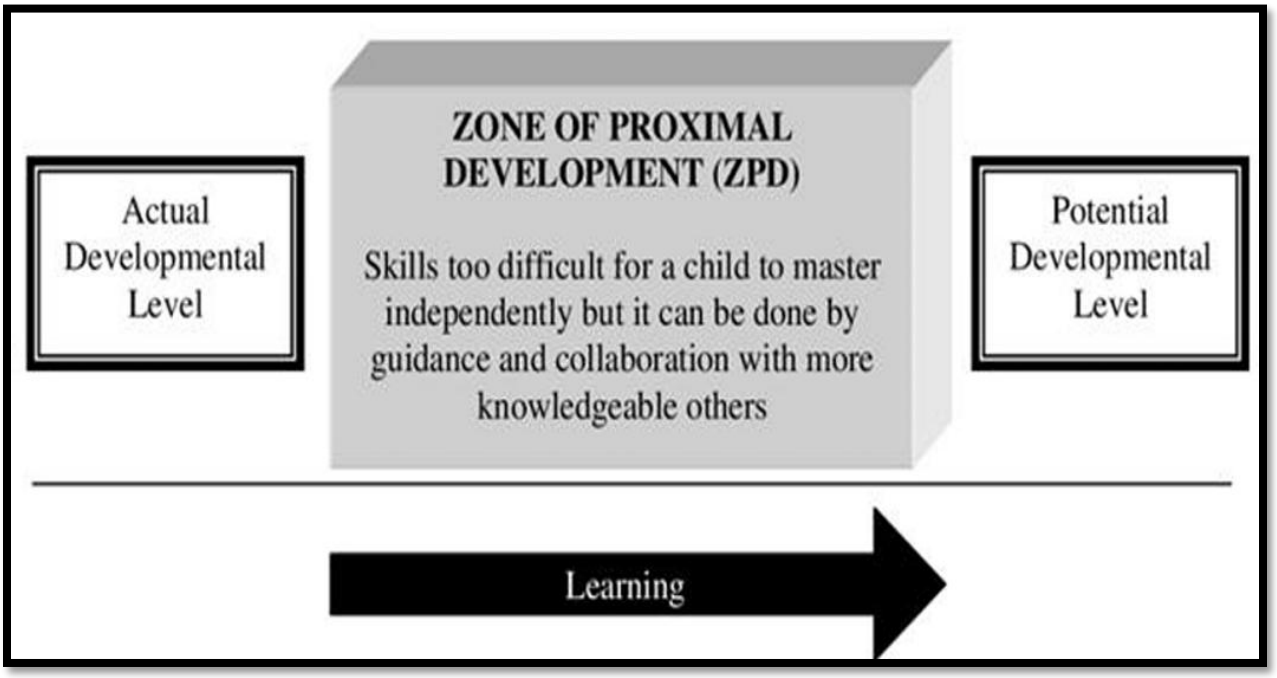


Figure 3.2: Illustration of the ZPD (Adopted from Ismail et al., 2017, p. 155)

Figure 3.2 above visually represents the progression from the actual developmental level through the ZPD, reaching the potential developmental level, facilitated by learning and support from the IKCs (Ismail et al., 2017). In the context of this study, it was intended that learners engaged within their ZPDs by participating in the presentation by the IKCs when they demonstrated the IK of marine biodiversity conservation. Consequently, the wisdom, skills and knowledge brought by IKCs were used as a cultural tool to mediate learning of the concept of marine biodiversity conservation. The study also allowed space for interactions between the IKCs, a critical friend, the

learners and me. The use of IK was a response to cultural tools that mediated thinking. Hence, as IKCs who were experienced in their culture (MKO) (Vygotsky, 1978) were integrating IK, this theory was used as a lens to understand how the integration of IK influences learners' talk and sense making. The use of isiXhosa (local language) as noted above, increased the learners' participation in the presentation and they spoke freely in their local language.

3.3 Analytical Framework: Cultural-Historical Activity Theory

The CHAT is a theory that is situated within the sociocultural theory (Vygotsky, 1978). Cole (1988) introduced CHAT and Engeström (1987) popularised the theory by developing the second and third generation. According to Ding (2020), CHAT presents a simple linear development process including the first generation (Vygotsky 1978), a second generation (Leontiev, 1978), and a third generation (Engeström, 1987). The CHAT assumes that human actions are complicated, multilayered, multi-voiced and collective. It thus acknowledges the significance of the social aspect of mediating learning and that individual or group interactions and actions are embedded in an activity social system. In this study, the first two generations of CHAT were used.

First generation CHAT (Vygotsky, 1978) is a derivative of Vygotsky's sociocultural theory, and it focuses on the triadic relationship between the subject, object and facilitating objects. The main idea is that human action is facilitated by tools and is directed towards an object (Morselli, 2019; Yamagata-Lynch, 2010). To Vygotsky, awareness develops from human activity arbitrated by artefacts (tools) and signs. According to Vygotsky (1978), the connection between a human subject and an object is not direct and can only be sought in the social order and values of the people. This is represented by a triad in Figure 3.3 below.

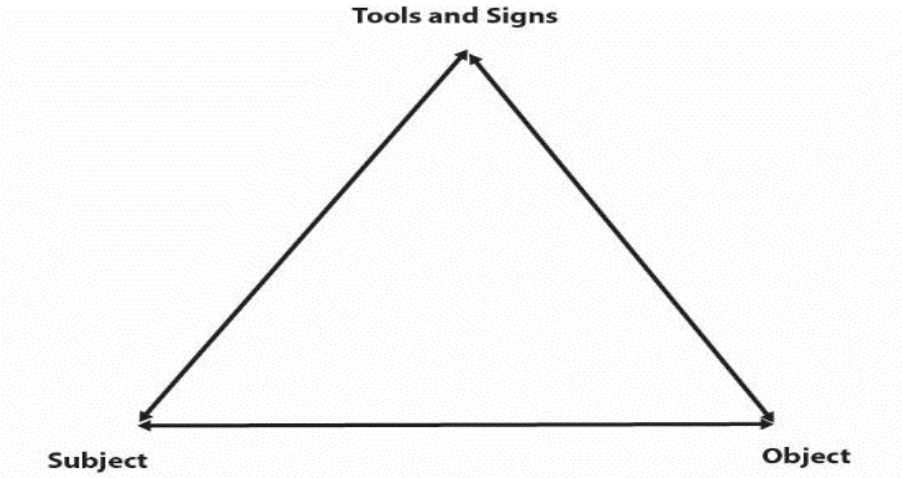


Figure 3.3: Cultural-Historical Activity Theory First generation (Engeström, 2001, p. 134)

To Engeström (2001), human actions cannot be explained using the simple, direct stimulus-response relationship. He believes that humans mediate their actions using cultural tools, symbols and artefacts. Therefore, people acquire knowledge using cultural tools as learning is mediated culturally. In this study, the subjects were the learners, the Indigenous Knowledge of marine biodiversity was the object and the concepts and experiences of IK that relate to marine biodiversity were the tools. The idea was to investigate how learners talked and made sense of marine biodiversity conservation when IK was mediated in a science class with concepts and experiences brought by the IKCs. That is, learner talk and sense making were the outcomes that were expected.

The second generation is a collective activity which Engeström (2001) views as a human activity system of complex interacting factors such as subjects, objects, mediating tools, rules, community and division of labour. The subjects in this study were the Grade 11 Life Sciences learners who intended to talk and make sense of marine biodiversity conservation when IK was integrated. To understand how the intervention created learning opportunities or not, the behaviours of these learners were not analysed in isolation but in conjunction with other factors that influenced them. In this study, the CHAT's second generation was used to elaborate on how learners talked and made sense of marine biodiversity conservation was influenced by the rules of the community. The IK bearers were the IKCs, the community members and thus the community. Their shared experiences and presentations were assumed to shift the learners' understanding and thus cause

them to talk about and make sense of the topic. The rules of the community and curriculum were intended to influence learners' sense making. The community in this case involved my critical friend, the knowledge bearers such as elders who grew up in marine environments, a fisherman and the learners. In this study, it was anticipated that CHAT might provide both the theoretical and practical tools that would enable Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity when IK was integrated.

The second generation surpasses Vygotsky's individually focused model. In the second generation, the community, rules and division of labour are included to analyse the importance of their interactions. Engeström insisted on this by expanding the unit of analysis for studying human behaviour from that of individual activity to a collective activity system (Engeström, 2015). As a result, Leontiev's second-generation CHAT focused on the mediational effects of the systematic organisation of human activity (Engeström, 1999). The second generation is represented by Figure 3.4 below.

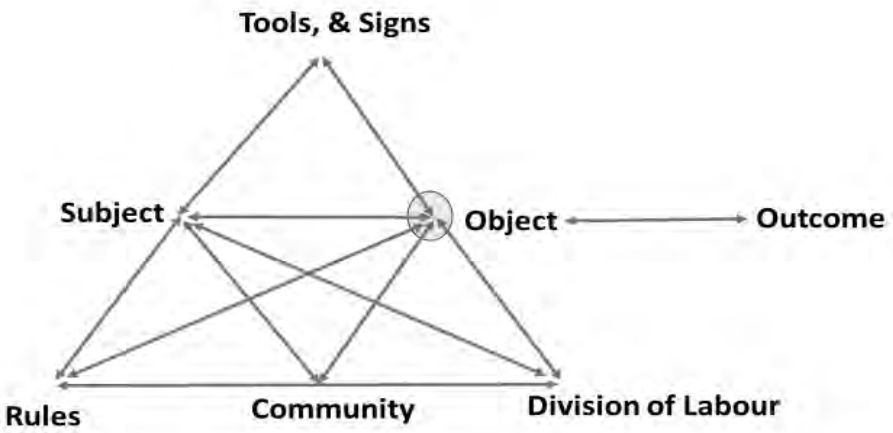


Figure 3.4: CHAT second generation Engeström (2001, p. 135)

To Cole (1988), the second CHAT generation is not sensitive to diversity. He mentioned that it does not give the flexibility to account for the influence of factors outside the activity systems that are under investigation. It is important to note that IK exists on the social plane first, in this case, culture and language, then it is mediated via tools, which in this study were the

presentations/demonstrations by community members so that it could be internalised, which is the sense making process.

In this study, it was anticipated that CHAT might provide both the theoretical and practical tools that would enable learner talk and sense making of marine biodiversity when IK is integrated. The second-generation model was used to examine how the different components of this intervention interacted during participatory and lesson observations and when analysing the constraining factors embedded in the integration of IK into the classroom. It was intended that this model would assist in identifying contradictions and how the participants collectively and individually made sense of the new knowledge.

3.4 How the two theories complement each other

Combining Vygotsky's theory with CHAT provided a robust framework for understanding and improving educational practice. This integration offered a holistic analysis of learning environments, considering both individual cognitive development and broader sociocultural activity systems. Complementing Vygotsky's theory with CHAT was justifiable due to their shared emphasis on sociocultural contexts, mediation and dynamic learning processes. Here are the key points.

Emphasis on Sociocultural Context

Vygotsky (1978) emphasises that cognitive development is deeply embedded in social interactions and cultural tools, while CHAT extends this by examining how human activities are situated within cultural and historical contexts, focusing on the broader activity systems that include tools, community, rules, and division of labour (Engeström, 1987).

Mediation of Learning

Vygotsky's (1978) theory introduces mediation through cultural tools and language, which are crucial for cognitive development (Vygotsky, 1978). CHAT explores various forms of mediation beyond tools and language, including symbols, rules, and community influences on learning processes (Engeström, 1999).

Activity Systems

Vygotsky (1978) focuses on individual development via interaction with more knowledgeable others, while CHAT broadens this focus to entire activity systems, understanding learning as participation in collective, goal-directed activities involving multiple actors (Engeström, 2001).

Dynamic and Multilayered Approach

Vygotsky (1978) describes cognitive development as dynamic, particularly through the ZPD (Vygotsky, 1978). CHAT provides a multilayered analysis, considering immediate interactions and historical and cultural influences on those interactions (Engeström, 1999).

Practical Application

Vygotsky (1978) offers practical strategies like scaffolding and guided participation (Vygotsky, 1978). CHAT enhances these strategies by analysing and designing educational activities considering all elements of the activity system, such as tools, community, and division of labour (Engeström, 2001).

Addressing Complex Educational Challenges

Vygotsky (1978) aids in understanding individual learning processes (Vygotsky, 1978), while CHAT equips educators with tools to address complex educational challenges by examining systemic and structural factors affecting learning, thus providing a comprehensive approach to educational reform (Engeström, 2001).

Justification for using CHAT as a complementary theory

Vygotsky's theory helps to understand the linear progression of learners understanding from a low level to a higher level of understanding (Vygotsky, 1978). Vygotsky's theory would only enable me to understand meaning-making as a linear process from a lower ZPD to a higher ZPD (Vygotsky, 1978). This would not help me account for the expansive learning opportunities that were generated during the interventions. However, CHAT was anticipated to provide both the

theoretical and practical tools that might enable Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity when IK is integrated.

3.5 Chapter Summary

The sociocultural theory and CHAT were used as complementary theoretical frameworks in this study. The SCT served as the primary theoretical framework, providing a lens to comprehend the social dynamics influencing the research. CHAT, on the other hand, offered analytical and methodological tools to understand the contradictions in science education and their impact on learning. Together, these theories informed the study by promoting learner talk and sense making of marine biodiversity conservation through IK shared by IKCs. CHAT specifically aided in accounting for both acquisitional and expansive learning experiences. By integrating these two theoretical lenses, it was anticipated to achieve a clearer understanding of the shifts in learner talk and sense making regarding the integration of IK into science lessons. This multifaceted approach allowed for a comprehensive analysis of the educational dynamics at play, highlighting the complementary nature of SCT and CHAT in addressing both the social and structural elements of learning.

CHAPTER FOUR: RESEARCH METHODOLOGY

4.1 Introduction

Creswell (2014) refers to methodology as the approach and rationale behind the method a researcher takes in conducting research. Creswell (2014) emphasises that research methodology involves the process, tools and procedures for collecting and analysing data. According to Brynard et al. (2015, p. 38), research methodology is "a reflection on the planning, structuring and execution of the research to comply with the demands of truth, objectivity and validity". Brynard et al. (2015), outline the importance of selecting appropriate methods (e.g. surveys, interviews, case studies) and explain that the methodology should be aligned with the research aims and objectives. To Bertram and Christiansen (2020), research methodology relates to how scholars go about finding knowledge about the world. They describe methodology as a plan that includes research paradigms (like interpretivism, and positivism), approaches (qualitative and quantitative), and specific methods of data collection and analysis (Bertram & Christiansen, 2020).

In the preceding chapter, I explored literature related to marine biodiversity conservation and the integration of IK within the science curriculum. I also outlined the theoretical and analytical frameworks guiding my study. In this section, I will delve into the research paradigms that underpinned this study, along with the research design I chose. In addition, I will address the research design, site selection, sampling methods and data collection techniques. I will further examine the validity, trustworthiness and ethical considerations associated with this study.

4.2 Research Paradigm

According to Kivunja and Kuyini (2017), a research paradigm is the agreed set of beliefs or thinking about how to carry out research and interpret its meaning. Similarly, Bertram and Christiansen (2020) refer to a research paradigm as a worldview that directs the research

process. This study was conducted within the interpretive paradigm which seeks to describe and understand how people make sense of their world and how they make meaning of their actions (Bertram & Christiansen, 2020). In this sense, Cohen et al. (2018) note that in an interpretive paradigm, the researcher aims to develop a greater understanding of how people make sense of the context in which they live and what makes sense to them. This paradigm together with a sociocultural theory was used to mobilise marine IK to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation.

This paradigm allowed my learners and I to interpret meaning within the social and cultural contexts of the natural setting of this research study, in this case, marine biodiversity conservation. For instance, in the context of my study, learners enquired about traditional marine conservation strategies from the IKCs to talk and make sense of the concept of marine biodiversity conservation. I complemented the interpretivist paradigm with the Indigenous research paradigm (Chilisa, 2012). To Chilisa (2012), the Indigenous research paradigm entails including perspectives and methods that draw from IK, languages, metaphors, worldviews, experiences and philosophies of the former colonised, historically oppressed and marginalised social groups. Within these paradigms, a qualitative case study approach was employed in the form of an intervention.

4.2.1 Interpretivist paradigm

According to Thomas (2013), the essence of interpretivism is to appreciate the worldviews of participants and how we can interpret and comprehend them. Concurring, Cohen et al. (2018) noted that in an interpretive paradigm, the researcher aims to develop a greater understanding of how people make sense of the context in which they live and what makes sense to them. To Bertram and Christiansen (2020), the interpretivist paradigm tries to understand how people make sense of their world and how they make meaning of their actions. In my study, the interpretive paradigm was relevant because it allowed an in-depth exploration of Grade 11 learners' talk and sense making regarding marine biodiversity conservation within their cultural contexts. By integrating IK into science lessons, this paradigm helped uncover how learners interpret and connect the scientific content with their lived experiences, values and cultural knowledge systems.

This resonates well with Creswell and Creswell (2018), who stated that researchers engage themselves in the situation in trying to make sense of it from the participants' point of view.

Scholars like Creswell and Creswell (2018) critique the interpretive paradigm by highlighting its subjectivity and potential biases. They argue that the interpretive approach relies heavily on the researcher's interpretations, which can introduce personal bias and affect the credibility and reliability of findings. As such I will complement the interpretivist paradigm with the Indigenous research paradigm (Chilisa, 2012). Chilisa (2012) explains that the Indigenous research paradigm involves using perspectives and methods that stem from IK, languages and worldviews.

4.2.2 Indigenous research paradigm

According to Chilisa (2012), knowledge is relational in the Indigenous research paradigm. Knowledge is shared among others and with respect to my study, I was answerable to all participants (Chilisa, 2012). Chilisa (2012) explains that the Indigenous research paradigm involves using perspectives and methods that stem from IK, languages and worldviews. It focuses on the experiences and philosophies of formerly colonised, historically oppressed and marginalised groups. To Chilisa (2012), the Indigenous research paradigm is informed and guided by relational ontologies, epistemologies and axiologies. Seehawer (2021) emphasises that the Indigenous research paradigm prioritises Indigenous worldviews, knowledge systems and methodologies, valuing them as legitimate and distinct from Western research paradigms. This approach seeks to decolonise research by ensuring that Indigenous voices and epistemologies guide the process, allowing for culturally relevant and context-specific insights.

The Indigenous research paradigm is closely aligned with this study as it centred on Indigenous worldviews, knowledge systems and practices in the exploration of marine biodiversity conservation. By integrating the perspectives and knowledge of IKCs, this study respected the cultural context and epistemological foundations of the community involved. This resonates well with Hart et al. (2010), who believe that an Indigenous research paradigm is structured within an epistemology that includes a subjectivity-based process. In this process, community elders are the custodians of the culture and therefore knowledge is developed through reliance on IKCs (Hart et al., 2010). The use of an Indigenous research paradigm allowed the study to bridge the gap between

IK and Western Science while fostering a decolonised, inclusive educational approach that is relevant to the learners' lived experiences and local traditions. In this study, I used the Ubuntu perspective which acted as a relational philosophy.

Ubuntu is a Southern African philosophy emphasising the idea that "I am because we are," emphasising the connection of individuals within a community. It summarises a worldview that prioritises shared wellbeing, sympathy and mutual respect, where an individual's humanity is acknowledged through their relationships with others. As Tutu (2021) explains, Ubuntu reflects a deep commitment to communal coordination and social justice. Seehawer (2023) adds that Ubuntu is not only a cultural principle but also a practical approach to promoting understanding, support and ethical conduct in social and educational contexts. Similarly, Metz (2022) highlights Ubuntu's role in promoting shared responsibility and collective identity, which contrasts with Western individualism.

In this study, the principles of Ubuntu were fundamental to the methodology and interactions with participants. The study adopted an Ubuntu-based approach by fostering an environment of mutual respect and shared knowledge between the researcher, learners and Indigenous Knowledge Custodians (IKCs). Ubuntu guided the respectful engagement with IKCs, ensuring their contributions to marine biodiversity conservation were valued and acknowledged. This approach facilitated a collaborative atmosphere where the integration of IK into the science curriculum was not just about adding content but about creating a communal learning experience. By emphasising the interconnectedness of the participants, the study represented the essence of Ubuntu, ensuring that the research process was inclusive, participatory, and respectful of all voices involved.

In summary, Vygotsky's (1978) sociocultural theory, which emphasises that people's actions are shaped by their social, cultural, and historical contexts, aligns closely with the Ubuntu perspective. This study observed how learners made meaning from activities through social interactions, using an interpretivist paradigm enhanced by an Indigenous paradigm rooted in Ubuntu. The spirit of Ubuntu was evident throughout the data collection process, as all participants, including learners, myself, my critical friend and the IKCs, collaborated effectively. The IKCs' willingness to participate and present further expressed the essence of Ubuntu, contributing to the study's success. The research design used in this study is discussed in the next section.

4.3 Research Design

According to Cohen et al. (2018), research design refers to the plan for conducting a research study. It involves strategies that link the research problem to the empirical investigation, ensuring consistency between the study's aims and the data collection techniques. Concurring, Bertram and Christiansen (2020) define a research design as a plan of how the researcher systematically collects and analyses the data that is needed to answer the research question. Within these paradigms, a qualitative case study approach was employed in the form of an intervention.

To Cohen et al. (2018), a case study is a detailed phenomenon under close consideration, which is designed to illustrate a more general principle. It is studied for its real-life context to understand the dynamics related to the case (Cohen et al., 2018). A case study was appropriate in this study to gain an in-depth understanding of the influence of IK on Grade 11 Life Sciences learners' talk and sense making of marine biodiversity conservation when IKCs' experiences and cultural heritages of marine biodiversity conservation are implemented. This resonates with Bertram and Christiansen (2020), who suggested that a case study allows for deep exploration of participants' lived experiences.

A case study employs multiple research instruments to gather data from diverse perspectives, enhancing the validity of the findings. For example, I collected information through participatory observations, stimulated recall interviews, group activities and learners' reflections. The case in this study was the Grade 11 Life Sciences learners from a township school in the Eastern Cape, South Africa. Forty-five Grade 11 Life Sciences learners, two elders who grew up in marine environments and a local fisherman were participants in this study. In addition, I asked one science teacher to be a critical friend to assist in reflections on this study. In the case of my study, my case was therefore my Grade 11 Life Sciences learners and the unit of analysis was learners' interactions with each other and the IKCs, how they used the IK of marine conservation to enhance learner talk and make sense of the concept of marine biodiversity conservation.

Similarly to Godlo (2024) and Shilomboleni (2024), in this study, I used a participatory approach informed by Chikamori et al.'s (2019) Transformation Model of Education for Sustainable Development (TMESD) framework. The TMESD framework outlines the process of integrating

IK into science lessons (Chikamori et al., 2019). This model was considered appropriate for elaborating on the impact of mobilising and integrating marine IK to support learners in science lessons. It was intended to make marine biodiversity conversation relevant and accessible to learners in a science class. This resonates with the goal of the study that sought to mobilise marine IK to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation.

Chikamori et al. (2019) describe the TMESD framework (see Figure 2.3) as consisting of three learning processes: understanding the present, exploring the past-present relationship and connecting the future-present. They refer to the past-present relationship as retroductive learning and the future-present relationship as retrodictive learning (see Figure 2.3). During this study, for instance, the IKCs shared the cultural heritage of marine biodiversity conservation to make learning about biodiversity accessible to learners. The TMESD framework therefore offered the IKCs a platform to share their traditional knowledge. When the IKCs shared their cultural heritage, learners were allowed to link the concept to their prior knowledge (linking the past) to understand the concept of marine biodiversity conservation (thinking of the present) as reiterated by Chikamori et al. (2019). Similarly to Nyamakuti (2020), I therefore acknowledge that the TMESD model facilitated learning and provided learning opportunities. This helped learners to grasp past, present and future circumstances (Nyamakuti, 2020).

Chikamori et al. (2019) stated that learners deliberately consider the present, learnt from the first learning process, in connection with what they know from the past. It was hoped that when learners comprehend the concept of marine conservation from ‘retroductive learning’, they would go through a retrodictive learning process. Learners would likely understand most of what is related to marine biodiversity and would be encouraged to make use of their IK to help them understand, talk and make sense of marine conservation in the future.

4.4 Research Goal and Research Questions

Cohen et al. (2018) define a research goal as a broad statement that outlines the primary aim or purpose of a research study. A research goal defines what the researcher intends to achieve. It provides overall direction and focus for the study, guiding the formulation of specific research

questions (Cohen et al., 2018). I now outline the goal of this study and the research questions that motivated this study.

4.4.1 Research goal

The main goal of this study was to mobilise marine IK to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation.

4.4.2 Research questions

1. What enables and/or constrains Grade 11 Life Sciences learners' talk and sense making of the topic of biodiversity conservation before the intervention?
2. How do lessons on biodiversity conservation that integrate IK shift (or not) Grade 11 Life Sciences learners' talk and sense making of this topic?

4.5 Research Site, Participants and Sampling

The study was conducted at Chigwe High School (pseudonym), a township school in the Buffalo City Municipality, Eastern Cape, South Africa (see Figure 4.1). The school has an enrolment of about 1 500 pupils from Grade 8 to 12 and about 98% of the learners at this school speak isiXhosa as their first language. This school consists of learners with different sociocultural backgrounds as many of them come from poor families that sorely depend on social grants and piece jobs with a few coming from middle-income groups. Convenient and purposive sampling was used in this study (Bertram & Christiansen, 2015) as it allowed me to select participants who were available and willing to take part in the research. The school was convenient to me since I have been their Life Sciences tutor for the past six years, thus my interactions with my research participants were easier because we knew one another very well.

Figure 4.1: Shows the map of the Eastern Cape with the Buffalo City Municipality where the study was conducted (Wikimedia.org/ Wikipedia)

A Grade 11 Life Sciences class was selected for this study and the topic of biodiversity conservation is part of their syllabus. The sample class consisted of 45 learners and a critical friend (a Life Sciences teacher at this school) was invited to be part of this research so that we could reflect together throughout the research process. Learners interacted with the IKCs in a classroom environment to discuss the Indigenous traditional marine conservation techniques. In this study, the IKCs were two elders who grew up in coastal areas and a fisherman (see Table 4.1 that shows the profiles of the three IKCs). The IKCs presented their IK and techniques of marine biodiversity conservation in class that was followed by an open questioning and discussion with learners. The study sought to understand how the use of IK of marine biodiversity conservation could support learner talk and sense making of the concept of marine biodiversity conservation among Grade 11 Life Sciences learners.

Table 4.1: IKCs who participated in the study

Clan name	Age	Gender	Level of education	Place of birth	Work experience	Language
MaNdaba	60	Female	Standard 10	Mooiplaas, East London	Chef	IsiXhosa
Mfene	68	Male	Standard 9	Ngqushwa, Peddie	Environmental control and security	IsiXhosa
Bhele	77	Male	Standard 6	Port Shepstone, KZN	National Railways	IsiXhosa

4.6 Data Gathering Methods

Data gathering methods refer to the systematic approaches and techniques used by researchers to collect evidence necessary to answer research questions and achieve the objectives of a study (Cohen et al., 2018; Bertram & Christiansen, 2020). The following data gathering methods were used to gather data in this study: a group activity, focus group interviews (sharing circles), participatory and lesson observations, learners' reflections and stimulated recall interviews. To Mill (2011), using different data gathering techniques allows the gathering of rich data and helps with the triangulation of data. I now discuss each of these data gathering techniques below.

4.6.1 Group activity

Similarly to Mayana's (2020) study, a group activity was employed as a data gathering method. This was to create a non-threatening classroom climate for the learners. A group activity assisted me in establishing learners' prior knowledge about marine biodiversity conservation. The data generated helped me answer research question one. In the group activity, learners were divided into nine mixed groups of five. Each group had a mixture of boys and girls. They were assigned to collect information from the community about marine traditional practices, marine Indigenous beliefs and myths and their contributions to marine sustain ability. Similarly to Godlo (2024), in

her study conducted in South Africa, learners were given four guiding questions to focus on and to later direct their discussions in their respective groups. This strategy was intended to ensure that the data generated from the group activity was appropriate to the study. In addition, the participants were allowed about 10 minutes to engage in group discussions in the classroom and thereafter documented their findings on the newsprints.

The four guiding questions were:

1. What are some traditional practices that you know from your home or community that are related to marine biodiversity conservation?
2. How have Indigenous practices contributed to the conservation of marine biodiversity?
3. What are the Indigenous beliefs and myths related to marine life?
4. Which modern ways are used to conserve marine biodiversity?

After the group discussions, which were in accordance with the guiding questions, each group presented their findings to the entire class. The entire session spanned approximately two hours, concluding within the planned timeframe. In this group activity, I observed that girls seemed to exhibit more confidence than boys. Many boys were initially reluctant to present, with the notable exception of Ndlovu (clan name) who delivered a captivating and poetic presentation in isiXhosa.

This activity fostered an inclusive and relaxed atmosphere where nearly every learner contributed, expressing their views openly in a non-threatening environment (Fakudze, 2021; Onwu et al., 2020). The high levels of engagement throughout the discussions showed that the group activity enabled learner talk. The dynamics of the discussions align with Vygotsky's (1978) sociocultural theory, which underscores the significance of culture and language in learning. The theory suggests that learners can better relate new information to their existing knowledge when allowed to use their preferred language. This was evident as learners constructed new knowledge and linked it to what they already knew, facilitated by the opportunity to communicate in their native language.

4.6.2 Participatory and lesson observation

Demunck and Sobo (1998) describe participatory observation as the primary method used by anthropologists during fieldwork. Dewalt and Dewalt (2002) further explain fieldwork as involving active observation, memory enhancement, informal interviewing, detailed notetaking,

and, crucially, patience. In this approach, the researcher actively participates in the daily lives or activities of the learners being studied, with a focus on observing their actions, listening to their conversations and questioning their behaviours over a period to gather data. Cohen et al. (2018) affirm that observations provide researchers with the opportunity to collect authentic information from naturally occurring social situations.

According to Rule and John (2011), a researcher observes specific details through observations, gathering data by watching behaviour and events and noting physical characteristics in a natural setting. This approach allowed the researcher to gain a deeper understanding of the context and to identify elements that may have been overlooked during interviews. Creswell (2016) suggested that participatory observation enables the researcher to dig deeper and uncover insights that might have remained hidden through direct inquiry. Creswell (2012) also noted that observations provide an open-ended, first-hand information on specific issues. Therefore, I believed that participatory observations could allow me to learn things that participants might have been reluctant to discuss during interviews.

In this study, I used participatory observation by acting as a co-learner, engaging in activities, participating in discussions, and asking analytical questions to the elders and fishermen to explore the potential for learner talk and sense making when integrating IK into teaching. My critical friend, MaJola, observed the lesson module I presented in class to learn from and reflect on it. All lessons were video recorded with the participants' permission. To facilitate analysis and discussion, the data was coded as shown in Table 6.1. Before the IKCs' presentations, I conducted a lesson on marine biodiversity conservation with the learners, which was coded as L1NIK meaning a lesson with no IK integration. During this lesson, learners participated in an activity involving a few questions (see Figure 6.1).

Subsequently, IKCs were invited to share IK related to marine biodiversity conservation. Following their presentation, my critical friend and I collaboratively designed an exemplar lesson that integrated this IK into the topic, coded as L1IK meaning a lesson that integrated IK. My critical friend observed while I taught this lesson in class. A post-activity was given to learners to attempt questions and engage in IK discussions in terms of marine conservation (see Figure 6.2). To gauge

the impact of the IK presentations and the exemplar lesson, I conducted a focus group interview (sharing circle) with the learners.

The goal was to determine if there was any shift in learner talk and sense making of the topic. During the sharing circles, we used the learners' clan names to reduce power dynamics (Mutanho, 2021) and create a comfortable environment for open discussion. The sharing circles were complemented by stimulated recall interviews and learners' journal reflections.

4.6.3 Focus Group Interviews (sharing circles)

According to Gay et al. (2011), an interview is a form of interaction where one person gathers information from another. In this study, sharing circles were used to explore learners' experiences of learning about marine biodiversity conservation through the integration of IK. The interviews focused on their experiences with IKCs presenting to them and how they related this knowledge to their local contexts. Conducted in the afternoon after school, nine selected representatives participated in these interviews. To address power dynamics and foster a welcoming, non-threatening environment, we advocated the use of clan names during the discussions. This approach aimed to make learners feel valued and comfortable, ensuring that their views were respected and not judged.

As noted by Godlo (2024), girls often dominated discussions due to their fluency in English and greater confidence compared to boys. This was the case in my study. To prevent gender dominance and encourage full participation, learners were allowed and even encouraged to speak in their mother tongue, isiXhosa. I emphasised that the purpose of the discussion was not competition but collaborative learning, helping the participants understand the importance of hearing everyone's voice. The use of clan names helped level the playing field, allowing all participants to contribute equally.

4.6.4 Stimulated recall interviews

A stimulated recall interview (SRI) is a collaborative inquiry between research participants and the researcher, with the dialogue focused on the practice through video or audio recall (Lyle, 2003). In this study, SRIs were used to explore learners' experiences of learning about marine biodiversity

conservation through the integration of IK. This is the same case with focus group interviews and therefore it complemented FGI. However, SRIs hoped to allow participants to recall their thinking based on the practice of the lesson through a video (Fox-Turnball 2009). I was interested in finding out if IK integration had stimulated/not stimulated learner talk and sense making on the topic of marine biodiversity conservation. Just as in focus group interviews, the same learner codes were employed. This was because the same learners who participated in the FGI were the ones who took part in the SRI (see Appendix E for details).

One difficult factor is that SRIs are perceived to be very exhausting because of having to really concentrate and the struggle to remember (Busse & Ferri, 2003). Since SRIs are reflective tools, they are not considered sufficient as they only focus on specific events and thus in this study, journal reflections were also used to reflect on the whole research process.

4.6.5 Learners' reflective journals

To Ngulube (2015), journals are a personal account of the learning experiences, and it is a way of giving learners a chance to express their state of mind and views about the learning experience so that they can make suggestions. In support, Bashan and Holsblat (2017) explain that writing in a reflective journal may be valuable to learners and educators for developing cognitive abilities for promoting their self-orientation and responsibility for the processes of their own and cooperative learning. Reflections afford educators opportunities to note their opinions and how knowledgeable involvement affects their interaction with what is being researched (Alvesson & Sköldberg, 2009). In addition, Goker (2016) claims that reflection plays a key role in educators' professional development as it affords them a chance to solve the problems encountered to change their teaching methodology.

Similarly to Mayana's (2020) study, I encouraged my learners to begin writing their reflective journals on all the lessons presented throughout the year in Life Sciences to prepare them for the data collection period. In this study, learners were required to reflect before, during and after the integration of IK into teaching. This approach was intended to give me an in-depth understanding of the learners' talk and sense making of marine biodiversity conservation. Learners were provided

with seven guiding questions to ensure their reflections were clear and to the point (see Appendix G).

Journal reflections were used to complement focus group interviews (sharing circles), lesson observations and stimulated recall interviews. The purpose of using journal reflections was to explore learners' experiences of learning about marine biodiversity conservation through the integration of IK. These reflections aimed to give learners a chance to express their thoughts and views about the learning experience and to make suggestions. In this study, all learners were issued with journals, ensuring that everyone had the opportunity to reflect on their experiences.

Table 4.2: Summary of data gathering methods used in this study

Phase	**Method to be used to gather data**	**Purpose**	**Research question**
Phase 1	Group activity	To determine learners' individual prior- knowledge, to find information from the community about marine biodiversity conservation.	1
Phase 2	Focus group interview	To find out the learners' talk, attitudes and sense making towards learning the concepts of biodiversity conservation. Establish how learners found the experiences of interacting with IKCs.	1
Phase 3	Participatory and lesson observation	To find out the influence of integrating IK in teaching marine biodiversity conservation. Using marine traditional knowledge as a mediator to learner talk and sense making of the topic marine biodiversity conservation.	1 & 2
Phase 4	Stimulated recall interviews	To reflect if there is a shift or not in learners' talk and sense making.	2
Phase 5	Learners' reflections .	To find out the influence of model lessons that integrate IK in teaching biodiversity when community members are knowledge bearers and not the classroom teacher.	1 & 2

4.7 Data Analysis

Data analysis is the procedure of making sense of the information through a multipart process that involves moving back and forth between tangible bits of data and non-concrete concepts (Merriam, 1998). In support, Cohen et al. (2018) elaborate that it involves organising, accounting, explaining and reducing data for it to have meaning. According to Cohen et al. (2018), early analysis reduces the problem of data overload by selecting significant features for future focus.

In their study, Atallah et al. (2010) emphasise using a combination of self-reporting tools, focus groups and interviews for data analysis. According to Atallah et al. (2010), this multifaceted method allows for a comprehensive understanding of the factors influencing learning and teaching in a subject. In this study, qualitative data analysis was employed, with themes identified, analysed, and reported (Braun & Clarke, 2006). This was also similar Atallah et al. (2010). Data from all five techniques used were coded, compared, contrasted, and cross-referenced, similarly to Shilomboleni (2024).

Drawing from Vygotsky's (1978) concept of social interactions, the data was analysed to determine whether the integration of IK enables and/or constraints learners' talk and sense-making or marine biodiversity conservation. Vygotsky's (1978) concept of social interactions was used as a lens to analyse the learners' learning through social interactions, considering their experiences, knowledge, feelings, arguments, and input.

The CHAT was used as an analytical tool to uncover discrepancies between the different participant activity systems in sense-making, particularly in relation to the integration of IK, as well as to understand the expansive learning opportunities created by this intervention. The CHAT allowed me to deeply analyse not only how learners engage in social interactions but also how these interactions contribute to a transformative learning process that integrates IK.

Triangulation from different data sources was utilised to build a coherent justification for the themes, and all the evidence collected during the study was recorded and securely stored. This was necessary to understand both learners' and teachers' conceptions and dispositions towards marine biodiversity conservation through qualitative methods. In chapter five, I presented data from the

group activities and presentations by IKCs. In chapter six I then presented data gathered from lesson observations, focus group interviews, SRIs and learners' journal reflections.

4.8 Validity and Trustworthiness

According to Kivunja and Kuyini (2017), a research study should meet three main criteria for trustworthiness and validity: credibility, dependability and confirmability. Cohen et al. (2018) supported this by stating that validity is crucial to effective research, asserting that research is worthless if it is invalid. To ensure validity and trustworthiness in this study, multiple data collection techniques were employed, including group activities, focus group interviews (sharing circles), participatory and lesson observations, learners' reflections and SRIs. The triangulation method was used to enhance the validity and trustworthiness of the data, ensuring that the research accurately reflected the participants' reality. Reflections on videos from group interviews with a critical friend and all stakeholders also contributed to the transparency and validation of the study. Presentations by Indigenous IKCs further validated the integration of Indigenous Knowledge in science. The research process was highly transparent, with detailed reports and conclusions (Bertram & Christiansen, 2015).

4.9 Ethical Considerations

Ethical considerations deal with principles and guidelines that ensure the rights, dignity, and wellbeing of participants are protected throughout the research process (Cohen et al., 2018). These considerations are crucial for maintaining integrity and trustworthiness in research (Cohen et al., 2018). Key ethical considerations in my study included respect and dignity; transparency and honesty; accountability and responsibility; Integrity and academic professionalism. I now discuss these considerations.

4.9.1 Respect and dignity

In this study, respect and dignity were shown by actively involving IKCs, such as elders who grew up in marine environments and a local fisherman, in the educational process. By inviting these IKCs to share their expertise on marine biodiversity conservation with Grade 11 Life Sciences learners, the research not only valued their knowledge but also recognised the importance of

Indigenous perspectives in scientific education. This approach ensured that the voices of the IKCs were heard and respected, and their contributions were integral to the learners' understanding of marine conservation, thereby affirming the dignity of the IKCs and their cultural heritage.

Furthermore, the study demonstrated respect and dignity towards the learners by acknowledging their existing knowledge and cultural background as valuable components of their education. By integrating IK into the science curriculum, the research aimed to create a more inclusive learning environment where learners could relate to and better understand the concepts being taught. This approach fostered a sense of belonging and respect for the learners' cultural identities, encouraging them to actively participate in discussions and make sense of marine biodiversity conservation within their sociocultural context. The use of participatory methods, such as group activities, sharing circles and reflections, further emphasised the respect for learners' voices and experiences throughout the research process.

4.9.2 Transparency and honesty

The research was transparent about its goals, which were to mobilise marine IK to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation. Transparency was further demonstrated through the informed consent process. This was achieved by issuing consent letters to all participants making sure they understood the scope behind the research. Furthermore, permission to carry out this research was sought in writing and granted by the DBE, IKCs, learners, my critical friend and the school principal.

4.9.3 Accountability and responsibility

In my research, I demonstrated accountability and responsibility by strictly adhering to Rhodes University's educational research ethics, principles and guidelines. I took full responsibility for all data gathered throughout the study, ensuring that it was securely stored and managed. Hard copies of data were safely kept in a lockable office within secure cabinets, while all digital data was stored on an external hard drive protected by passwords. To respect the participants' autonomy and rights, I obtained explicit consent from learners and IKCs regarding the use of their real names and images in the study. This included seeking their permission to use unblurred images where necessary,

ensuring that their preferences were fully respected. By taking these measures, I upheld the ethical standards of the research and maintained the trust and confidence of all participants involved.

4.9.4 Integrity and academic professionalism

I maintained integrity and academic professionalism throughout my research by ensuring that the thesis is entirely my own work, grounded in my original ideas. All external sources that informed my study were precisely cited, with full acknowledgement of the authors' contributions, reflecting a commitment to academic honesty and respect for intellectual property and ideas.

4.10 Chapter Summary

This chapter provided a comprehensive overview of the research methodology employed in the study. The goal was to mobilise marine IK to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation. As alluded to earlier this study was informed by the interpretive paradigm and the Indigenous research paradigm that complemented each other. As well a qualitative case study research design was employed. Additionally, different data gathering methods and research ethical issues were considered and explained. In the next chapter, I present, analyse and discuss the data generated from group activities.

CHAPTER FIVE: GROUP ACTIVITY

5.1 Introduction

The main goal of this study was to mobilise marine IK to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation. This was intended to make marine biodiversity conservation relevant and accessible to learners in a science class. In this chapter, I thus present, analyse and discuss the observations made during the learners' group activity. This was intended to answer the research question 1:

> *What enables and/or constrains Grade 11 Life Sciences learners' talk and sense making of the topic of biodiversity conservation before the intervention?*

5.2 Summary of Qualitative Data Generated During the Group Activity

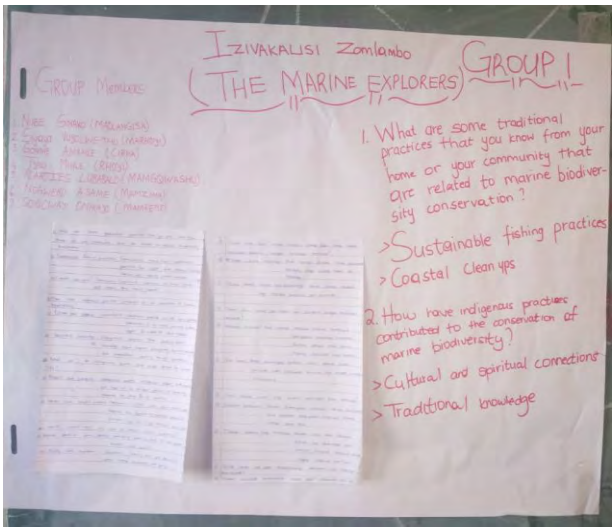
In the group activity, learners were divided into nine mixed groups of boys and girls to collect information from the community about marine traditional practices, marine Indigenous beliefs and myths and their contributions to marine sustainability. Similarly to Godlo's (2024) study conducted in South Africa, learners were given four guiding questions to focus on and later direct their discussions in their respective groups. This strategy was intended to ensure that the data generated from the group activity was appropriate to the study. In addition, the participants were allowed about 10 minutes to engage in group discussions in the classroom and documented their findings on the newsprints thereafter.

The four guiding questions were:

1. What are some traditional practices that you know from your home or community that are related to marine biodiversity conservation?
2. How have Indigenous practices contributed to the conservation of marine biodiversity?
3. What are the Indigenous beliefs and myths related to marine life?

4. Which modern ways are used to conserve marine biodiversity?

After the group discussions, which were in accordance with the guiding questions, each group presented their findings to the entire class as shown in Figures 5.1, 5.2, 5.10 and 5.11 below (see Appendix J for all newsprints). Learners were also given codes such as L1M which means learner number one male, L5F which means learner number 5 female and so on. Notably, the groups decided to name themselves, resulting in the following codes: G1TME for Group 1, The Marine Explorers; G2IS for Group 2, and Isizwe Sikaqamatha, just to mention a few. Please see Appendix I for all group names and their meanings.



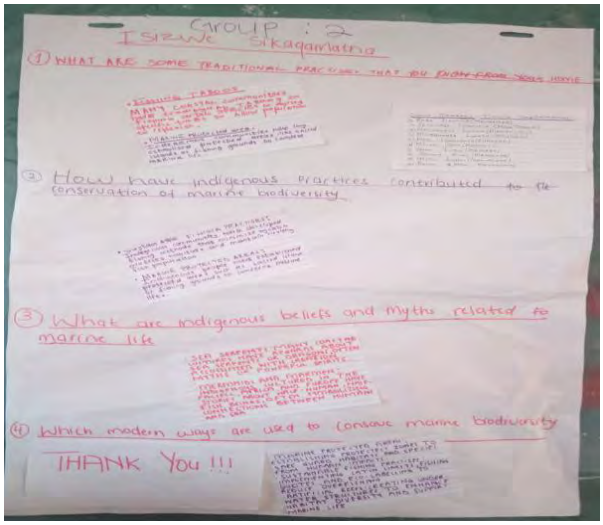


Figure 5.1: Newsprint presented by G1TME Figure 5.2: Newsprint presented by G2IS

Figure 5.3: Learners brainstorming and discussing in groups

[1] **Figure 5.4: Learners presenting in class**

The presentations adhered to the guiding questions, with a designated time afterwards for learners to pose their questions. I strategically scheduled the activity in the afternoon to minimise disruptions, ensuring a smooth flow. The entire session spanned approximately two hours, concluding within the planned timeframe. The discussions proved to be captivating, with learners showing high levels of engagement throughout their presentations (Vygotsky, 1978). Each group delivered its presentations, and the resulting data was used for analysis. From these presentations, four prominent themes emerged: 1) traditional practices, 2) conservation of marine life, 3) Indigenous beliefs and myths, and 4) modern methods of marine conservation. These themes helped address the second research question. A detailed summary of the presentations from all three groups is provided in Tables 5.1 and 5.2 below.

[1] These learners requested that their faces should not be blurred.

Table 5.1: Showing group responses from the group activity for group one to group five

	Group codes:				
From guiding questions	**G1TME**	**G2IS**	**G3FML**	**G4IY**	**G5U**
Theme 1: Traditional practices	Catch-and-release fishing and community coastal cleanups.	Introduction of fishing taboos and marine sacred areas.	Introduction of sacred areas for fishing, catching limits and inhibiting night harvesting.	Using traps and nets with large spaces, seasonal fishing and fostering a sense of stewardship to members.	Community-based management, emphasis on spiritual connections and passing down knowledge about marine conservation to future generations.
Theme 2: conservation of marine life	Passing down traditional knowledge to new generations thereby encouraging conservation of marine life. Believing in cultural and spiritual connections has resulted in deep respect for marine life and thus conservation.	Fishing taboos have prevented people harvesting fish at specific periods and thus allowing fish population to flourish.	Prevention of night fishing prevented overfishing as daylight fishing can easily be controlled by community patrols.	Rotational fishing resulted in sustainable harvesting as well as little disruption to breeding cycles.	Spiritual connectedness fosters a deep reverence and respect for marine life. This promotes cultural care and protection.
Theme 3: Indigenous beliefs and myths	Whales and dolphins are sacred messengers and guides.	Mermaids and mermen are believed to be half human and half fish. This symbolises the connection between humans and fish.	The great turtle created the world by carrying soil on its back. Mermaids and sea serpents symbolise human connection.	Some fish and whales' behaviours portrayed as guidance and message from ancestors.	The belief that some marine mammals convey messages between humans and the marine spirits.

Theme 4: Modern ways of conservation	Implementing policy and legislation to preserve marine habitats.	Implementing catch limits and establishing protected zones to safeguard marine habitats and species.	Education and awareness and using technology to prevent poaching.	Establishing marine protected areas, using technology to monitor biodiversity in a sea and implementing harsh laws against overfishing and poaching.	Implementing catch limits, fishing quotas and ecolabelling. Raising awareness and marine conservation education.

Table 5.2: Showing group responses from the group activity for group six to group nine

		Group codes:		
From guiding questions	**G6M**	**G7INY**	**G8ME**	**G9TSM**
Theme 1: Traditional practices	Seasonal fishing closures, marine resource monitoring.	Restriction to hunt a specific species of fish and harvesting only what you need at a specific time, e.g. the Khoisan people are only allowed to take what is needed at a specific time.	Sustainable fishing practices like catch-and-release as well as establishing marine protected areas.	Gear restrictions to minimise bycatch and seasonal fishing restrictions.
Theme 2: conservation of marine life	Reduction in overfishing and poaching.	Allowing time for growth and reproduction of species.	Availability of marine protected areas improves the index of diversity of species.	Intergenerational knowledge has allowed transfer of preserving traditional practices.
Theme 3: Indigenous beliefs and myths	Ancestors are among marine life; they can consult and cleanse themselves at the sea.	Nami Wata a sea goddess in Zulu culture is known to be powerfully associated with fertility. Mermaids are associated with beauty and seduction. They are believed to be half fish and half human.	Sea gods and goddesses are believed to protect marine life. Also, possibility of connection between humans and marine spirits.	The rainbow serpent created rivers, ocean currents and lakes. Inyakamba is a snake that is so powerful that can destroy many things if provoked.

Theme 4: Modern ways of conservation	Awareness, ecolabelling and community engagement practices.	Harnessing ocean energy to reduce fossil fuel dependence as well as using underwater sensors and monitoring systems.	Reducing greenhouse emissions to address ocean acidification and thermal pollution.	Ocean clean up initiatives include removal of plastics and debris from ocean and coastlines.

The results of the group activities, as detailed in the study, provide insightful perceptions of mobilising marine IK to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation. The findings are classified into four themes: 1) traditional practices, 2) conservation of marine life, 3) Indigenous beliefs and myths, and 4) modern methods of marine conservation**.**

5.2.1 Traditional practices

The presentation of traditional practices for marine conservation among the learner groups echoes broader themes in IK literature. Scholars such as Berkes (2012) have noted the critical role of Traditional Ecological Knowledge (TEK) in environmental sustainability, particularly in community-based resource management. G2IS's and G3FML's mention of fishing taboos and sacred areas aligns with findings from McMillen et al. (2014) who describe how ritual prohibitions help manage fish stocks. Similarly, the seasonal fishing closures discussed by G6M and G7INY reflect traditional Khoisan practices, where cyclical patterns of harvest align with species reproduction, thus protecting biodiversity (Roberts, 2001).

Furthermore, community involvement and spiritual connections discussed by G4IY and G5U echo ideas from Agrawal (1995), who explored how community-based management systems foster a strong sense of ownership, cultural continuity, and environmental stewardship. This mirrors global examples where TEK is central to managing natural resources. Eventually, the variations in practices from spiritual elements to practical regulations underscore the compliance and relevance of Indigenous practices in modern marine conservation, a concept explored in the literature by scholars like Mazzocchi (2006), who highlights how TEK provides valuable insights into the sustainable management of marine ecosystems.

A key similarity across these groups is the emphasis on sustainable fishing practices and community involvement. However, the methods varied, with some groups incorporating spiritual elements and others focusing more on specific regulations and community monitoring. Mazzocchi (2006) described this trend as the flexibility of Indigenous practices in modern marine conservation.

5.2.2 Conservation of marine life

The emphasis on traditional knowledge in marine conservation, as highlighted by the groups, aligns with existing literature on Indigenous ecological practices. Berkes (2012) discusses how the passing down of traditional knowledge fosters a deep respect for ecosystems, which is critical for sustainability. Community-based monitoring and practices like fishing taboos, as mentioned by groups like G3FML and G7INY, are well-documented in McMillen et al. (2014), who explain that such practices maintain ecological balance and biodiversity.

Cultural and spiritual connections, as emphasised by G2IS and G5U, are integral to Indigenous practices and promote conservation as a moral duty (Agrawal, 1995). The focus on marine protected areas and intergenerational knowledge transfer, as highlighted by G8ME and G9TSM, echoes the significance of place-based learning and time-specific resource management discussed by Mazzocchi (2006), which ensures that both knowledge and practices are passed down effectively across generations. The literature supports that combining cultural beliefs with regulatory measures enhances conservation efforts and sustains marine biodiversity.

A common thread that emerged is the use of traditional knowledge to inform sustainable practices. Differences lie in the specific methods, with some groups focusing on cultural beliefs and others on regulatory measures.

5.2.3 Indigenous beliefs and myths

Indigenous beliefs and myths are deeply intertwined with conservation practices as seen in various studies. Berkes (1999) emphasises that myths and spiritual beliefs often guide Indigenous communities in their environmental stewardship. Indigenous beliefs and myths played a significant role in shaping conservation practices. For instance, G1TME viewed whales and dolphins as sacred

messengers. G2IS and G3FML included mythical beings like mermaids and sea serpents, symbolising connections between humans and marine life. G4IY believed in the guidance of ancestors through marine animal behaviours. G5U and G6M emphasised the role of ancestors and marine mammals as messengers. G7INY highlighted cultural figures like the sea goddess Nami Wata and mermaids, while G8ME and G9TSM discussed sea gods and the rainbow serpent creating water bodies.

The similarity here is the deep cultural integration of marine life into spiritual beliefs, fostering a sense of reverence and protection. However, the differences lie in the specific myths and cultural figures each group focused on.

5.2.4 Modern ways of conservation

Modern conservation methods varied but shared a focus on integrating traditional knowledge with contemporary practices. G1TME and G2IS advocated policy implementation and establishing protected zones. This mirrors the broader global efforts towards marine protected areas (MPAs). Research by Dudley (2008) emphasises the significance of MPAs as a modern conservation tool, promoting biodiversity while incorporating local governance and traditional knowledge systems to ensure sustainable management. G3FML and G4IY emphasised education, technology use and strict laws against overfishing and poaching. G5U combined catch limits, fishing quotas and ecolabelling with educational efforts.

G6M and G7INY focused on community engagement, harnessing ocean energy and using monitoring technology. G8ME targeted reducing greenhouse emissions to mitigate ocean acidification, while G9TSM concentrated on ocean cleanup initiatives. The inclusion of education, ecolabelling, and greenhouse emissions reduction by groups like G5U and G8ME reflects an integrated approach that is emphasised by Cinner et al. (2012), who argue that combining environmental education with traditional practices raises awareness and ensures that future generations are equipped with the knowledge and tools for sustainable resource use.

The commonality among these groups is the blending of traditional and modern methods to enhance conservation efforts. Nonetheless, differences emerged in the specific modern techniques

each group prioritised, such as legislative measures, technological solutions or direct environmental actions.

5.2.5 Summary

This synthesis reveals the diverse approaches of the nine groups in addressing marine biodiversity conservation. While each group brought unique traditional practices, beliefs and modern methods to the table, common themes of sustainability, community involvement and the integration of traditional and modern knowledge emerged. Berkes (2012) highlights that IKS, which often emphasise sustainability, community stewardship, and spiritual connections to the environment, are vital for informing ecological practices in ways that WS sometimes overlooks. The variations in specific practices and beliefs underscore the richness of IK and its potential to inform contemporary conservation strategies. Incorporating IK into modern conservation methods not only increases the effectiveness of environmental strategies but also fosters cultural continuity and social empowerment, as noted by Mazzocchi (2006).

In this group activity, I observed that girls exhibited more confidence than boys. Many boys were initially reluctant to present, with the notable exception of Ndlovu (clan name) who delivered a captivating and poetic presentation in isiXhosa. For example, he reflected, *"Iinkcubeko nezokholo ezidibanisa abantu bethu zibangele intlonipho enzulu kubomi baselwandle kwaye ke oko kwakhokelela kulondolozo"* (The cultural and spiritual connections that our people have has resulted in a deep respect for marine life and thus conservation).

Also, while most girls chose to present in English, the boys who did present used isiXhosa exclusively. Ndlovu's eloquence inspired other boys to participate, leading to increased male involvement. In my view and with my teaching experience, this choice of language could indicate that girls feel societal pressure to use English as the language of academic success, while boys' use of isiXhosa reflects a stronger connection to cultural identity. Norton (2000) alludes that choosing to use native languages can imply a credible link to cultural identity and group cohesion. This scholar further alludes that women and girls often adapt to societal expectations where English is seen as a language of socioeconomic progression (Norton, 2000)

This activity fostered an inclusive and relaxed atmosphere where nearly every learner contributed, expressing their views openly in a non-threatening environment (Fakudze, 2021; Onwu et al., 2020). It could be surmised, therefore, that the dynamics of the discussions align with Vygotsky's (1978) sociocultural theory, which underscores the significance of culture and language in learning. The theory suggests that learners can better relate new information to their existing knowledge when allowed to use their preferred language. This was evident as learners co-constructed new knowledge and linked it to what they already knew, facilitated by the opportunity to communicate in their native language isiXhosa in the context of this study.

5.3 Chapter Summary

In this chapter, I presented, analysed, interpreted and discussed data generated from the group activity. This was aimed at answering my research question one. The findings revealed that learners are motivated to learn science. Seemingly, there is evidence to show that learners knew some traditional practices related to marine biodiversity conservation as presented in Tables 5.1 and 5.2. They demonstrated a good understanding of what IK is all about and the benefits of its integration into science classrooms as well as in marine biodiversity conservation. The findings clearly show that learners are positive about learning science and involving IK in science. In the next chapter, I present, analyse and discuss data generated from the presentations by the IKCs.

CHAPTER SIX: PRESENTATIONS BY INDIGENOUS KNOWLEDGE CUSTODIANS

6.1 Introduction

In the preceding chapter, I undertook a comprehensive presentation, analysis and discussion of qualitative data derived from learners' group activities. The main goal of this study was to mobilise marine IK to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation. This was intended to make marine biodiversity conservation relevant and accessible to learners in a science class. In this chapter, I thus present, analyse and discuss the observations made during the presentations by the IKCs. This was intended to answer research question 2:

> *How do lessons on biodiversity conservation that integrate IK shift (or not) Grade 11 Life Sciences learners' talk and sense making of this topic?*

6.2 Presentation by IKCs

Table 6.1 below provides detailed profiles of the three IKCs who shared their Indigenous Knowledge on marine biodiversity conservation with Grade 11 Life Sciences learners from a township school. These IKCs volunteered to present in the classroom, offering their expertise to help learners understand and discuss marine biodiversity conservation. The insights and information shared by the IKCs were subsequently used to co-develop an exemplar lesson integrating the IKCs' IK on the topic under study.

Table 6.1: Showing the profiles of the three IKCs

	Name: Sindiswa Maponono Language: IsiXhosa Year of birth: 1964 Place of birth: Mooiplaas, East London Level of education: Standard 10 Clan Name: MaNdaba Work experience: Chef
	Name: Sipho Lukwe Language: IsiXhosa Year of birth: 1956 Place of birth: Ngqushwa, Peddie Level of education: Standard 9 Clan Name: Mfene Work experience: Environmental control and security
	Name: Ndodana Mzamo Language: IsiXhosa Year of birth: 1947 Place of birth: Port Shepstone, KZN Level of education: Standard 6 Clan Name: Bhele Work experience: National Railways

Figure 6.1: Showing the three IKCs (Mfene on the left, next to him is MaNdaba (middle) and Bhele on the right)

Figure 6.2: Showing the three IKCs with some learners

Figure 6.1 above illustrates the three IKCs who co-presented their skills, wisdom and knowledge of marine biodiversity conservation to Grade 11 Life Sciences learners. Similarly to Godlo's (2024) study, clan names were used instead of pseudonyms to address power dynamics (see

Section 1.4), with the IKCs being identified as Mfene, MaNdaba[2], and Bhele. The clan names provided a respectful and culturally appropriate way to recognise their contributions as reiterated by Mutanho (2021) in his study.

The backgrounds of these community members revealed both similarities and differences. All were native isiXhosa speakers, and there were two males and a female, however I was sensitive to gender issues. Mfene, a fisherman and MaNdaba were born in the Eastern Cape Province, while Bhele hailed from KwaZulu-Natal, indicating regional diversity. Their ages also varied, with Bhele being the oldest, followed by Mfene and MaNdaba the youngest. These variations among the IKCs added depth to their collective presentation. Detailed profiles of each IKC, including their unique backgrounds and experiences, can be found in Table 6.1

Table 6.2: Raw data from IKCs

Indigenous Knowledge custodian	Raw data
 **Presenter 1: Mfene the fisherman**	• **Rituals and cultural practices** (*Imicimbi yeNkcubeko kunye neMiqondiso):* We practised rituals called the "First Fish Ceremony" to celebrate the first catch of the fishing season. This involved returning part of the catch to the sea as a gesture of gratitude to the ancestors. • **Community-based management** (*Ulawulo oluSekwe kuLuntu*): Coastal communities had local councils that oversee marine resource management. These councils established fishing rules and designated fallow areas. Decisions were made collectively, incorporating traditional knowledge and ensuring compliance through social norms. • **Knowledge transfer by elders** (*Ukuhanjiswa koLwazi kunye neNtetho*): Elders used to pass down knowledge to us through storytelling, songs and communal gatherings. Stories about the ocean often included moral lessons on respecting marine life and practising sustainable harvesting, ensuring that younger generations continue these practices. • **Sustainable fishing techniques** (*Iindlela zokuLoba eziZinzileyo):* We were encouraged to use woven reed baskets or traps known as 'izibani'. These are selective, and they minimise the amount and size of fish we could catch at a time. These traps capture specific sizes and types of fish, reducing the impact on non-target species, and thus helping maintain fish populations and ecosystem balance. • **Seasonal fishing practices** (*Iindlela zokuLoba eziThobela amaXesha onyaka*): We Xhosa people used to follow lunar cycles and seasonal changes for fishing activities. For instance, they

[2] The prefix 'Ma' in MaNdaba denotes a female and for a male the clan name would be Ndaba.

	avoid fishing during the breeding seasons of key species to ensure fish populations remain healthy and sustainable. • **Low and high tides** (*Ithafa lolwandle kunye nemvuthu yolwandle*): We engaged in fishing activities during low tides, which allowed us to access areas where fish and other marine life become trapped in shallow pools. Fishing during low tide minimised environmental disruption and promoted sustainable harvesting of marine resources. • **Sacred sites and taboo areas** *(Iindawo ezingcwele kunye neeNdawo ezineMithombo*): There were sacred coastal areas, like the estuary of the Mzimvubu River which we believed in. In these areas, fishing was heavily restricted. This together with other practices, allowed marine life to thrive.
 **Presenter 2: Bhele**	• **Restrictions on night fishing** *(Izithintelo zokuLoba ebusuku*): To prevent overfishing, some communities-imposed restrictions on night fishing. This practice helped reduce pressure on fish populations and allowed them to feed and reproduce without constant human interference. • **Use of traditional herbal remedies** (*Ukusetyenziswa kweMithi yeMveli*): Whenever marine-derived substances were used in traditional medicine, it was advised to harvest them sustainably. For example, certain shellfish were believed to have medicinal properties and were harvested in a way that ensures their populations remain sustainable. • **Respect for marine spirits** (*Ukuhlonela imimoya yeLwandle*): We Xhosa people believe in marine spirits or ancestors that inhabit certain parts of the ocean. These beliefs foster a respectful attitude towards the sea and its creatures. For instance, certain rocks or underwater features may be considered the dwelling places of spirits, and these areas are protected from human disturbance. This encourages protective behaviours and rituals that safeguard marine environments from exploitation and harm. • **Use of marine plants** (*Ukusetyenziswa kweZityalo zoLwandle*): Seaweeds and other marine plants were harvested sustainably for food, medicine and cultural purposes. The Xhosa people harvested seaweeds in a way that allows for regrowth, ensuring that these important marine plants continue to thrive and provide habitat for marine creatures. • **Ecological indicators and traditional monitoring** (*Izalathisi zeNdalo kunye noHlolo lweMveli): Abantu abangamaXhosa basebenzisa izalathisi zendalo, ezifana nokuziphatha kweentaka, ukuvuthwa kweentyatyambo kwezinye izityalo, okanye ukubonakala kweentlobo ezithile zolwandle, ukulinganisa impilo yendalo yolwandle. Umzekelo, ukufika kwe-sardine run ecaleni kweWild Coast akuboniwa kuphela njengenethuba lokuloba kodwa njengomqondiso wempilo ebanzi yendalo yolwandle.* [The Xhosa people used natural indicators, such as the behaviour of birds, the flowering of certain plants, or the appearance of specific marine species, to gauge the health of the marine environment. For instance, the arrival of the sardine running along the Wild Coast was observed not just as a fishing opportunity but as an indicator of broader marine health].

Presenter 3: MaNdaba

- **Cultural beliefs and taboos** (Iinkolelo zeNkcubeko kunye neZithintelo): It was unacceptable to catch pregnant fish or the first fish of the season. This allowed the protection of vulnerable stages of marine species and thus their continued abundance. (*We identified pregnant fish by certain physical characteristics such as the size and shape of the fish's belly, which would swell as the eggs developed, changes in the fish's behaviour or the texture of its abdomen when handled, providing further clues*).
- **Intergenerational learning** (*UkuFunda kweziZukulwana eziHlangeneyo): Ulwazi malunga neentlobo zezinto eziphilayo elwandle kunye neendlela ezizinzileyo zokuzingela lwalufundiswa abantwana nolutsha ngokubathatha inxaxheba kwimisebenzi yokuloba kunye nokubalisa amabali. Oku kwaqinisekisa ukuqhubeka kweendlela ezizinzileyo kwaye kwazisa uqhakamshelwano oluqinileyo lwezizukulwana eziselula nolwandle.*
  [Knowledge about marine biodiversity and sustainable practices was actively taught to children and youth through participation in fishing activities and storytelling. This ensured the continuity of sustainable practices and deepened the younger generation's connection to the marine environment].
- **Adaptive management practices** (*Iindlela zoLawulo eziHlangeneyo): AmaXhosa bazilungelelanise iindlela zabo ngokusekelwe kutshintsho lwendalo kunye nokubeka esweni iimeko. Umzekelo, xa kusibonakala ukuba uhlobo oluthile lweentlanzi luyancipha, iinkokeli zoluntu zazibeka izithintelo zethutyana zokuloba olo hlobo lwentlanzi de inani lalo liphinde libuyele esiqhelweni.*
  [We Xhosa people adapted their practices based on environmental changes and observations. For instance, if a particular fish species shows signs of decline, community leaders would impose temporary bans on fishing for that species until its population recovers].
- **Traditional festivals and marine education** (*Imibhiyozo yeNkcubeko kunye neMfundo yeLwandle): Imibhiyozo yethu yemveli kunye nemisitho yoluntu yayiquka amacandelo emfundo malunga nokubaluleka kokukhuselwa kolwandle. Umzekelo, ngexesha le festivali yonyaka ethiwa 'Inkciyo, amantombazana amancinci ayefundiswa ngeendlela ezizinzileyo zokuvuna kunye nokubaluleka kwenkcubeko kwezona ntlobo zinto ziphilayo eziselwandle'.*
  [Our traditional festivals and community events included educational components about the importance of marine conservation. For instance, during the annual "Inkciyo" festival, young girls were taught about sustainable harvesting practices and the cultural significance of marine biodiversity].
- **Fishing gear limitations** (Izithintelo kuMatshini wokuLoba): Izixhobo zokuloba zemveli, ezifana nemigca yezandla kunye neentlanzi ezincinci, zazisetyenziswa endaweni yezixhobo zanamhlanje ezonakalisayo ezifana neentleke. Ezi ndlela zemveli zazincinci kakhulu ekuwenzakaliseni okusingqongileyo kolwandle kwaye zazinceda ukugcina ibhalansi ye-ecological.
  [Traditional fishing gear, such as hand lines and small nets, were used instead of more destructive modern equipment like trawlers.

	These traditional methods were less harmful to the marine environment and helped maintain ecological balance]. • **Protection of marine mammals** (UkuKhathalela iiMameli zeLwandle): Izilwanyana zaselwandle ezifana neendlovu zaselwandle kunye neefudo zazihlonitshwa kakhulu kwaye azizingelwanga. Ukuzigcina nokuzihlonipha ezi zidalwa kwanceda ukugcina inani lazo kwaye kwanceda ekugcineni impilo yesistim yolwandle. [Marine mammals such as dolphins and whales were often regarded with respect and were not hunted. Observing and respecting these creatures helped maintain their populations and contributed to the overall health of the marine ecosystem].

6.3 Linking Presentations by IKCs to Modern Science

Indigenous Knowledge Custodians (IKCs) shared engaging insights into marine biodiversity conservation, showing how traditional practices connect with modern scientific ideas. Through their presentations, they highlighted rituals, community management, knowledge sharing, and sustainable techniques that reflect principles found in modern-day conservation frameworks. This section explores these connections, showing how Indigenous Knowledge provides a strong foundation for merging ecological stewardship with modern science to promote sustainable marine resource management. The contributions from three presenters are detailed below, illustrating the powerful relationship between traditional wisdom and scientific approaches to conservation.6.3.1

6.3.1 Presenter 1: Mfene the fisherman

Rituals and Cultural Practices: The 'First Fish Ceremony' is a critical cultural practice that blends gratitude and respect for marine life, ensuring sustainable fishing through the return of a portion of the catch to the sea. This ritual strongly aligns with scientific conservation principles, as it emphasises maintaining ecological balance and avoiding resource exploitation. Returning part of the catch mirrors modern conservation frameworks, such as those outlined by Berkes (2012), which focus on preventing resource overexploitation through balanced resource use. This cultural approach encourages respect for marine life, a principle also found in sustainable fisheries management practices.

Community-based management*:* Local councils in coastal communities manage marine resources collectively, showcasing a governance model that integrates TEK with social norms. This communal approach to resource management is reflected in modern conservation strategies, which emphasise the role of community involvement in managing and protecting ecosystems (Berkes, 2008). These community-based systems promote local stewardship, similar to modern concepts of co-management between local communities and governmental bodies, ensuring that the knowledge and needs of local fishers are incorporated into policy decisions.

Knowledge transfer by elders*:* Storytelling and communal gatherings provide a framework for passing down marine conservation practices across generations. This form of knowledge transfer, deeply rooted in oral traditions, parallels scientific education methods that emphasise experiential learning. Similarly to Berkes's (2012) seminal work, this traditional form of knowledge dissemination ensures the continuity of sustainable practices and fosters an enduring connection to marine resources across generations. This intergenerational learning fosters stewardship, a concept also critical to modern sustainability education.

Sustainable fishing techniques*:* Selective fishing techniques, such as using traps that minimise bycatch, demonstrate an advanced understanding of marine ecology. These practices mirror modern sustainable fishing methods which aim to reduce harm to non-target species (Garcia et al., 2003). The use of selective gear reflects the principles of conservation, minimising environmental disruption while maximising the longevity of marine resources, which is a fundamental aim of contemporary fisheries management practices.

Seasonal fishing practices*:* Fishing practices aligned with lunar cycles and breeding seasons reflect a sophisticated understanding of ecological rhythms. This approach parallels modern scientific fisheries management, which emphasises the importance of timing in harvesting to avoid overexploitation of vulnerable species. As noted by Scoones (2009), harvesting in sync with natural cycles ensures the preservation of species and promotes long-term sustainability by allowing populations to regenerate during critical periods.

Low and high tides*:* As highlighted in this study, fishing during low tides promotes sustainable resource use by minimising environmental disruption and allowing for selective harvesting in

shallow pools. This practice echoes Berkes's (2012) sentiments who discusses the significance of "harvesting at the right time" in TEK. By targeting specific periods, such as low tides, these fishing practices ensure that vulnerable species are protected, particularly during periods of high tides when marine life is more dispersed.

Sacred sites and taboo areas*:* The establishment of sacred areas where fishing is restricted acts as a conservation measure to promote biodiversity. This concept is similar to the modern establishment of MPAs in contemporary conservation science, which restrict fishing activities in certain zones to protect ecosystems and ensure species regeneration (Berkes, 2008). By safeguarding these areas, both traditional and modern conservation systems aim to preserve marine biodiversity for future generations.

6.3.2 Presenter 2: Bhele

Restrictions on night fishing: Imposing limits on night fishing demonstrates a traditional proactive approach to resource management, similar to modern sustainable fishing practices. The restriction aims to reduce overfishing and protect vulnerable species during times when they are less visible, which aligns with scientific recommendations that emphasise limiting human impact during critical ecological periods. As noted by Scoones (2009), balancing resource use with species protection is crucial for sustainability, which this practice demonstrates.

Use of traditional herbal remedies: Sustainably harvesting marine-derived substances for traditional medicine shows a deep understanding of resource sustainability. This practice parallels conservation medicine's scientific principles, which focus on ensuring the continued availability of medicinal plants while preserving ecosystems (Garcia et al., 2003). The practice of using marine plants and herbs sustainably mirrors the modern understanding of balancing biodiversity conservation with human health needs.

Respect for marine spirits: Indigenous beliefs in marine spirits are integral to fostering a protective and reverent attitude towards the ocean. This respect for marine ecosystems reflects a principle of stewardship for natural resources that modern environmental science also supports. Much like modern conservation ethics, which advocate the sustainable management of ecosystems

for future generations (Berkes, 2008), these spiritual beliefs promote behaviours that align with sustainable marine resource management.

Use of marine plants: Sustainably harvesting seaweeds for food and medicine represents a practice that supports ecosystem health. This is linked with scientific approaches advocating sustainable use of marine resources, where both traditional and modern practices aim to minimise the ecological footprint while meeting human needs. Berkes (2012) emphasises how Indigenous practices of resource use often suggest scientific principles in terms of sustainability.

Ecological indicators and traditional monitoring*:* Using natural indicators, such as fish behaviour and environmental signs to assess marine health reflects a deep, sophisticated understanding of ecological dynamics. This method is closely related to scientific monitoring techniques in marine biology, where observational data is critical for assessing the health of ecosystems (Garcia et al., 2003). Traditional monitoring systems provide valuable insights into marine conservation, complementing modern data-driven approaches to managing marine biodiversity.

6.3.3 Presenter 3: MaNdaba

Cultural beliefs and taboos*:* The prohibition against catching pregnant fish reflects a deep-seated cultural conservation ethic, prioritising the protection of vulnerable populations. This aligns with modern scientific principles of species conservation, particularly the safeguarding of reproductive individuals, which is crucial for sustaining fish populations. In both Indigenous practices and modern fisheries management, there is an emphasis on limiting fishing during critical reproductive periods, similar to Berkes (2008) who discusses the importance of resource management practices that ensure long-term ecosystem resilience. These practices reinforce the connection between traditional conservation methods and scientific approaches, especially in managing marine biodiversity.

Intergenerational learning: Teaching sustainable marine conservation practices across generations fosters stewardship and ensures that traditional methods complement modern scientific approaches. This approach to knowledge transfer helps adapt IK to modern ecological challenges, combining traditional wisdom with contemporary scientific insights. Scoones (2009)

emphasises this by highlighting the importance of integrating local knowledge into broader sustainability efforts, fostering adaptability and resilience. By engaging younger generations, communities ensure that cultural practices remain relevant and contribute to long-term conservation goals.

Community involvement: Incorporating community participation in monitoring marine health creates conservation strategies that are culturally relevant and widely accepted. This communal involvement, which incorporates TEK, mirrors modern community-based resource management models, ensuring that both scientific and cultural principles guide conservation efforts. This participatory approach aligns with Scoones' (2009) livelihoods perspective, which highlights the interplay between social, environmental and economic systems in resource management.

Sustainable fishing practices: Sustainable fishing methods, such as using selective fishing gear and enforcing seasonal restrictions, contribute to marine biodiversity protection. These traditional practices echo scientific principles that promote ecological balance while simultaneously supporting the livelihoods of local fishers. By adopting sustainable practices, communities engage in adaptive resource management, a key point discussed by Scoones (2009), who emphasises how sustainable resource use is linked to livelihoods and local knowledge systems.

Education and awareness: Raising awareness of the importance of marine health and human impact on ecosystems is critical. Educational initiatives can empower communities to become advocates of sustainable ocean practices. By integrating traditional and scientific perspectives, educational programmes can bridge the gap between cultural values and ecological principles, ensuring a more holistic approach to marine conservation. This blend of knowledge-sharing supports both environmental sustainability and community wellbeing, as discussed in the works of Berkes (2008) and Scoones (2009).

6.4 Chapter Summary

In this chapter, the focus was on analysing data derived from presentations by IKCs to address research question two of the study. The findings revealed a rich interplay between TEK and modern scientific approaches to marine biodiversity conservation. This integration highlighted not only the cultural heritage and sustainable practices of a rural community but also the adaptability

of traditional knowledge in contemporary contexts. The observations made during participatory activities indicated a shift in learners' understanding of marine biodiversity as they engaged with the IKCs, demonstrating that traditional knowledge can effectively convey scientific concepts that might otherwise seem abstract.

The chapter emphasised the significance of using the local language, isiXhosa, during interactions between learners and IKCs, which fostered a comfortable and engaging learning environment. This linguistic choice encouraged learners to actively participate and ask questions, thereby breaking down cultural barriers that typically discourage questioning elders (Ivana, 2022). The positive responses from learners, such as nodding in agreement and appreciation, underscored the effectiveness of these interactions. However, the chapter also presented a contrasting viewpoint from one learner, MaGaba, who expressed scepticism about the relevance of elders in the classroom, suggesting that their contributions might not align with the curriculum. This debate highlights the complexities of integrating traditional knowledge within formal educational settings.

Ultimately, the chapter illustrated the profound value of traditional knowledge in marine biodiversity conservation and its evolving relationship with modern scientific practices. The contributions from both learners and IKCs underscored the necessity of preserving TEK as a crucial aspect of cultural heritage and sustainable environmental management. Moving forward, the chapter advocates the continued recognition and integration of this wisdom into educational curricula and conservation strategies, emphasising that a collaborative approach between traditional knowledge and scientific research is essential for fostering a sustainable future for marine ecosystems.

The next chapter will delve into data from focus group interviews, lesson observations and learners' reflective journals to further explore these themes.

CHAPTER SEVEN: INSIGHTS FROM LESSON OBSERVATIONS, INTERVIEWS AND LEARNERS' REFLECTIONS

7.1 Introduction

In the preceding chapter, I undertook a comprehensive presentation, analysis and discussion of the qualitative data derived from participatory observations conducted during the presentations delivered by the three IKCs. This analysis provided valuable insights into the dynamics of these discussions and the effectiveness of the presentations in conveying important concepts related to marine conservation.

In the current chapter, I present, analyse and discuss qualitative data, but this time, the focus will be on lesson observations. For this purpose, I used an exemplar lesson that effectively integrated IK into the broader topic of marine biodiversity conservation (see Figure 7.2). In addition, I conducted focus group interviews (sharing circles), which allowed participants to engage in meaningful dialogue about their experiences and perspectives. To enrich the data collection process further, I also employed SRIs, enabling learners to reflect on their learning experiences in a structured manner. Furthermore, I gathered insights from learners' journal reflections, which provided a personal and introspective view of their understanding and engagement with the material.

The study intended that the data collected through these various methods would comprehensively address both my research questions, ensuring a thorough exploration of the themes related to the integration of IK in educational contexts, and the implication of IK integration for marine conservation. Through this multifaceted approach, I hoped to shed light on the effectiveness of mobilising Indigenous perspectives into the curriculum and its impact on learners' talk and sense making of marine biodiversity conservation.

7.2 Data Generated from Lesson Observation

Creswell (2012) points out that observations provide open-ended and firsthand information on a specific issue. Kraus (2023) describes observing as the act of watching and mentally understanding an ongoing process. This aligns with the method of lesson observation used in this study. My critical friend, MaJola, observed the lesson I presented in class to learn from and reflect on it. In this section, I discuss the data generated from two lesson activities on marine biodiversity conservation, as well as an intervention lesson that integrated IK into marine biodiversity conservation. All lessons were video recorded with the participants' permission. To facilitate analysis and discussion, the data gathering tools were coded as shown in Table 7.1 below.

Table 7.1: Data gathering tools and corresponding codes

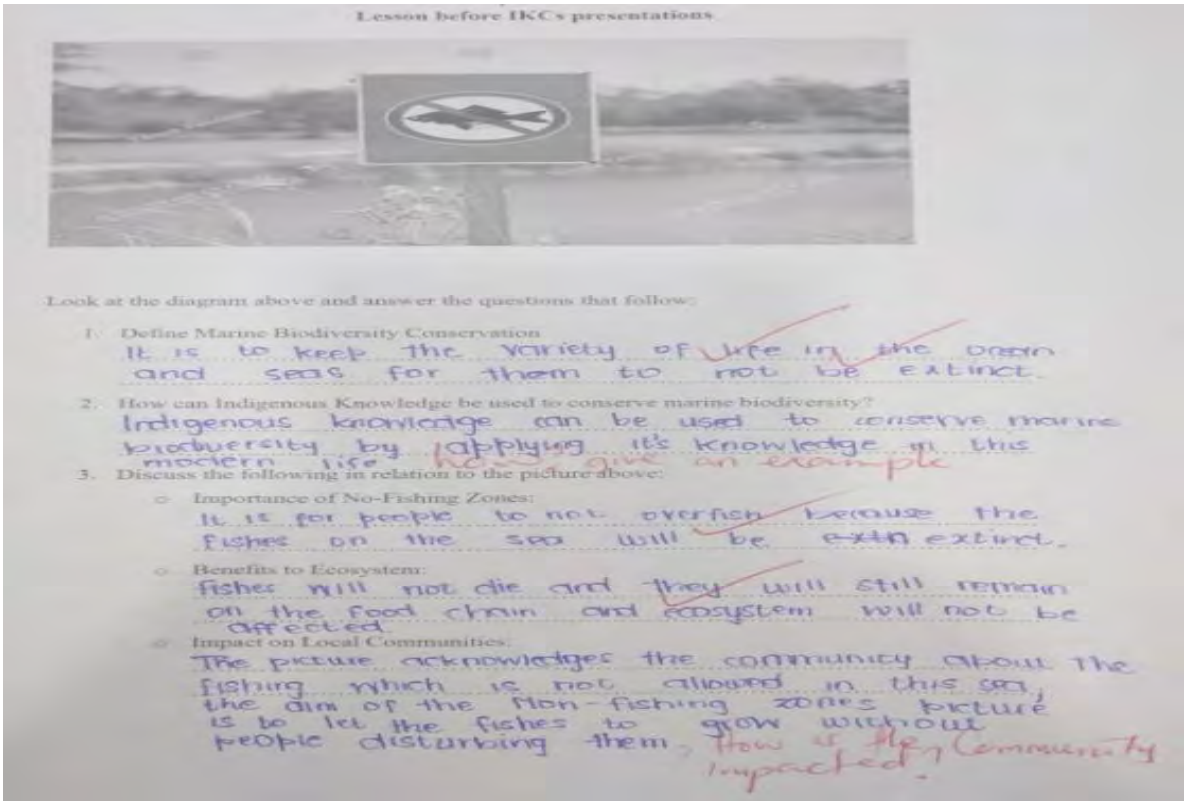
Data gathering tools	**Codes used**
Lesson with no IK integration	LNIK
Lesson that integrated IK	LIK
Learners' journal reflection	L1J- L12J
Focus group interview or sharing circle	FGI
Stimulated recall interviews	SRI

Before the presentations by the IKCs, I conducted a lesson on marine biodiversity conservation with the learners, which was coded LNIK. During this lesson, learners participated in an activity involving a few questions (see Figure 7.1). Subsequently, IKCs were invited to share their IK related to marine biodiversity conservation. Following their presentation, my critical friend and I collaboratively designed an exemplar lesson that integrated this IK into the topic, coded as LIK in the study (see Appendices D and E), for responses gathered after IK was integrated. My critical friend observed while I taught this lesson in class. A post-activity was given to learners to attempt questions (activities1-3) and engage in IK discussions in terms of marine conservation (see Figure 7.2). To gauge the effect of the IK presentations and the exemplar lesson, I conducted a Focus Group Interviews or sharing circle with the learners. The goal was to determine if there was any

shift in their learner talk and sense making of the topic. During the sharing circle, we used the learners' clan names to reduce power dynamics (Mutanho, 2021) and create a comfortable environment for open discussions. The sharing circle was complemented by stimulated recall interviews and learners' journal reflections, which were coded as (L1J–L12J), where L1J means 'learner 1 journal reflection', L2J means 'learner 2 journal reflection', and so on.

7.2.1 Data generated from a lesson without IK integration (LNIK)

As indicated earlier, I presented a lesson on marine biodiversity conservation before the intervention exemplar lesson that integrated IK into science. The purpose was to identify any prior IK possessed by learners. In addition, this lesson provided a baseline of scientific knowledge that would later be expanded upon through the integration of IK. Kibirige and Van Rooyen (2006) assert that the use of IK as prior everyday knowledge in the classroom can enhance science teaching and serve as a foundation for exploring concepts related to WS, which, in this study, would enable learners to compare and synthesise scientific and Indigenous perspectives on marine conservation. In this lesson, I taught the concept of marine biodiversity conservation. The lesson focused on the variety of life in ocean ecosystems and the importance of protecting these species and habitats. The lesson covered topics such as the different types of marine organisms, the roles they play in the ecosystem, the threats they face (like pollution and overfishing) and the actions we can take to conserve and protect marine biodiversity for future generations. Learners were then asked to complete a question activity, an example of which is shown in Figure 7.1 below.


Lesson before IKCs presentations

Look at the diagram above and answer the questions that follow:

1. Define Marine Biodiversity Conservation
   It is to keep the variety of life in the oceans and seas for them to not be extinct.
2. How can Indigenous Knowledge be used to conserve marine biodiversity?
   Indigenous knowledge can be used to conserve marine biodiversity by applying it's knowledge in this modern life how give an example
3. Discuss the following in relation to the picture above:
   - Importance of No-Fishing Zones:
     It is for people to not overfish because the fishes on the sea will be extinct extinct.
   - Benefits to Ecosystem:
     fishes will not die and they will still remain on the food chain and ecosystem will not be affected.
   - Impact on Local Communities:
     The picture acknowledges the community about the fishing which is not allowed in this sea, the aim of the Non-fishing zones picture is to let the fishes to grow without people disturbing them, How is the Community impacted.

Figure 7.1: Lesson without IK integration

The activities were done in groups to encourage collaboration among learners and to support those who struggled with the content knowledge. While the learners appeared to grasp the concepts as they were introduced, they had difficulty connecting these ideas to the local knowledge they had from home. Therefore, learners struggled to make sense of the content. There was evidence that learners possessed some form of IK from their home environments. However, when MaJola, a critical friend, asked them, "*Do you think you can understand IK better if we bring in some elders to explain it to us*?" MaDlamini from group 1 responded, "*They can't even speak English; how are they going to stand in front of a Grade 11 class*?" This response highlighted that some learners see language as a barrier to the sharing of knowledge.

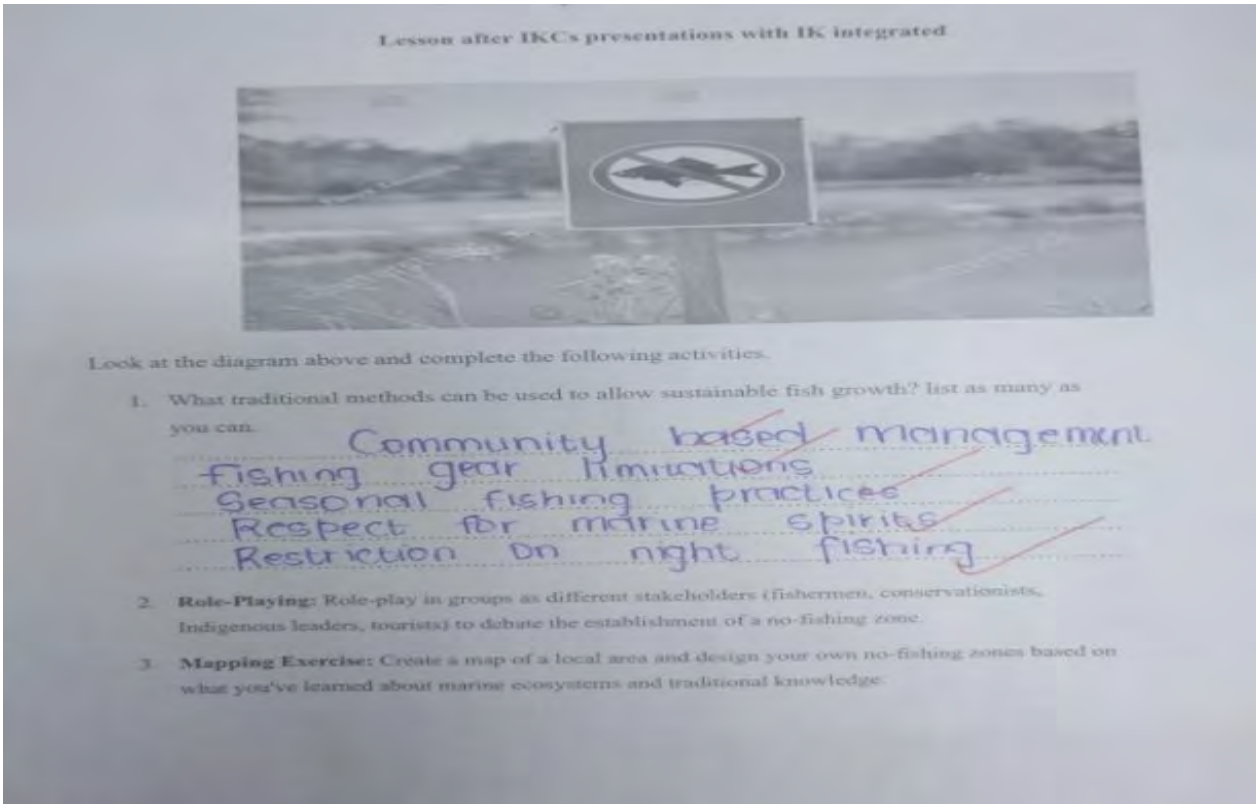
On the other hand, some learners seemed to be uncertain about how to integrate the two concepts in a science classroom. They acknowledged the importance of IK but were unsure how to apply it effectively. For example, during a focus group interview, MaFaku from group two said, "*I do not understand the link between the two; science must be separated from our Indigenous Knowledge*

as this brings confusion". Echoing MaFaku's statement, Horsthemke and Schafer (2008) highlight that some learners may feel uncertain or hesitant about merging IK with science, perceiving them as distinct and potentially contradictory. This uncertainty reflects broader tensions in education about how to respect and integrate IK without diminishing the universality of scientific principles (Horsthemke & Schafer, 2008). Many learners also expressed the belief that with technology advancing rapidly, there is little need to rely on IK for marine biodiversity conservation.

7.2.2 Data generated from the exemplar lesson that integrated IK into marine biodiversity conservation

To prevent conflicts between different knowledge systems, Hatcher et al. (2009) and others proposed the 'two-eyed-seeing' approach in educational settings. This approach intentionally combines various ways of understanding, allowing both perspectives to coexist harmoniously. The guiding principle of 'two-eyed-seeing' in integrative sciences encourages the holistic view of the Indigenous sciences to 'dance with' the Western science's focus on individual parts (Hatcher et al., 2009).

Onwu et al. (2020) and Gwekwerere (2016) support this approach by emphasising the importance of engaging learners in lesson activities rooted in real-world contexts, which can spark their interest and curiosity to learn new concepts. Following this principle, I taught an exemplar lesson that integrated IK after the presentation by the IKCs. In this lesson, learners were challenged with three activities, as shown in Figure 7.2 below. The first activity asked about the traditional methods used to maintain marine biodiversity. The second was a group role play, where learners took on the roles of various stakeholders (fishermen, conservationists, Indigenous leaders, tourists) to debate the establishment of a no-fishing zone (see Figure 7.3). The third activity involved a mapping exercise, where learners created a map of a local area and designed a no-fishing zone based on their understanding of marine ecosystems and traditional knowledge (see Figure 7.4). In this lesson learners showed interest in all activities, especially during the role play. In my view, this sparked their interest and curiosity to learn new concepts (Gwekwerere, 2016).



Lesson after IKCs presentations with IK integrated

Look at the diagram above and complete the following activities.

1. What traditional methods can be used to allow sustainable fish growth? list as many as you can.

Community based management
fishing gear limitations
Seasonal fishing practices
Respect for marine spirits
Restriction on night fishing

2. **Role-Playing:** Role-play in groups as different stakeholders (fishermen, conservationists, Indigenous leaders, tourists) to debate the establishment of a no-fishing zone.
3. **Mapping Exercise:** Create a map of a local area and design your own no-fishing zones based on what you've learned about marine ecosystems and traditional knowledge.

Figure 7.2: Lesson after IKCs' presentations with IK integration

7.2.2.1 Summary of activity one

In response to question 1, all groups successfully listed at least five traditional methods for the sustainable development of the marine ecosystem (Figure 7.2). This was a particularly rewarding moment for me when Mngxongo from group 1 remarked, "*Now I understand what you meant by integrating Indigenous Knowledge".* She then asked me how I would implement IK in UK schools. I responded that I did not yet know yet, and I hoped that this research would possibly shed some ideas on how to do so. These conversations made my learners more comfortable, as they could see that I was also learning from this research.

7.2.2.2 Summary of activity two

The second activity was a group role play, where learners took on the roles of various stakeholders (fishermen, conservationists, Indigenous leaders, and tourists) to debate the establishment of a no-fishing zone (see Figure 7.3).

Figure 7.2: Learner representing groups for the role play

The class was divided into four groups, which were named and coded as follows:

- Group 1: Fishermen (G1F)
- Group 2: Conservationists (G2C)
- Group 3: Indigenous leaders (G3IL)
- Group 4: Tourists (G4T).

The full details of the discussion are available in Appendix H. The debate among the different groups revealed a significant shift in learners' understanding and sense making of marine biodiversity conservation.

Through role play, learners were able to explore the difficulties of the issue from multiple perspectives, allowing them to see beyond their initial positions. The fishermen's concerns about their livelihoods (Scoones, 2009) and the conservationists' emphasis on long-term sustainability highlighted the tension between immediate economic needs and environmental protection. This contradiction prompted learners to consider the necessity of balancing these interests rather than choosing one over the other. These contradictions, or conflicts of interest, are seen as opportunities for learning and transformation (Vygotsky, 1978). Through their participation in different roles,

learners could experience the competing motives of different actors (fishermen, conservationists, etc.), prompting them to negotiate and rethink their initial positions. This aligns with Vygotsky's (1978) idea that cognitive development occurs when learners encounter new perspectives, encouraging them to move beyond individual viewpoints and co-construct solutions.

Moreover, the involvement of Indigenous leaders introduced the importance of integrating IK into modern conservation efforts. The learners recognised that Indigenous practices, which have sustained ecosystems for centuries, should be respected and included in the management of marine resources. This led to a discussion about the value of co-management, where different stakeholders could work together to ensure that all voices are heard and that conservation strategies are effective and culturally sensitive (Berkes, 2018).

The role plays also brought out the potential for sustainable tourism to support conservation efforts, with learners seeing how tourism could be aligned with both environmental and cultural preservation. Scoones (2009), in his livelihood framework, emphasises the interconnectedness of economic sustainability and natural resource management. Saarinen (2016) highlights that community-based tourism, especially in Indigenous contexts, can facilitate the transfer of traditional knowledge and promote sustainable practices that benefit both ecosystems and local economies. Considering the above discussion, it appeared that integrating learners' IK of marine biodiversity conservation enhanced their understanding of the topic (Mavuru & Dudu, 2021). The discussions (see Appendix H) clearly reveal the deep understanding of learners, evidenced by the improved learner talk and sense making. In my view, these two cannot be separated as they influence each other.

The class vote favoured the establishment of a no-fishing zone with a trial period and a co-management approach. This demonstrated that learners had not only understood the diverse viewpoints but also appreciated the importance and the use of IK in environmental issues. I therefore believe that the learner talk and sense making shifted from their initial positions before the IK lesson and integration. This is because learners were motivated to easily learn as they were able to connect new concepts to their previous knowledge (Ahied et al., 2020).

This was evidenced by G3IL's response during role play. G3IL said, "*It is crucial that our traditional practices are respected*". G3IL further mentioned that people have lived sustainably for centuries, and therefore specific provisions that allow for cultural exceptions within the no-fishing zone are required. Their ability to engage deeply with the topic and work towards a solution that considered both ecological and socioeconomic factors showed a mature and nuanced approach to marine biodiversity conservation and thus sense making in my view. This exercise proved effective in promoting critical thinking and understanding, encouraging learners to consider the interconnectedness of IK and WS. Kibirige and Van Rooyen (2006) emphasise that the use of IK as Indigenous prior knowledge in the classroom can enhance science teaching and serve as a foundation for exploring concepts related to WS. This resonates with Le Grange et al.'s (2020) study, which assumes that decolonising the curriculum does not involve destroying all that is Westernised but places it on an equal footing with other ways of knowing, such as IK.

Figure 7.3: Shows an activity where learners created a map showing no-fishing zones

7.2.2.3 Summary of activity three

In the last activity, learners were asked to create a map of a local area and design their own no-fishing zones. This was based on what they had learnt about marine ecosystems and traditional knowledge (see Figure 7.3 above).

In line with all the above discussions, it was evident that when learners are dynamically engaged in similar applicable pieces of knowledge from both WS and IK, they are prompted to try and reach an understanding of science concepts (Onwu et al., 2020). This echoes the idea of using the exemplar lesson that integrated IK into discussing marine biodiversity conservation. The study intended to link the two knowledge systems to support learners in talking and making sense of marine biodiversity conservation. This resonates with the Life Sciences CAPS document, which states in Specific AIM 3 that "Life Sciences should allow learners to be exposed to the history of science and indigenous knowledge systems from other times and other cultures" (DBE, 2011, p. 17). As such, the exemplar lesson was successful, as learners were able to connect their IK of marine biodiversity conservation to science concepts related to marine conservation. For example, one learner appreciated the knowledge shared by the IKCs and acknowledged that respecting marine spirits has a great impact on restricting people from exploitation. To further explore learners' experiences with the exemplar lesson that integrated IK into marine biodiversity conservation, a focus group interview (sharing circle) was conducted.

7.3 Data Generated from the Focus Group Interview (Sharing Circle)

Lavallee (2009) describes sharing circles as an essential method in Indigenous research that fosters a collective and inclusive way of knowledge exchange. According to Gay et al. (2011), an interview is a form of interaction where one person gathers information from another. In this study, sharing circles were used to explore learners' experiences of learning about marine biodiversity conservation through the integration of IK. Lavallee (2009) notes that sharing circles promote relationship-building and community solidarity, making them particularly effective for fostering collaborative learning. In this study, the interviews focused on learners' experiences of the IKCs presentation to them and how they related this knowledge to their local contexts.

Conducted in the afternoon after school, nine selected representatives participated in these interviews. These participants were selected by their peers and agreed to represent the entire cohort. To address power dynamics and foster a welcoming, non-threatening environment, we advocated the use of clan names during the discussions. This approach aimed to make learners feel valued and comfortable, ensuring that their views were respected and not judged.

As noted by Godlo (2024), girls often dominate discussions due to their fluency in English and greater confidence compared to boys. This was the case in my study too. To prevent gender dominance and encourage full participation, learners were allowed and even encouraged to speak in their mother tongue, isiXhosa. I emphasised that the purpose of the discussion was not competition but collaborative learning, helping the participants understand the importance of hearing everyone's voice. The use of clan names helped level the playing field, allowing all participants to contribute equally. The clan names were coded as follows: MaDlamini (L1DL), MaFaku (L2MF), Boyabenyathi (L3BB), MaRhadebe (L4RH), MaGaba (L5MG), Dlamini (L6DL), Mfene (L7MF), Mngxongo (L8MG), and MaFaku (L9MK).

During the sharing circle, learners revealed that they enjoyed the lessons with IK integrated into them and also enjoyed participating in the IKCs' presentations on marine conservation. From the discussions, it was evident that the lessons were engaging, interesting and integrative (Ahied et al., 2020). For example, L3BB said, "*Ndiyabulela indlela le mfundiso engakhange igxile kuphela kwiinyani, kodwa kwakhona kwindlela amasiko ethu anendima yokukhusela ubomi baselwandle. Ndavakalelwa kukuba ibaluleke ngakumbi kum*" [I appreciated how the lesson did not just focus on facts but also on how our traditions play a role in protecting marine life. It felt more relevant to me].

Interestingly, L1DL, who was not keen or interested in the IKCs being invited to the classroom, had a drastic turnaround and change in perceptions. In her response to the fourth question in the sharing circle that asked the learners to identify the experiences of integrating IK in a lesson, L1DL said, "Ndiyifumene *inomtsalane kakhulu kuba idibanise into esifunda ngayo ekhaya kunye neyona sifundiswa yona eklasini. Ikwenze lula ukuyiqonda imiba kuba ndiyakwazi ukuyinxulumanisa nobomi bam bemihla ngemihla"* [I found it very engaging because it connected what we learn at home with what we are taught in class. It made the concepts easier to understand since I could relate them to my everyday life]. According to CHAT (Vygotsky, 1978), learning is a social process mediated by tools (like language and cultural knowledge) and shaped by historical and cultural contexts. L1DL's ability to relate classroom concepts to real-life experiences highlighted the mediation of knowledge between different activity systems. In this case, home and school. In the context of this study, this learner shifted in her thinking, and thus sense making was achieved.

Also, learner talk was achieved as she was confident and talked about how she could now easily link the two knowledges.

Another learner commented, "*I felt more involved in the lesson because it included things I was familiar with, like the fishing practices my family talks about*" (L7MF). This was evidence enough to show that IK is science-related. Many learners appreciated the IKCs by acknowledging and showing that what they do at home can be science-related and is applicable to science lessons. For instance, L2MF said, "*Well, my experience was very breathtaking because I learnt a lot of things that I did not know about marine biodiversity*". L2MF further acknowledged that myths about mermaids are a good example of how IK can be a powerful instrument for teaching the understanding of marine biodiversity.

The sharing circle citations give evidence that learners appreciate IK and can easily understand concepts when IK is integrated. This coincided with the idea of Shizha (2009), who believed that when IK is integrated into learning, learning becomes relevant and learners will respond well to the new knowledge. To support this, L8MG stated, "*It is important that we do not lose our local knowledge while learning science. Integrating the two can strengthen both*". L6DL stated, "I now believe that using our local knowledge in science makes the subject more relevant and interesting". Like Godlo (2024), I can acknowledge that I have also deprived my learners of interesting and engaging science lessons in the past due to my lack of the IK that is relevant to them.

Regarding home knowledge and the WS taught in school, many learners felt that their home knowledge was valuable. For instance, L2MF said:

> *My grandmother often talks about the importance of planting certain plants near water sources to prevent soil erosion. In Life Sciences, we learned about the role of vegetation in protecting ecosystems, which makes me realise that our traditional practices are based on scientific principles*.

To L5MG, science at school is related to the knowledge she gets from home. L5MG acknowledges that things that are said and taught at home often emerge in school. For example, L5MG said:

> *At home, we have stories about respecting the ocean and its creatures. When we learned about marine ecosystems in class, I realised these stories were teaching us to be aware of how everything in the ocean is connected, just like in the food webs we studied*.

Storytelling, as highlighted in the learner's reflection, is a key element of Indigenous pedagogy. It is not only a method for passing down knowledge but also for fostering an understanding of the interconnectedness of all life, including ecosystems like the marine environments discussed in class. Seehawer et al. (2022) revealed that a storyteller does not give an analysis of the story but leaves this to each listener, who brings their experiences to the analysis of the story. Considering the above, I could conclude that the stories these learners were told are linked to science and influence their perceptions about their IK and WS. Reflecting on these discussions, it appears that blending Indigenous pedagogical approaches, like storytelling, with scientific concepts can promote culturally relevant education. This appears to enhance engagement and understanding for learners from Indigenous backgrounds.

However, L9MK does not believe that there is a relationship between IK and WS, and he said, "*It is different because we only learn about science at school and not at home. Teachers should not take everything into classrooms*". This resonates with Hodson (2009) and Horsthemke and Schafer (2008), who warned that not anything and everything should be included in the curriculum under the banner of science.

From a CHAT perspective, the learner's response reflects a contradiction between different activity systems (IK and WS). The learner's comment highlights a boundary between WS and IK that remains unchallenged in their worldview, despite exposure to IKCs and lessons integrating IK. According to CHAT (Vygotsky, 1978), contradictions like this are essential for learning, as they push individuals to negotiate, rethink and eventually transform their understanding. However, the learner's response suggests that the intervention has not yet succeeded in fully reconciling these two systems in his mind. In addition, Vygotsky's (1978), notion of the ZPD could suggest that the learner may need further guided support to link what they are learning at school with their experiences at home. Without this support, they may continue to view IK and WS as separate, rather than complementary (Vygotsky, 1978).

In this study, and as alluded to by Le Grange (2007), it was evident that learners come to school with local knowledge, which is their IK. For example, L6DL said, "*The idea that our traditional ceremonies have a role in conservation was very interesting*". Le Grange (2007) highlighted that learners are unable to connect this knowledge with science because of cognitive dissonance. This study has proved that IK is relevant to science and can stimulate interest in learning. This makes science learning relevant to the learner, therefore improving their talk and sense making. The integration of IK in the isiXhosa language with examples that were relevant and familiar to learners made science accessible. For example, L1DL mentioned that using IK and teaching using their home language would help them better understand Life Sciences. This proves that the integration of IK into biodiversity conservation lessons shifted my Grade 11 Life Sciences learners' talk and sense making.

Fascinatingly, L1DL believes that Life Sciences teachers should start using IK often in science lessons. She also mentioned that teaching using isiXhosa would even engage learners further and increase learner talk, participation and sense making. When given the opportunity to say her remarks, she said, *"IK should be included in classes so that we can preserve history and maintain our identity as Africans".* This illustrates a major shift in this learner's thinking (*They can't even speak English; how are they going to stand in front of a Grade 11 class?*) and thus sense making. This accomplished the second objective of my study, in my view.

7.4 Data Generated from SRIs

A SRI is a collaborative inquiry between research participants and the researcher, with the dialogue focused on the practice through video or audio recall (Lyle, 2003). In this study, SRIs were used to explore learners' experiences of learning about marine biodiversity conservation through the integration of IK, similar to an Focus Group Interviews or sharing circle. However, in this study, I hoped the SRIs would allow participants to recall their thinking based on the practice of the lesson through a video (Fox-Turnball 2009). I was interested in finding out whether or not IK integration stimulated learner talk and sense making on the topic of marine biodiversity conservation. Just as in focus group interviews (sharing circles), the same learner codes were employed. This was because the same learners who participated in the sharing circle participated in the SRIs (see Appendix E for details).

Like in the sharing circle, the data from the SRIs revealed that learners appreciated the integration of IK in marine biodiversity. For instance, L1DL said, "*I felt more connected to the lesson because it related to what I already knew from home. It wasn't just about facts from a textbook; it was about things that are important to my community*". As alluded to before, this illustrates a change in this learner's thinking and is evidence of sense making.

It was also evident that sense making shifted as learners appreciated that their traditional practices have a lot in common with scientific conservation methods. For example, the way elders manage fishing seasons is like the scientific concept of sustainable fishing. L2MF recommended that science teachers be trained to integrate IK into their lessons. In this regard, L2MF believes that the lessons would be more inclusive and help learners connect with the material being taught.

In this study, many learners understood the link, relevance, importance and enlightenment brought into science classrooms by IKCs. However, L9MK believes that science lessons should stick to scientific content. L9MK said, "*If we want to learn about Indigenous Knowledge, it should be in a different class so that those who are interested can choose to learn about it without confusing it with science*". I observed that L9MK was consistent about the separation of the two; she argued that mixing the knowledges would cause confusion.

As mentioned earlier, this echoes with some researchers. For example, Hodson (2009) warned that not anything and everything should be included in the curriculum under the banner of science. I appreciated that MaFakuL9MK participated in the research. I also appreciated that she showed some appreciation to IK and the IKCs. For instance, she said to MaJola, "*The way the IKCs explained the connection between spiritual beliefs and environmental practices was really interesting. It gave me a new perspective on how deeply connected our culture is to nature*". To L9MK, IKCs have interesting vital knowledge that can cause a shift in learners' thinking as supported by the above statement. However, she preferred to keep them separate so that she can learn each one at a time.

7.5 Data Generated from Learners' Journal Reflections

Journal reflections were used to complement the Focus Group Interviews (sharing circle), lesson observations and stimulated recall interviews. As such, the purpose of using journal reflections was much the same as that of the sharing circle – journal reflections aimed to give learners a chance to express their state of mind and views about the learning experience and make suggestions. In this study, all learners were issued with the learner journals. The idea was to give everyone the opportunity to reflect on their experiences. However, only 12 learners submitted their reflections. For the purposes of easy analysis, learners who participated in journal reflections were coded as L1J–L12J. See Appendix G for details.

The analysis of the journal reflections and sharing circle revealed that the learners appreciated the contributions made by IKCs with regard to marine biodiversity conservation. Learners were able to link WS to IK and thus achieved sense making. This made science relevant, and the learners found it clearer and easier to understand (Mavuru & Ramnarain, 2020). For instance, L9J said, "*I learned that our traditions include many practices that are designed to protect the environment. It made me see how much wisdom is in our culture*". This reflects the work of Berkes (2012*)*, who discusses how TEK embodies sustainable environmental management practices that have been honed over generations.

L9J also commented, "*I enjoyed the storytelling aspect of the presentations. It was a different way of learning that made the concepts more memorable*". Archibald (2008) emphasises that Indigenous storytelling is not simply about transmitting knowledge but involves teaching learners how to "make meaning" of the world around them. In this way, storytelling shaped L9J's understanding of natural relationships and human responsibilities toward the environment, in line with Indigenous worldviews (Archibald, 2008). L9J went further by noting that he now understands that conservation is not just a modern idea. In this case, the IKC presentations served as a resource that was used to learn science at school (Aikenhead & Jegede, 1999).

The data presented from the sharing circle and learners' journal reflections showed – from the presentation of marine biodiversity conservation by the IKCs and the exemplar lesson that integrated IK into marine biodiversity conservation – that IK was related to science learnt in class.

This made science relevant, and the learners found it clearer and easier to understand (Mavuru & Ramnarain, 2020). This was evident in L6J's comment that "*IK is relevant because it's based on sustainable practices, but I think it should be taught as a complement to science, not as part of it*". L3J highlighted that IK integration provided a practical approach to conservation.

7.6 Themes that Emerged from my Data Analysis

Data gathered from the collection tools was analysed to formulate themes, and the following emerged:

1. Holistic understanding and IK;
2. Sense making and conceptual integration of marine biodiversity conservation and IK;
3. Community-embedded learning experiences;
4. Learner talk and critical thinking; and
5. Shift in learning**.**

I now discuss these themes.

7.6.1 Holistic understanding and IK

The integration of IK allowed learners to contextualise scientific concepts in their cultural heritage and made the content more relatable and relevant (Mavuru & Ramnarain, 2020). By hearing the IKCs' presentations, learners, like MaDlamini and Mngxongo, acknowledged how traditional practices align with scientific principles, thereby enriching their understanding. For instance, they said the following:

> MaDlamini: "*Before the Indigenous Knowledge Custodians (IKC) presentations, I did not really see how science and our traditions could connect. But when Bhele explained how our ancestors used to respect the breeding seasons of fish, I realised that this is similar to what we learn in class about protecting species during vulnerable times*".
>
> Mngxongo: "*The idea that everything in nature is connected, like what MaNdaba said, helped me understand why we should not just look at fish populations alone but the whole marine ecosystem*".

The IK offered a holistic view, emphasising the interconnectedness of marine ecosystems and the cultural and spiritual relationship between humans and nature. IK stressed the importance of preserving ecosystems, guided by practices that have been developed over generations. From these citations, it could be assumed that learners had a better understanding of IK and related it to knowledge passed on from one generation to the next orally. Therefore, I can assume that learners' sense making shifted. These findings resonate with the definition of IK given by various scholars such as Kibirige and Van Rooyen (2006) and Nyika (2017).

7.6.2 Sense making and conceptual integration of marine biodiversity conservation and IK

The integration of WS and IK fostered a deeper sense making process for learners. Before the presentations by IKCs, learners seemed to struggle to make sense of concepts related to marine biodiversity conservation. The IKCs' presentations and the exemplar lesson that integrated IK helped learners make sense of the content knowledge on biodiversity. Nikodemus (2017) observes that sense making is the process of materialising meaning, which is the case in the context of this study, and that it is an essential component of language, speech and communication. Learner talk was also enhanced during the activities, as evidenced by responses in the role play. It was evident that learners argued and interacted with each other. Kibirige and Van Rooyen (2006) argue that integrating IK promotes communication skills and learner talk. For instance, learners like Mfene and Dlamini appreciated the value of combining both knowledge systems, which enhanced their overall understanding of marine biodiversity conservation.

> Mfene: "*At first, I didn't see how the things we learned in class about marine ecosystems connected to what we do at home. But after the Indigenous Knowledge Custodians (IKCs) presentations, I started to understand how both ways of knowing can help us protect marine life better*".
>
> Dlamini: "*The presentations made it easier to see how science and our traditions can work together. Before, I thought they were separate, but now I understand that they both help us understand the ocean in different ways*".

The integration of WS and IK in the lesson on marine biodiversity conservation clearly promoted a deeper sense making process among learners, as reflected in their increased understanding and

engagement. Nikodemus (2017) emphasises that sense making involves materialising meaning through communication, which is critical in educational contexts. This was evident in the role plays where learners actively discussed and argued, enhancing their comprehension. Kibirige and Van Rooyen (2006) similarly argue that integrating IK improves communication skills and encourages learner talk. Mfene and Dlamini's reflections (above) draw attention to how combining IK and WS enriched their understanding of marine ecosystems, reflecting the complementarity of these knowledge systems in marine conservation. Literature supports that such integrative approaches not only promote cultural relevance but also enhance conceptual understanding, which is critical for meaningful learning.

In summary, the integration of IK, as demonstrated through the presentations by Bhele, Mfene and MaNdaba and in the exemplar lesson, has had a profound impact on learners' talk and sense making of marine biodiversity conservation. The complementary nature of both knowledge systems provided learners with a more holistic, sustainable and inclusive approach to conservation. This enabled them to engage more deeply with the content and see the relevance of what they were learning to their own lives and communities.

7.6.3 Community-embedded learning experiences

Through the presentations by the IKCs, learners experienced the direct integration of IK with WS. These community-embedded learning experiences allowed them to see how traditional practices and scientific principles can work together in real-life scenarios. Seehawer and Breidlid (2021) highlight that through embedding learning in the community, traditional practices are seen not in isolation but in relation to scientific principles. This highlights their potential to work together. During the discussions and reflections, many learners expressed how these experiences deepened their understanding of marine biodiversity conservation. Seehawer and Breidlid (2021) argue that fostering a dialogue between IK and WS creates a holistic learning experience. These dialogues are critical for acknowledging the value of both knowledge systems, especially in educational settings where learners engage with real-world challenges (Seehawer and Breidlid, 2021).

For example, in the sharing circle, L1DL mentioned how the custodians' stories made science more relatable, while L11J highlighted in their journal reflection that learning directly from

community members made the concepts feel more tangible and applicable to their own lives (Seehawer and Breidlid, 2021). These interactions encouraged learners to engage actively with the material, asking questions and sharing their own knowledge from home. L3J journaled that the inclusion of elders in the learning process made the lesson more meaningful, as it connected classroom knowledge with the wisdom of the community. This resonates with Lavallee (2009) and Klein (2011), who suggested that elders have an important role to play in the education of learners by using culturally embedded knowledge and relating it to science concepts. This is possible because elders, in this case IKCs, are the custodians of the cultural heritage.

7.6.4 Learner talk and critical thinking

The integration of IK promoted a rich and dynamic dialogue among learners. As such, this demonstrates the shift in learner talk. Learners were encouraged to express their thoughts and ask questions, which enhanced their engagement with the topic. For instance, in their journal entry, L12J pointed out that hearing the custodians speak in their native language helped them connect more deeply with the material, and L7MF in the sharing circle, mentioned how the presentations by the custodians sparked new thoughts on how traditional and scientific knowledge can complement each other. This resonates with Mavuru and Ramnarain (2017), who argue that using home languages helps learners who lack confidence in English to talk and construct their understanding of scientific concepts. The dialogue also encouraged critical thinking, as learners like L9MK questioned the implications of integrating IK with WS in the sharing circle. This reflective discussion helped learners see the value of a balanced approach to understanding marine biodiversity conservation.

7.6.5 Shifts in learning

The integration of IK in the teaching of marine biodiversity conservation led to a noticeable shift in how learners approached the subject. Initially, students viewed marine conservation through a primarily Western scientific lens, focusing on empirical data and theoretical concepts. However, the inclusion of Indigenous perspectives, particularly through the presentations by the IKCs, introduced a more holistic approach to learning (Aikenhead & Jegede, 1999). Literature supports the idea that IK fosters a more culturally relevant and contextualised form of education, which

helps learners make connections between classroom concepts and their lived experiences (Battiste, 2005).

This shift was evident in the way students started to connect scientific principles with the cultural and ethical practices of their communities. For example, in the sharing circle, L1DL mirrored how the custodians' teachings made science more relatable and less abstract, while L8MG noted that the lessons now felt more relevant to their daily lives. This blending of knowledge systems helped learners to see the interconnectedness between human actions and environmental health, encouraging a deeper understanding and appreciation for sustainable practices. The presentation by the IKCs further facilitated this integration, allowing students to see how science and culture can coexist and contribute to practical solutions for environmental issues. This echoes Berkes' (2012) idea that TEK and scientific principles can work synergistically to enhance biodiversity conservation, providing a well-rounded understanding that encourages long-term environmental stewardship. This shift in learning highlighted the importance of integrating different knowledge systems to enrich students' educational experiences and equip them with the tools to address difficult environmental challenges.

7.7 Chapter Summary

In this chapter, I presented the data from the learner observations, focus group interview (sharing circle), SRIs and the learners' journal reflections to address both research questions. Findings showed that learners understood the significance of IK in education. They also found the IK on marine biodiversity conservation useful and interesting. Learners enjoyed every aspect of this study, as is evidenced by some learners advocating for more involvement of IKCs. In the next chapter, I will present and discuss the findings, the recommendations and the conclusion.

CHAPTER EIGHT: SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

8.1 Introduction

In the previous chapter, I presented, analysed and discussed the data generated from the lesson observations, a focus group interview, SRIs and learner journal reflections. In this chapter, I present a summary of the findings and recommendations for this study. I also suggest areas of future research, the limitations of the study and some personal reflections. The chapter concludes with the overall conclusion of the study.

8.2 Overview of the Study

The main goal of this study was to mobilise marine IK to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation. To generate data, I employed five data gathering techniques: a focus group interview (sharing circle), group activity, participatory observation, stimulated recall interviews and learners' journal reflections. The idea of using many data generation methods was for triangulation purposes. The data generated was analysed and discussed in relation to the literature and theories. This study was informed by two theories, namely Vygotsky's (1978) sociocultural theory and the CHAT. To achieve this goal, the following research questions were addressed:

Research Questions

1. What enables and/or constrains Grade 11 Life Sciences learners' talk and sense making of the topic of biodiversity conservation before the intervention?
2. How do lessons on biodiversity conservation that integrate IK shift (or not) Grade 11 Life Sciences learners' talk and sense making of this topic?

8.3 Summary of Findings

In this section, I present my findings in relation to my research questions.

8.3.1 Research question one

> *What enables and/or constrains Grade 11 Life Sciences learners' talk and sense making of the topic of biodiversity conservation before the intervention?*

During the learner activity, learners were encouraged to share traditional practices related to marine biodiversity conservation that they know from home or their community. The conversations, interactions and presentations during this stage provided insights into learners' motivation towards learning science. There is evidence to show that learners knew some traditional practices related to marine biodiversity conservation. For instance, G1TME highlighted catch-and-release fishing and community coastal cleanups. G4IY talked about the use of traps and nets with large spaces, seasonal fishing and fostering a sense of stewardship to members. Furthermore, G2IS highlighted the introduction of fishing taboos and marine sacred areas. These citations and more (see Tables 5.1 and 5.2) show that learners were already equipped with some traditional knowledge. The findings clearly show that learners are positive about learning science as well as involving IK in science.

In addition, during the sharing circle, learners were prompted to highlight if there is a relationship between knowledge from home and science taught at school. The findings revealed that learners acknowledge that there are ties between the two knowledges and they can be linked. For instance, L1DL said, "*At home, we have always been taught that certain times of the year are not good for fishing because the fish are either breeding or too young. This is like what we learned in school about breeding seasons and how overfishing during these times can deplete fish populations".* L2MF said, "*My family has a rule about not taking more than we need from the sea. In class, we learned about sustainable use of resources, and it clicked that this is what my family has been practicing all along".*

Noticeably, learners' performance in Life Sciences has been relatively poor – as evidenced by the Department of Education candidates' performance report (DBE, 2023). This study found that these

poor results are attributed to lessons that are boring and have no relevance to learners' daily life experiences. This resulted in learners' negative attitudes toward science and their lack of motivation. Therefore, a need was identified to relate science to learners' daily life experiences to enhance motivation, improve attitudes to learning, increase understanding and consequently improve results. These findings resonate with Gwekwerere (2016), who contends that the integration of IK to mediate learning helps learners understand that science occurs in their daily life experiences and connect it to what happens in the classroom. Also in support, Mavuru and Ramnarain (2020) argue that integrating daily life experiences helps learners link outside science with classroom science and motivates them to learn science.

In this study, learners acknowledged the importance of including their life experiences in science learning. This was clear from L3J's journal reflection: "*I think it is a valuable addition. It brings a new perspective to science and makes it more relatable to our daily lives".* As such, learners believed that including relevant IK in textbooks and training teachers with relevant IK would drastically increase their motivation. Through this, learner talk and sense making could potentially be consistently achieved.

Many learners also highlighted traditional practices like seasonal fishing, the establishment of MPAs and fishing taboos as key enablers in their understanding of marine biodiversity conservation. For example, in the group activities, G5U emphasised community-based management and spiritual connections as fostering a deep respect for marine life. This suggests that when learners can relate conservation topics to practices they are familiar with, it enhances their engagement and understanding. Groups like G3FML and G7INY noted the role of cultural and spiritual beliefs in conservation, such as the belief in ancestors among marine life or the importance of spiritual practices like consulting the sea. These beliefs offer learners a framework within which they can better understand the importance of conserving marine biodiversity, showing that integrating IK with scientific concepts can make conservation more relatable and meaningful.

The mythological and spiritual narratives related to marine life, such as mermaids symbolising the connection between humans and fish (G2IS, G7INY), provided learners with a deeper, culturally rooted understanding of marine ecosystems. This suggested that incorporating these narratives into

the curriculum could help interpret scientific concepts and make them more accessible. The responses also indicated that learners were aware of modern conservation methods, such as the implementation of laws, technology and awareness programmes that complement traditional practices. For instance, G8ME and G9TSM discussed the importance of technology in monitoring biodiversity and reducing greenhouse emissions. This demonstrates that when learners see how modern practices align with or enhance traditional methods, their sense making is improved.

While learners appreciated both traditional and modern methods, there was a potential constraint in fully integrating these perspectives. Some groups struggled with reconciling modern scientific approaches with their traditional knowledge systems, which created confusion and hindered effective sense making. In some cases, learners saw IK as less relevant in a modern scientific context, especially if it is not effectively integrated into the curriculum. For example, while groups like G4IY recognised the importance of using traditional fishing methods, they also emphasised the need for modern conservation strategies. It is important that learners are shown how these methods can complement each other, as this would promote their understanding of conservation as a holistic practice.

The analysis of learner responses to the guiding questions during the group activities revealed that enabling factors, such as the connection to traditional practices, cultural and spiritual beliefs and the integration of modern conservation methods, significantly enhance learners' talk and sense making of marine biodiversity conservation. However, constraints such as the potential disconnect between IK and modern science and the perceived relevance of traditional practices can hinder this process. Addressing these constraints through a more integrated and culturally responsive curriculum could further improve learners' understanding and engagement with the topic.

8.3.2 Research question two

> *How do lessons on biodiversity conservation that integrate IK shift (or not) Grade 11 Life Sciences learners' talk and sense making of this topic?*

8.3.2.1 Focus group interviews

The integration of IK in biodiversity conservation deepens learners' understanding by offering a holistic perspective that goes beyond the biological and ecological lens often provided by WS. Literature supports the idea that IK enriches the learning process by integrating cultural, spiritual and community-based practices that have been proven effective over generations in maintaining ecosystems (Battiste, 2005). In this study, for instance, learners' discussions on seasonal fishing, taboos and sacred areas mirror TEK, which emphasises the sustainable use of resources and the need to respect the environment (Berkes, 2012). These practices often align with scientific conservation methods but offer additional extents, such as the spiritual and cultural significance attached to biodiversity.

This approach aligns with the work of Agrawal (1995), who argues that IK provides a nuanced understanding of environmental stewardship that is linked to daily practices and beliefs. The shift from a purely scientific view to a more integrated understanding of conservation is beneficial in educational settings because it not only broadens learners' ecological literacy but also fosters a sense of cultural pride and environmental responsibility (Dei, 2000). Learners' reflections show how the IKCs' presentations bridged the gap between WS and IK, making abstract scientific concepts more relatable by grounding them in familiar, culturally relevant practices.

8.3.2.2 Role play and lesson observation

The findings of the role play, and lesson observations reflect key themes in the literature on the integration of IK and WS concepts. The use of role plays and debate to explore real-world scenarios fostered an artistic learning environment, where learners actively constructed knowledge through experience and reflection, as noted by scholars like Vygotsky (1978). This aligns with culturally responsive teaching, which emphasises the inclusion of learners' cultural backgrounds to enhance engagement and learning outcomes (Gay, 2010).

Literature also supports the idea that engaging students in role play, particularly when involving multiple perspectives (e.g., fishermen, Indigenous leaders, conservationists), promotes critical thinking and problem-solving skills. According to Aikenhead and Michell (2011), integrating IK

into science education allows learners to see the practical relevance of both knowledge systems and encourages them to think holistically about environmental issues, such as marine biodiversity conservation.

In addition, studies have shown that integrating IK into classroom settings enhances motivation and engagement because learners can relate conceptual concepts to familiar cultural practices. McKinley and Stewart (2012) argue that culturally responsive pedagogies help bridge the gap between school-based learning and learners' lived experiences, making the content more meaningful and memorable. In this study, learners' references to fishing taboos and the spiritual significance of marine life reflect a deeper understanding of conservation as not just a scientific practice but also a cultural and spiritual one, as noted in works by Berkes (2012) and Agrawal (1995).

8.3.2.3 Stimulated recall interviews

The SRIs further confirmed how incorporating both knowledge systems fosters a deeper, more meaningful understanding of environmental conservation and related scientific concepts. This is evident in research that discusses how students can connect classroom learning with personal and cultural experiences when IK is included in the curriculum. According to Aikenhead and Ogawa (2007), this integration enables students to view science through a culturally relevant lens, which enhances their sense making and promotes an inclusive understanding of scientific phenomena.

Stimulated recall interviews (SRIs) allow learners to reflect on their experiences and are particularly effective in confirming shifts in understanding. In my study, they provided insights into how students interpreted their learning experiences, revealing their evolving perspectives. In this study, learners transitioning from a modern, technique-focused view of conservation to one that includes cultural respect and TEK align with findings from Berkes (2012), who argues that TEK plays a critical role in sustaining ecosystems through long-established practices. These shifts are indicative of learners moving towards a more integrated, culturally aware perspective of environmental conservation.

Furthermore, Kibirige and Van Rooyen (2006) emphasise that incorporating IK in science education helps learners appreciate the interconnectedness of WS and cultural practices. The

recognition that traditional practices are also key to conservation supports a broader understanding of biodiversity, which goes beyond just scientific data to include cultural values and practices. This holistic approach aligns with the idea that education should not only impart knowledge but also foster students' connection to their cultural identity and heritage, which is a crucial component of meaningful learning.

8.3.2.4 Learner journal reflections

The journal reflections provided a personal and introspective view of the shifts in learners' understanding. Many reflections indicated that learners had a newfound appreciation for how their cultural heritage could contribute to modern conservation efforts. They expressed that the integration of IK made the lessons more engaging and helped them see the value of blending different knowledge systems. For example, some learners reflected on how they previously saw marine biodiversity as a purely scientific issue but now recognise the importance of Indigenous practices in maintaining the health of marine ecosystems. This shows a clear shift in how they conceptualise biodiversity conservation, moving from a strictly scientific understanding to one that values the role of Indigenous practices.

The data from the various sources clearly demonstrates that lessons on biodiversity conservation that integrate IK do indeed shift Grade 11 Life Sciences learners' talk and sense making of the topic. The integration of IK helps learners move from a predominantly WS perspective to a more holistic understanding that values and incorporates traditional practices and beliefs. This shift is evidenced by their enhanced engagement, deeper understanding, and ability to apply both scientific and Indigenous perspectives in discussions and problem-solving activities related to biodiversity conservation.

8.4 Recommendations

Based on the findings above, the study recommends that curriculum developers should systematically integrate IK into the Life Sciences curriculum, particularly in topics related to marine conservation. This integration should go beyond token inclusion and instead embed IK in a way that is aligned with learning objectives and outcomes. They should develop learning materials that reflect the local context and include examples of Indigenous practices relevant to

the learners' communities. These materials should be designed in collaboration with IKCs to ensure cultural accuracy and relevance (Klein, 2011). This would make science appropriate, accessible and significant to learners (Shinana et al., 2021).

Furthermore, the study recommends that teachers should tap into the wisdom of IKCs (Klein, 2011). To achieve this, schools should establish strong partnerships with local communities and IKCs. These partnerships can facilitate the regular involvement of IKCs in and outside the classroom, ensuring that learners benefit from authentic and meaningful learning experiences. In addition, schools should create opportunities for community-embedded learning experiences, such as field trips, workshops and hands-on activities that allow learners to engage directly with traditional practices and local ecosystems.

Lastly, this study recommends formal recognition and compensation of IKCs by the DBE. This would be a vital way of appreciating their involvement in the learning process. As such, the DBE should offer training programmes for IKCs to help them adapt their knowledge to the formal education context while maintaining the integrity of their cultural practices.

8.5 Areas of Further Research

Further research in the field of Life Sciences can be done using longitudinal studies to assess the long-term impact of integrating IK into science education. This research could explore how sustained exposure to IK in the curriculum influences learners' understanding of biodiversity, their environmental stewardship and their cultural identity over time. Furthermore, studies exploring the potential of digital platforms and technologies to support the integration of IK in science education can be undertaken. Research could focus on how virtual reality, mobile apps and other digital tools can enhance the delivery and understanding of IK.

8.6 Limitations of the Study

The focus of the study was to mobilise marine IK to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation. The sample size of 45 participants was relatively small and cannot be generalised to represent all the learners in the Buffalo Municipality region where the study was conducted. However, the findings do highlight

the significant value of IK when integrated into science lessons. In addition, since the study focused on integrating IK in a specific cultural context (the isiXhosa culture in this study), the findings might not be directly transferable to other cultures or regions where IK systems and educational practices differ significantly.

While the use of the isiXhosa language fostered social interactions and active participation (Vygotsky, 1978) and created a non-threatening environment (Fakudze 2021), some information might have been distorted throughout this study when my critical friend, MaJola and I translated the data to English. However, MaJola tried to safeguard the quality and validity of data in this study.

Since the IKCs presented in the classroom (an unusual environment), they may have been intimidated and not fully expressed their cultural norms and knowledge due to stage fright. To curb this, I stood next to them throughout their presentation and also offered a glass of water. I had warned my learners before the presentation about the possibility of this occurring and gave a stern look (nonverbal warning) to those learners who started behaving inappropriately.

Another significant factor was that all study activities were conducted in the afternoon, which limited our ability to organise a field trip to the sea. We were mindful of the potential challenges of learners returning home late, which prevented us from incorporating this experiential learning opportunity.

If I were to conduct this study again, I would consider holding the IKCs' presentations in natural settings to help learners build a stronger connection to the marine environment. In addition, I would plan a field trip to the sea, allowing students to experience marine conservation concepts firsthand, and making the learning more tangible and meaningful.

8.7 Personal Reflections

In 2022, I embarked on my journey toward a Master of Education (MEd) in Science Education at Rhodes University. This decision was largely inspired by my friend and colleague, Brian Shambare. Our time together at the Uitenhage Life Sciences Paper 2 marking centre in December 2019 marked a turning point in my academic aspirations. Brian was always diligently working on

his laptop after our marking sessions, and my curiosity got the better of me. When I asked him what kept him so busy despite the tiring days, he revealed that he was working on his master's data analysis. Interested, I inquired further, and Brian introduced me to his supervisor, Dr Simuja, who graciously explained the entire process of applying for the programme. Initially, I planned to begin my studies in 2020, but due to a late application, I had to wait until 2021. Unfortunately, my application did not go through, and it took the entire year for me to finally be accepted.

I did not receive any formal notification of my acceptance, and it was not until I received an email from Mthembu on January 31, 2022, with the subject "orientation meeting" that I realised I had been accepted. I joined the Google meeting, where the idea of IK was introduced by Mthembu and Ndlovu. The concept resonated with me deeply, and I immediately began working on my research topic. The first half of 2022 was a period of intense motivation and progress. However, in July, I made the decision to move to the UK to teach, which introduced new challenges. Settling into a new country while continuing my studies proved to be overwhelming, and I contemplated quitting. Yet, every time I grew too silent, I would receive an email from Mthembu, inquiring about my wellbeing and subtly asking about the progress of my proposal. His concern was echoed by my fellow students, particularly Rhadebe, who reached out to encourage me. This support restored my determination, and I resumed my work with renewed strength.

My proposal was initially rejected, which dealt a significant blow to my motivation. I considered giving up once more, but Mthembu encouraged me to address the reviewers' comments and resubmit. When my proposal was finally accepted, it reignited my enthusiasm. The continuous encouragement from my supervisor and the support of my peers were instrumental in keeping me on track. Without the unwavering support of the IK family, I might have abandoned the programme in 2023.

Despite the challenges I faced, this study has been a transformative experience, both professionally and personally. It has deepened my understanding of the integration of IK into science education and inspired me to integrate IK into my teaching. The process has also improved my confidence in speaking isiXhosa, highlighting the importance of using learners' native languages to enhance their understanding. The love, care and support I received from Prof. Ken, Dr Mutanho and my fellow students were profound, teaching me the value of checking in on loved ones.

Finally, this study has instilled in me a deeper appreciation for Ubuntu. The cooperation and wisdom shared by the IKCs were invaluable. Their willingness to contribute to my research, despite their busy schedules, was truly touching. In my language, we say '*Kusatenda uroyi'*, which means those who cannot acknowledge the help they receive from others are considered ungrateful. I want to express my heartfelt gratitude to everyone who contributed to the success of this study. It was especially heartwarming to know that the IKCs were proud to share their knowledge with the learners and wanted to be visibly associated with the success of this study.

8.8 Conclusion

The primary objective of this study was to mobilise marine IK to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation. The study sought to uncover the factors that enable or constrain learner engagement and comprehension both before and after the integration of IK. By tapping into the expertise of IKCs, the study provided learners with a unique opportunity to connect their home knowledge with the scientific concepts taught in school.

The presentations by the IKCs served as a catalyst, motivating learners and helping them bridge the gap between traditional knowledge and modern science. The findings of this study demonstrated that integrating IK into the teaching of science not only enhances learner participation and engagement but also fosters meaningful learning experiences. The IKCs' contributions, combined with the exemplar lesson that integrated learners' IK, significantly stimulated learner talk and improved their sense making of marine biodiversity conservation.

The study highlighted the potential of IK to enrich the educational experience by making learning more relevant and culturally significant for the learners. This approach not only validated the learners' sociocultural backgrounds but also showed that IK could be a powerful tool in promoting active learning and a deeper understanding of scientific concepts. Overall, the study highlighted the importance of integrating IK into the curriculum to create a more inclusive and effective learning environment.

References

Alvesson, M., & Sköldberg, K. (2009). *Reflexive methodology – new vistas for qualitative research* (2nd ed.). Sage.

Aikenhead, G. S. (1996). Science education: Border crossing into the subculture of science. *Studies in Science Education, 27*(1), 1-52.

Aikenhead, G. S., & Jegede, O. J. (1999). Cross-cultural science education: A cognitive explanation of a cultural phenomenon. *Journal of Research in Science Teaching, 36*, 269-287.

Agrawal, A. (1995). Dismantling the divide between indigenous and scientific knowledge. *Development and Change, 26*(3), 413–439.

Ahied, M., Fikriyah, A., Rosidi, I., & Muharami, L. K. (2020). Activating students' prior knowledge of basic science concepts on animal and human systems and organs. *Biosfer Jurnal Pendidikan Biologi, 13*(2), 280-291.

Aikenhead, G. S., & Ogawa, M. (2007). Indigenous knowledge and science revisited. *Cultural Studies of Science Education*, 2(3), 539-620.

Aikenhead, G. S., & Michell, H. (2011). *Bridging cultures: Indigenous and scientific ways of knowing nature.* Pearson Canada.

Alexander, R. (2008). *Towards dialogic teaching: Rethinking classroom talk*. Dialogos.

Archibald, J. (2008). *Indigenous storywork: Educating the heart, mind, body, and spirit.* UBC Press.

Ash, D. (2004). Reflective scientific sense-making dialogue in two languages: The science in the dialogue and the dialogue in science. *Science Education, 88*, 855-884.

Asheela, E., Ngcoza, K. M., & Serry, J. (2021). The use of easily accessible resources during hands-on practical activities in rural under-resourced Namibian schools. In *School science practical work in Africa* (pp. 14-31). Routledge.

Atallah, S., Roux, L., & Gray, M. (2003). The influence of dispositions on learning: Constructive and destructive attitudes. *Journal of Educational Psychology, 45*(4), 523-534.

Atallah, F., Bryant, S. L., & Dada, R. (2010). Learners' and teachers' conceptions and dispositions of mathematics from a Middle East perspective. *US-China Education Review, 7*(8), 43-49.

Bashan, B., & Holsblat, R. (2017). Reflective journals as a research tool: The case of student teachers' development of teamwork. *Cogent Education*, *4*(1), 1374234.

Battiste, M. (2005). Indigenous knowledge: Foundations for first nations. *WINHEC: International Journal of Indigenous Education Scholarship*, 1.

Berkes, F. (1999). *Sacred ecology: Traditional ecological knowledge and resource management. Taylor & Francis.*

Berkes, F. (2008). *Sacred ecology: Traditional ecological knowledge and resource management* (2nd ed.). Taylor & Francis.

Berkes, F. (2012). *Sacred ecology* (3rd ed.). Routledge.

Berkes, F. (2018). *Sacred ecology* (4th ed.). Routledge.

Bertram, C., & Christiansen, I. (2015). *Understanding research: An introduction to reading research.* Van Schaik.

Bertram, C., & Christiansen, I. (2020). *Understanding research: An introduction to reading research* (3rd ed.). Van Schaik.

Bertrand, M., & Demps, D. (2018). Youth participatory action research findings as mirror material: Implications for advancing educational equity through formative interventions.

Mind, Culture, and Activity, 25(2), 151-163. https://doi.org/10.1080/10749039.2018.1434798

Berg, B. L. (2009). *Qualitative research methods for the social sciences*. Pearson.

Birhane, A., Isaac, W., Prabhakaran, V., Diaz, M., Elish, M. C., Gabriel, I. (2022). Power to the people? Opportunities and challenges for participatory AI. *EAAMO, 22*,1-8.

Boblett, N. (2012). Scaffolding: Defining the metaphor. *Working Papers in TESOL and Applied Linguistics, 12*, 1-16.

Bourke, B. (2014). *Positionality: Reflecting on the research process*. http://www.nova.edu/ssss/OR/OR19/

Bowers, C. (2007). Introducing eco-justice and the revitalization of the common issues into thinking about environmental education. In D. Zandvliet & D. Fisher (Eds.), *Sustainable communities, sustainable environments: The contributions of science and technology education* (pp. 47-60). Sense Publishers.

Braun, V., & Clarke, V. (2006). Using thematic analysis in Psychology. *Qualitative Research in Psychology, 3*(2), 77-101.

Brynard, D. J, Hanekon, S. X, & Brynard, P. A. (2015). *Introduction to research*. Van Schaik Publishers.

Busse, A., & Ferri, R. B. (2003). Methodological reflections on a three-step-design combining observation, stimulated recall and interview. *Zentralblatt für Didaktik der Mathematik*, *35*(6), 257-264.

Cajete, G. (2000). *Native science: A tribal approach to alternative knowledge*. Clear Light Publishers.

Chikunda, C., & Chikunda, P. (2015). Capability approach: Potential for transformative education research on gender and culture in Zimbabwe. *Cultural and Pedagogical Inquiry, 7*(2), 10-26.

Chikamori, K., Tanimura, C., & Ueno, M. (2019). Transformational model of education for sustainable development (TMESD) as a learning process of socialization. *Journal of Critical Realism*. https://doi.org/10.1080/14767430.2019.1667090

Chilisa, B. (2012). *Indigenous research methodologies*. Sage.

Cohen, L., Manion, L., & Morrison, K. (2011). *Research methods in education* (7th ed.) Routledge.

Cohen, L., Manion, L., & Morrison, K. (2018). *Planning educational research: Research methods in Education.* Routledge.

Cole, M. (1988). The second generation of cultural-historical activity theory: Addressing diversity and external influences. *Journal of Educational Psychology, 80*(3), 245-259.

Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (4th ed.). Pearson Education.

Creswell, J. W. (2014). *Research design*. Sage.

Creswell, J. W. (2016, March). *Advances in mixed methods research*. Paper presented at the 18th CAQD conference, Berlin, Germany.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches.* Sage

Cardinale, B., Duffy, J., & Gonzalez, A. (2012). Biodiversity loss and its impact on humanity. *Nature, 486*, 59-67.

Chan, K. W. (2011). Conceptions of learning and knowledge in education: The role of culture and experience. *Educational Research Review, 6*(2), 202-213.

Cinner, J. E., McClanahan, T. R., MacNeil, M. A., Graham, N. A. J., Daw, T. M., Mukminin, A., Feary, D. A., Rabearisoa, A. L., Wamukota, A., Jiddawi, N. J., Campbell, S. J., Baird, A. H., Januchowski-Hartley, F. A., Hamed, S., Laharil, R., Morove, T., & Kuangel, J. (2012).

Co-management of coral reef social-ecological systems. *Proceedings of the National Academy of Sciences*, *109*(48), 1952-1960.

Cohen, L., Manion, L., & Morrison, K. (2018). *Planning educational research: Research methods in education.* Routledge.

Cooper, C. R. (2014). Cultural brokers: How immigrant youth in multicultural societies navigate and negotiate their pathways to college identities. *Learning, Culture and Social Interaction, 3*, 170-176

Cooper, C. R., Denner, J., & Lopez, E. M. (1999). Cultural brokers: Helping Latino children on pathways toward success. *The Future of Children, 9*, 51-57.

Crick, R. D., & Yu, G. (2008). Assessing learning dispositions: is the effective lifelong learning inventory valid and reliable as a measurement tool? *Educational Research, 50*(4), 387402.

Darrah, R. (2023). Marine conservation: Safeguarding oceans, aquatic life, and ecosystems. *Journal of Environmental Science and Marine Conservation, 37*(1), 99-112. https://doi.org/10.1234/jesmc.2023.37.1.99

Davis, M., & Rangel, C. (2018). Integrating Indigenous perspectives in biodiversity conservation: Challenges and opportunities. *Journal of Environmental Education and Sustainability, 24*(3), 145-160. https://doi.org/10.1080/1096825X.2018.1431051

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

Dei, G. J. S. (2000). Rethinking the role of indigenous knowledge in the academy. *International Journal of Inclusive Education*, *4*(2), 111-132.

Department of Basic Education. (2011). *National Curriculum Statement (NCS). Grades R-12: Curriculum and Assessment Policy Statement (CAPS) for Natural Sciences*. Government Printers.

Department of Basic Education. (2023). *NSC exam results: School subject report*. Government Printers. https://www.education.gov.za/Portals/0/Documents/Reports/2021NSCReports/NSC23%20Technical%20Report.pdf?ver=2024-01-18-161615-123

DeMunck, V. C., & Sobo, E. J. (Eds) (1998). *Using methods in the field: A practical introduction and casebook.* AltaMira Press.

DeWalt, K. M., & DeWalt, B. R. (1998). Participant observation. In H. R. Bernard (Ed.), *Handbook of methods in cultural anthropology* (pp. 259-300). AltaMira Press.

Dong, A., Siu-Yong, M., & King, R. B. (2020). How does prior knowledge influence learning engagement? The mediating roles of cognitive load and help-seeking. *Frontiers in Psychology, 11*, 591203.

Driver, R., Guesne, E., & Tiberghien, A. (Eds.). (1994). *Beliefs, misconceptions, and understanding*. Cambridge University Press.

Dudley, N. (Ed.). (2008). *Guidelines for applying protected area management categories*. International Union for Conservation of Nature (IUCN).

Duffy, J. E. (2003). Biodiversity loss, trophic skew and ecosystem functioning. *Ecology Letters, 6*(8), 680-687.

Engeström, Y. (1987). *Learning by expanding: An activity theoretical approach to developmental research*. Orienta-Konsultit.

Engeström, Y. (1999). *Innovative learning in work teams: Analyzing cycles of knowledge creation in practice.* Cambridge University Press.

Engeström, Y. (2001). Expansive learning at work: towards an activity-theoretical reconceptualization. *Journal of Education and Work, 14*(1), 133-156.

Engeström, Y. (2015). *Learning by expanding: An activity-theoretical approach to develop mental research.* Cambridge University Press.

Eun, B. (2008). Making connections: Grounding professional development in the developmental theories of Vygotsky. *The Teacher Educator, 43*(2), 134-155.

Fakudze, C. (2021). The influence of local worldview presuppositions on learners' conceptions of selected Mechanics topics. *South African Journal of Education, 41*(2), 1-11.

Finlay, L. (2002). "Outing" the researcher: The provenance, process, and practice of reflexivity. *Qualitative Health Research, 12*(4), 531-545.

Fox-Turnball, W. (2009). Stimulated recall using autography: A method for investigating technology education. *Proceedings of the pupil's attitude towards technology conference (PATT-22)*, 204-217.

Galam, R. G. (2015). Gender, reflexivity, and positionality in male research in one's own community with Filipino seafarers' wives. *Forum, Qualitative Social Research, 16*(3). https://doaj.org/article/007a279a8d7a48e491072626de54172b

Gay, G. (2010). *Culturally responsive teaching: Theory, research, and practice* (2nd ed.). Teachers College Press.

Gay, L. R, Miles, G. E., & Airasian, P. (2011). *Educational research: Competencies for analysis and applications* (10th ed.). Pearson Education International.

Glasson, G.E., Mhango, N., Phiri, A., & Lanier, M. (2010). Sustainability science education in Africa: Negotiating indigenous ways of living with nature in the third space. *International Journal of Science Education, 32*(1), 125-141.

Göker, S. D. (2016). Use of reflective journals in development of teachers' leadership and teaching skills. *Universal Journal of Educational Research*, *4*(12A), 63-70.

Garcia, S. M., Zerbi, A., Aliaume, C., Do Chi, T., & Lasserre, G. (2003). *The ecosystem approach to fisheries: Issues, terminology, principles, institutional foundations, implementation, and outlook*. FAO Fisheries Technical Paper No. 443. Food and Agriculture Organization of the United Nations.

Godlo, L. P. (2024). *Making sense of the topic of conservation of heat energy: Using traditional brick making in a Grade 7 Natural Sciences class in a rural school* [Unpublished master's thesis]. Rhodes University.

Govender, N. (2014). Re-envisioning pedagogy for African Higher Education: Students' status of science and IKS via argumentation discourses. *Alternation Special Edition, 12*, 358-384.

Graven, M. (2012). The evolution of an instrument for accessing early learning mathematical dispositions. In *Early childhood educational research and development week programme proceedings* (pp. 53-55). Rhodes University.

Gwekwerere, Y. (2016). Schooling and the African child. In G. Emeagwali & E. Shizha (Eds.), *African indigenous knowledge and the sciences: Journeys into the past and present* (pp. 33-46). Sense Publishers.

Halpern, B. S., et al. (2015). Spatial and temporal changes in cumulative human impacts on the world's ocean. *Nature Communications, 6*, 7615. https://doi.org/10.1038/ncomms8615

Handayani, R. D., Wilujeng, I., & Prasetyo, Z. K. (2018). Elaborating indigenous knowledge in science curriculum sustainability. *Journal of Teacher Education for Sustainability, 20*(2), 74-88.

Hart, M. A. (2010). Indigenous worldviews, knowledge, and research: The development of an indigenous research paradigm. *Journal of Indigenous Social Development, 1*(1A).

Harvard Graduate School of Education. (n.d.). *Activating prior knowledge: Connecting students' experiences to class concepts.* https://instructionalmoves.gse.harvard.edu/activating-prior-knowledge-connecting-students-experiences-class-concepts

Hatcher, A., Bartlett, C., Marshall, A., & Marshall, M. (2009). Two-eyed seeing in the classroom environment: Concepts, approaches and challenges. *Canadian Journal of Science, Mathematics and Technology Education, 9*(3), 141-153.

Hatcher, A., Bartlett, C., Marshall, M., & Marshall, A. (2017). Two-eyed seeing: A framework for understanding indigenous and non-indigenous perspectives in science education. *Canadian Journal of Science, Mathematics and Technology Education, 17*(3), 366-381. https://doi.org/10.1080/14926156.2017.1341733

Hodson, D. (2009). *Teaching and learning about science: language, theories, methods, history, traditions and values.* Sense Publishers.

Holmes, A. G. D. (2020). Researcher positionality: A consideration of its influence and place in qualitative research: A new researcher guide. *Shanlax International Journal of Education, 8*(4), 1-10.

Horsthemke, K., & Schäfer, M. (2007). Does indigenous knowledge have a place in the South African curriculum? *Journal of Education*, 41, 29-48.

Horsthemke, K., & Schäfer, M. (2008). Does indigenous knowledge have a place in the South African curriculum? *Journal of Education*, *43*, 57-84.

Howie, S. J. (2011). *Mathematics and science performance in grade 8 in South Africa 1998/1999 TIMSS-R*. Human Social Research Council.

John- Steiner, V., & Mahn, H. (1996). Sociocultural approaches to learning and development: *A Vygotskian framework. Educational Psychologist, 31*(3/4), 191-206.

Ismail, N., Ismail, K., & Mohamad Aun, N. S. (2017). *The role of scaffolding in problem solving skills among children.* Department of Psychology and Human Development, Faculty of Social Sciences and Humanities, National University of Malaysia.

Ivana, F. (2022). *How to overcome cultural and language barriers in the workplace*. Study Smarter.

Kakambi, W. M. (2020). *Using the indigenous technology of dyeing and weaving African baskets as a cultural tool to mediate learning of chemical and physical changes* [Unpublished master's thesis]. Rhodes University.

Kibirige, I., & van Rooyen, H. (2006). Enriching science teaching through the inclusion of indigenous knowledge. In J. de Beers & H. van Rooyen (Eds.), *Teaching science in the OBE classroom.* Macmillan.

Kim, H., Anderson, C. W., & Nguyen-Jahiel, K. (2018). Teaching science through dialogue: Focus on learner talk. *Journal of Science Teacher Education*, *29*(3), 222-241.

Kivunja, C., & Kuyini, A. B. (2017). Understanding and applying research paradigms in educational contexts. *International Journal of Higher Education, 6*(5), 26. https://doi.org/10.5430/ijhe.v6n5p26

Klein, J. (2011). Indigenous knowledge and education – the case of the Nama people in Namibia. *Education as Change, 15*(1), 81-94. https://doi.org/10.1080/16823206.2011.554847

Kraus, S. F. (2023). The method of observation in science education: Characteristics dimensions from the education perspective. *Sci & Educ*. https://doi.org/10.1007/s11191-023-00422-x

Kuhlane, Z. (2011). *An investigation into the benefits of integrating learners' prior everyday knowledge and experiences during the teaching and learning of acids and bases in Grade 7: A case study* [Unpublished master's thesis]. Rhodes University.

Kuhnlein, H. V., Erasmus, B., Spigelski, D., & Burlingame, B. (2013). *Indigenous peoples' food systems and well-being: interventions and policies for healthy communities*. Food and Agriculture Organization of the United Nations (FAO).

Lavallée, L. F. (2009). Practical application of an indigenous research framework and two qualitative indigenous research methods: Sharing circles and Anishnaabe symbol-based reflection. *International Journal of Qualitative Methods*, *8*(1), 21-40.

Le Grange, L. (2007). Integrating western and indigenous knowledge systems: The basis for effective science education in South Africa? *Int Rev Educ, 53*, 577-591.

Le Grange, L., Du Preez, P., Ramrathan, L., & Blignaut, S., (2020). Decolonising the university curriculum or decolonial-washing? A multiple case study. *Journal of Education, 80*, 25-48.

Leontiev, A. N. (1978). *Activity, consciousness, and personality*. Prentice-Hall.

Liveve, A. K. (2022). *Revitalisation and indigenisation of the science curriculum through drum making, drumming, music and dance* [Unpublished doctoral thesis]. Rhodes University.

Liou, P-Y., & Hung, Y-C. (2015). Statistical techniques utilized in analyzing PISA and TIMSS data in science education from 1996 to 2013: A methodological review. *International Journal of Science and Mathematics Education, 13*, 1449-1468.

Luehmann, A. (2009). Students' perspectives of a science enrichment programme: Out-of school inquiry as access. *International Journal of Science Education, 31*, 1831-1855. https://doi.org 10. 1080/09500690802354195

Lyle, J. (2003). Stimulated recall: A report on its use in in naturalistic research. *Journal of Research in Science and Teaching, 41*(4), 370-391.

Maitlis, S., & Christianson, M. K. (2014). Sensemaking in organizations: Taking stock and moving forward. *Academy of Management Annals, 8*(1), 57-125. https://doi.org/10.1080/19416520.2014.873177

Mavhunga, F., & Kibirige, I. (2018). Tapping the tacit knowledge of playfield swings to learn physics: A case study of childhood reflections by pre-service teachers. *African Journal of Research in Mathematics, Science and Technology Education, 22*(2), 221-230.

Mavuru, L., & Dudu, W. T. (2021). Advances in inquiry-based science education in Zimbabwean schools. In U. Ramnarain (Eds.), *School science practical work in Africa. Experiences and challenges.* Routledge.

Mavuru, L., & Ramnarain, U. (2017). Teachers' knowledge and views on the use of learners' socio-cultural background in teaching natural sciences in grade 9 township classes. *African Journal of Research in Mathematics, Science and Technology Education, 21*(2), 176-186.

Mavuru, L., & Ramnarain, U. (2020). Learners' socio-cultural backgrounds and science teaching and learning: A case study of township schools in South Africa. *Cultural Studies of Science Education,* 1-29.

Mazzocchi, F. (2006). Western science and traditional knowledge: despite their variations, different forms of knowledge can learn from each other. *EMBO Reports*, 7(5), 463-466.

Mayana, X. (2020). *Exploring affordances and hindrances when indigenous knowledge is integrated in the topic on waves and sound in a grade 10 Physical Sciences township class* [Unpublished master's thesis]. Rhodes University.

McGregor, D. (2004). Coming full circle: Indigenous knowledge, learning, and education. In D. P. Battiste (Ed.), *Reclaiming Indigenous voice and vision* (pp. 1-19). UBC Press.

McKinley, E., & Stewart, G. (2012). Indigenous science education in Aotearoa New Zealand. *Cultural Studies of Science Education*, *7*(2), 549-577

McMillen, D., Jones, P., & Taylor, M. (2014). Ecological balance and traditional knowledge in marine conservation. *Marine Ecology and Conservation, 18*(2), 101-112

Mercer, N. (2000). *Words and minds: How we use language to think together*. Routledge.

Merriam, S. B. (1998). *Qualitative research and case study applications in education* (2nd ed.). Jossey-Bass.

Merriam, S. B., & Tisdell, E. J. (2015). *Qualitative research: A guide to design and implementation*. John Wiley & Sons.

Metz, T. (2022). Ubuntu: A moral theory of human relationships. *Philosophical Studies*, *179*(1), 25-43.

Michie, M., Hogue, M., & Rioux, J. (2022). Two-ways thinking and two-eyed seeing as ways of implementing indigenous perspectives in the science education curriculum. *Cultural Studies of Science Education, 17*(1), 83-100. https://doi.org/10.1007/s11422-022-10077-7

Michie, M., Hogue, M., & Rioux, J. (2023). Two-ways thinking and two-eyed seeing as ways of implementing indigenous perspectives in the science education curriculum. *Disciplinary and Interdisciplinary Science Education Research, 5*(23). https://doi.org/10.1186/s43031-023-00084-3

Mill, G. E. (2011). *Action research: A guide for the teacher researcher* (4th ed.). Pearson Education.

Moberg, F., & Folke, C. (1999). Ecological goods and services of coral reef ecosystems. *Ecological Economics, 29*(2), 215-233. https://doi.org/10.1016/S0921-8009(99)00009-9

Morselli, D. (2019). Understanding human action through cultural-historical activity theory: A contemporary perspective. *Journal of Activity Theory, 15*(2), 45-62.

Mosimege, M. D., & Onwu, G. (2004). Indigenous knowledge systems and science education. *Journal of the Southern African Association for Research in Mathematics, Science and Technology Education, 8*, 1-12.

Msimanga, A., & Lelliot, A. (2014). Talking science multilingual contexts in South Africa: Possibilities and Challenges of engagement in learners' home language in high school classrooms. *International Journal of Science Education, 36*(7), 1159-1183.

Mukwambo, M., Ngcoza, K., & Chikunda, C. (2014). Africanisation, ubuntu and IKS: A learner centred approach. *Schooling, Society and Inclusive Education: An African Perspective*, 65-80.

Mushayikwa, E., & Ogunniyi, M. (2011, January). *Modelling the integration of IKS into the teaching and learning of science.* [Conference Paper] In Proceedings from the 19th conference of the Southern Association of Research in Science, Mathematics and Technology Education (pp. 408-425).

Mutanho, C. (2021). *Exploring indigenisation of the science curriculum at a higher education institution: Affordances and hindrances* [Unpublished doctoral thesis]. Rhodes University.

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

Nakashima, D. J., Galloway McLean, K., Thulstrup, H. D., & Castillo, A. (2012). *The role of indigenous knowledge in disaster risk reduction and resilience*. UNESCO, Paris.

Nikodemus, K. S. (2017). *Exploring how Grade 11 Physical Science learners make sense of the concept of rates of reactions through the inclusion of the indigenous practice of making Oshikundu* [Unpublished master's thesis]. Rhodes University.

Norton, B. (2000). *Identity and language learning: Gender, ethnicity and educational change*. Longman/Pearson Education.

Nyamakuti, N. M. (2020). *Exploring the effect of the indigenous technology of oil extraction on Grade 10 Biology learners' perspectives and sense making of enzymes* [Unpublished master's thesis]. Rhodes University.

Nyika, R. (2017). Views and experiences of Gweru rural primary school teachers on integrating indigenous knowledge system in the teaching and learning of environmental science in Zimbabwe. *Scholars Journal of Art, Humanities and Social Sciences, 5(*4A), 280-286.

Ngulube, P. (2015). Qualitative data analysis and interpretation: systematic search for meaning. In *Addressing research challenges: making headway for developing researchers* (pp. 131-156).

Oakley, L. (2004). *Cognitive development*. Routledge.

Okanlawon, A. E. (2017). Teaching chemistry to students with learning difficulties: exemplary adaptive instructional practices of experienced teachers. *IFE PsychologIA: An International Journal*, *25*(2), 262-279.

O'Leary, Z. (2014). *The essential guide to doing your research project* (2nd ed.). Sage.

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

Onwu, G. O. M., & Mufundirwa, C. (2020). A two-eyed seeing context-based approach for incorporating indigenous knowledge into school science teaching. *African Journal of Research in Mathematics, Science and Technology Education, 24*(2), 229-240.

Pimm, S.L. (2021). What is biodiversity conservation? *Ambio, 50*, 976-980

Primack, R. B. (2014). *Essentials of conservation biology* (6th ed.). Sinauer Associates.

Reddy, V. Zuze, T. L, Visser, M., Winnaar, L., Juan, A., Prinsloo, C. H., Arends, F., & Rogers, S. (2015). *Beyond benchmarks: What twenty years of TIMMS data tell us about South African education*. HSRC Press.

Richardson, J. T. E. (2011). Approaches to studying conceptions of learning and learning styles in higher education. *Learning and Individual Difference, 21*, 288-293.

Roberts, C. M. (2001). Marine protected areas and fishery management: A global overview. *Environmental Conservation, 28*(4), 288-296.

Rojas-Drummond, S., Torreblanca, O., & Pedraza, H. (2013). Dialogic scaffolding': Enhancing learning and understanding in collaborative contexts. *Learning, Culture and Social Interaction, 2*(1), 11-21.

Roschelle, J. (1995). Learning in interactive environments. Prior knowledge and new experience. In J. Falk & L. Dierking (Eds.), *Public institutions for personal learning: Establishing a research agenda* (pp. 37-51). American Association of Museums.

Sala, E., & Knowlton, N. (2006). Global marine biodiversity trends. *Annual Review of Environment and Resources, 31*, 93-122.

Sannino, A., Engeström, Y., & Lemos, M. (2016). Formative interventions for expansive learning and transformative agency. *Journal of the Learning Sciences, 25*(4), 599-633. doi.org/10.1080/10508406.2016.1204547

Scoones, I. (2009). Livelihoods perspectives and rural development. *The Journal of Peasant Studies, 36*(1), 171-196.

Seehawer, M. (2018). South African science teachers' strategies for integrating Indigenous and Western knowledges in their classes: Practical lessons in decolonisation. *Educational Research for Social Change, 7*(Special Issue), 91-110. Retrieved from http://ersc.nmmu.ac.za

Seehawer, M., & Breidlid, A. (2021). Dialogue between epistemologies as quality education: Integrating knowledges in Sub-Saharan African classrooms to foster sustainability learning and contextually relevant education. *International Journal of Educational Development*, *86*, 102470. https://doi.org/10.1016/j.ijedudev.2021.102470

Seehawer, M., Nuntsu, S. N., Mashozhera, F., Ludwane, A., Speckman, M. (2022). Creating a sense of belonging: Enabling transformative learning through participatory research in an Ubuntu paradigm. In A. Nicolaides et al. (Eds.) *The Palgrave handbook of learning for transformation* (pp. 469-481). Routledge.

Seehawer, M. (2023). Ubuntu as a relational philosophy in education: Fostering inclusivity and empathy. *Journal of African Philosophy*, *14*(3), 45-59.

Shilomboleni, H (2022). *Mobilising the indigenous technologies of making oshikundu and preserving ombidi to support Grade 10 Biology learners to make sense of the concepts of diffusion and osmosis* [Unpublished master's thesis]. Rhodes University.

Shinana, E., Ngcoza, K. M., & Mavhunga, E. (2021). Development of teachers' PCK for a scientific inquiry-based teaching approach in Namibia's rural schools. *African Journal of Research in Mathematics, Science and Technology Education, 25*(1), 1-11.

Shizha, E. (2007). Critical analysis of problems encountered in incorporating indigenous knowledge in science teaching by primary school teachers in Zimbabwe. *The Alberta Journal of Educational Research, 53*(3), 302-319.

Shizha, E. (2009). Indigenous knowledge and science education: A framework for integration. *International Journal of Educational Development, 29*(4), 379-388.

Shizha, E. (2013). *Indigenous discourses on knowledge and development in Africa*. Routledge.

Simasiku, F.S. (2022). *Leveraging a peer-learning community and expert community members in the integration of indigenous knowledge into learning and teaching of Grade 10 Chemistry on the rate of reactions* [Unpublished doctoral thesis]. Rhodes University.

Sinay, S. (2024). The impact of human activities on marine biodiversity loss. *Ocean and Environmental Studies, 42*(4), 215-228. https://doi.org/10.5678/oes.2024.42.4.215

Southerland, S. A. (2000). Epistemic universalism and the shortcoming of curricular multicultural science education. *Science and Education, 9*, 289-307.

Snively, G., & Corsiglia, J. (2008). Discovering Indigenous science: Implications for teaching and learning. *Canadian Journal of Science, Mathematics and Technology Education, 8*(2), 383-395. https://doi.org/10.1080/14926150802289991

Stott, D. (2016). Making sense of the ZPD: An organising framework for mathematics education research. *African Journal of Research in Mathematics, Science and Technology Education, 20*(1), 25-34.

Taber, K. S. (2020). Mediating learning leading development in the social development theory of Lev Vygotsky. In B. Akpan & T. Kennedy (Eds.), *Science education theory and practice: An introductory guide to learning theory* (pp. 277-291). Springer.

Taylor, N. (1999). Curriculum 2005: Finding a balance between school and everyday knowledges. In N. Taylor & P. Vinjevold (Eds.), *Getting learning right: Report of the president's education initiative research project* (pp. 105-130). Joint Education Trust.

Taylor, D. L., & Cameron, A. (2016). Valuing IKS in successive South African physical sciences curricula. *African Journal of Research in Mathematics, Science and Technology Education*, *20*(1), 35-44.

Thomas, G. (2013). *How to do your research project: A guide for students in education and applied social sciences* (2nd ed.). Sage.

Thompson, A. G. (1992). Teachers' beliefs and conceptions: A synthesis of the research. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning: A project of the National Council of Teachers of Mathematics* (pp. 127-146). Macmillan Publishing Co, Inc.

Tsai, C. C., & Kuo, Y. C. (2008). Conceptions of learning science and their influence on learning. *International Journal of Science Education, 30*(11), 1535-1550.

Tutu, D. (2021). *The essence of Ubuntu: Ethics and philosophy in African thought*. Ubuntu Books.

Tyeda, N. (2024). *Mediating learning of nutrition through using traditional food processing and preservation to grade 6 rural school learners* [Unpublished master's thesis]. Rhodes University.

United Nations Environment Programme (UNEP). (2020). *Marine and coastal biodiversity*. Nairobi: United Nations Environment Programme. Retrieved from https://www.unep.org/resources/report/marine-and-coastal-biodiversity

Vygotsky, L. S. (1978). *Mind in society: Interaction between learning and development*. Harvard University Press.

Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. (2005). Organizing and the process of sense making. *Organization Science, 16*(4), 409-421.

Woolfolk, A., Hughes, M., & Walkup, V. (2008). *Psychology in education*. Pearson.

Wyatt, T. R., de Dousa, E. B. C., & Mendenhall, S. C. (2017). Professional development as a process of cultural brokering: Positioning coaches as cultural brokers. *Journal of Educational Research and Practice, 7*, 95-110.

Yamagata-Lynch, L. C. (2010). *Activity systems analysis methods: Understanding complex learning environments.* Springer.

Zohar, A., & Dori, Y. J. (2003). Higher order thinking skills and low achieving students: Are they mutually exclusive? *Journal of the Learning Sciences, 12*, 145-183.

Appendices

Appendix A1: Ethical Clearance

RHODES UNIVERSITY
Where leaders learn

Education Faculty Research Ethics Committee
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28 March 2024

Prof Kenneth Ngcoza

Education Department

K.Ngcoza@ru.ac.za

Dear Prof Kenneth Ngcoza and Mr Aswad Sibanda

Re: Exploring the influence of indigenous knowledge on grade 11 Life Sciences learners' sense making of marine biodiversity conservation.

APPLICATION NUMBER: 2023-7240-8066

This letter confirms that your research ethics application has been reviewed and **APPROVED** by the Education Faculty Research Ethics Committee (EF-REC). Your permission letter(s) where applicable have been received and you are free to proceed with your study.

Approval is granted for 1 year. An annual ethics renewal application needs to be submitted each year. Should any substantive change(s) be made during the research process, that may have ethical implications, you should notify the Education Faculty REC Chair via email. This includes changes in investigators. The REC Chair will advise as to whether a new application is necessary.

Do keep this clearance letter secure and accessible throughout your study and after its completion. It will be needed when a thesis is examined and when publications are submitted to journals.

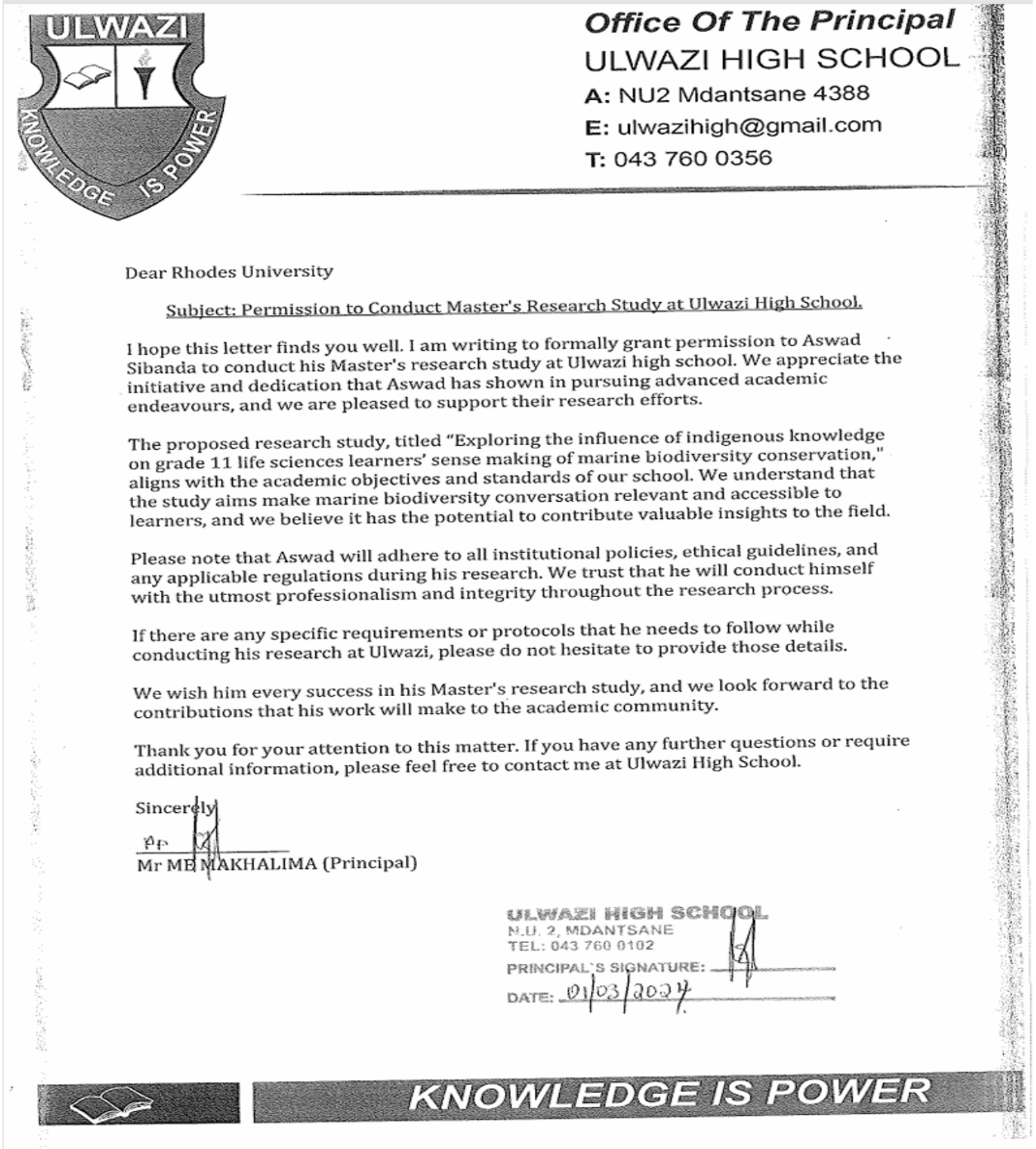
Please also submit a brief report to the REC Chair on the completion of the research. This can be done via email. The purpose of this report is to indicate whether the research was conducted successfully and whether any ethics-related matters arose that the committee should be aware of, in order to guide future studies.

Sincerely,

Prof Mags Blackie

Chair: Education Faculty Research Ethics Committee

Appendix A2: Letter of approval from the Principal of Ulwazi High School



ULWAZI
KNOWLEDGE IS POWER

Office Of The Principal
ULWAZI HIGH SCHOOL
A: NU2 Mdantsane 4388
E: ulwazihigh@gmail.com
T: 043 760 0356

Dear Rhodes University

Subject: Permission to Conduct Master's Research Study at Ulwazi High School.

I hope this letter finds you well. I am writing to formally grant permission to Aswad Sibanda to conduct his Master's research study at Ulwazi high school. We appreciate the initiative and dedication that Aswad has shown in pursuing advanced academic endeavours, and we are pleased to support their research efforts.

The proposed research study, titled "Exploring the influence of indigenous knowledge on grade 11 life sciences learners' sense making of marine biodiversity conservation," aligns with the academic objectives and standards of our school. We understand that the study aims make marine biodiversity conversation relevant and accessible to learners, and we believe it has the potential to contribute valuable insights to the field.

Please note that Aswad will adhere to all institutional policies, ethical guidelines, and any applicable regulations during his research. We trust that he will conduct himself with the utmost professionalism and integrity throughout the research process.

If there are any specific requirements or protocols that he needs to follow while conducting his research at Ulwazi, please do not hesitate to provide those details.

We wish him every success in his Master's research study, and we look forward to the contributions that his work will make to the academic community.

Thank you for your attention to this matter. If you have any further questions or require additional information, please feel free to contact me at Ulwazi High School.

Sincerely

Mr ME MAKHALIMA (Principal)

ULWAZI HIGH SCHOOL
N.U. 2, MDANTSANE
TEL: 043 760 0102
PRINCIPAL'S SIGNATURE:
DATE: 01/03/2024

KNOWLEDGE IS POWER

Appendix B1: Letter to The Eastern Cape Department of Education

The Director: Corporate Planning, Monitoring and Research Coordination
Eastern Cape Department of Education
Private Bag X 0032
Bisho
5605

Dear Sir/Madam

Re: Request for Permission to Conduct Educational Research with Grade 11 learners at Ulwazi High School in East London Buffalo City Municipality.
I am Aswad Sibanda (Student number:22s7360), a part-time student doing Masters in Science Education with Rhodes University, South Africa and a former Life Sciences teacher at East London science College from February 2012 to July 2022 when I relocated to the United Kingdom. I hereby humbly request your permission to conduct research study with Grade 11 Life Sciences learners at Ulwazi High School which is in your District. I plan to conduct the study in August 2024. The purpose of the study is to mobilise marine Indigenous Knowledge to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation. In this study learners will be required to interact with the three community members who will be presenting about indigenous knowledge related to traditional ways marine biodiversity conservation in class.

I will seek permission from the community members, parents or guardians of the learners and agreement from the learners to participate in the research. I will also work with a Life Sciences teacher who will be my critical friend in this study. She will observe the community members who will share traditional ways of marine biodiversity conservation. She will also be requested to indicate that she agrees to be part of the study and that she understands what her role will be.

I would like to assure your office that, should I be granted permission, the Rhodes University's research ethics will apply throughout the process of the study. The identity of participants and their views will be treated with a high degree of confidentiality.

Your consideration in this regard will be highly appreciated.

Yours Sincerely

Aswad Sibanda (Master's student/scholar, Rhodes University)

Rhodes University, Research Office, Ethics
Ethics Coordinator: ethics-commitee@ru.ac.za
Telephone: +27 (0) 46 603 7727 f: +27 (0) 86 616 7707Room 220, Main Admin Building,
Drostdy Road, Grahamstown, 6139

Appendix B2: Letter to the District Director, Department of Education

The District Director
Eastern Cape Department of Education
Buffalo City Municipality
East London

Dear Sir/Madam

Re: Request for permission to conduct educational research with Grade 11 Life Sciences learners at Ulwazi High school.

I am Aswad Sibanda (22s7360), a Master's Student in Science Education at Rhodes University. I have been teaching in this district at East London Science College from February 2012 to July 2022 when I relocated to the United Kingdom. I hereby humbly request your permission to conduct my research study with Grade 11 Life Sciences learners, their Life Sciences teacher who will be a critical friend in this study and three community members as bearers of indigenous knowledge (IK). The purpose of this study is to mobilise marine Indigenous Knowledge to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation. This study is expected to commence in August 2024. This study is developmental as it involves mainly face-to-face sessions which include focus interviews, participatory lesson observation, learner's reflections and stimulated recall interviews. These procedures are scheduled to be conducted during and after school hours and only during Life Sciences lessons.

Written consent will be sought from all 45 Grade 11 participant learners, school principal, community members and critical friend (Life Sciences teacher), who will be in class during data gathering. Learners and community members will be the main participants, and during this process I and the critical friend will be co-learners while observing and reflecting on the proceedings.

I would like to assure your office that, should I be granted permission, the Rhodes University's research ethics will apply throughout the process of the study. The identity of participants and their views will be treated with a high degree of confidentiality.

Your consideration in this regard will be highly appreciated.

Yours Sincerely

Aswad Sibanda (Master's student/scholar, Rhodes University)

Rhodes University, Research Office, Ethics
Ethics Coordinator: ethics-commitee@ru.ac.za
Telephone: +27 (0) 46 603 7727 f: +27 (0) 86 616 7707Room 220, Main Admin Building,
Drostdy Road, Grahamstown, 6139

Appendix B3: Permission letter to the School Principal of Ulwazi High School

The School Principal
Ulwazi High School
Mdantsane
East London

Dear Sir
Subject: Request for Permission to Conduct Educational Research at Ulwazi School.
I am Aswad Sibanda (Student number:22s7360), a Master's Student in Science Education at Rhodes University and a former Life Sciences teacher at East London Science College. I hereby humbly request your permission to conduct a research study with your Grade 11 Life Sciences class and your Life Sciences teacher who will be a critical friend in this study at your school. In this study three community members who are bearers of the indigenous knowledge (IK) will also be part of the team. The purpose of this study is to mobilise marine Indigenous Knowledge to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation. This study is expected to commence in August 2024.This study is developmental as it involves mainly face-to-face sessions which include focus interviews, participatory lesson observation, learner's reflections and stimulated recall interviews. These procedures are scheduled to be conducted during and after school hours and only during Life Sciences lessons.

Written consent will be sought from all 45 Grade 11 participant learners, school principal, community members and critical friend (Life Sciences teacher), who will be in class during data gathering. Learners and community members will be the main participants, and during this process I and the critical friend will be co-learners while observing and reflecting on the proceedings.

I would like to assure your office that, should I be granted permission, the Rhodes University's research ethics will apply throughout the process of the study. The identity of participants and their views will be treated with a high degree of confidentiality.

Your consideration in this regard will be highly appreciated.

Yours Sincerely

Aswad Sibanda (Master's student/scholar, Rhodes University)

Rhodes University, Research Office, Ethics
Ethics Coordinator: ethics-commitee@ru.ac.za
Telephone: +27 (0) 46 603 7727 f: +27 (0) 86 616 7707Room 220, Main Admin Building,
Drostdy Road, Grahamstown, 6139

Appendix B4: Appendix B4: Letter to Research Participants (critical friend)

Dear (Name)

My name is Aswad Sibanda a former Life Sciences teacher at Est London Science College. I hereby humbly request that you become part of my research as a critical friend. As an experienced Life Sciences teacher, I have carefully considered you and I would like to ask you to assist me reflecting the student journal reflections during the entire period of research. The research will be conducted at your school with your Grade 11 Life Sciences learner's class. The purpose of this study is to mobilise marine Indigenous Knowledge to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation.

This study is expected to commence in August 2024.This study is developmental as it involves mainly face-to-face sessions which include focus interviews, participatory lesson observation, learner's reflections and stimulated recall interviews. These procedures are scheduled to be conducted during and after school hours and only during Life Sciences lessons. In some lessons I will be recording the proceedings so that I can review what happened in the lessons. The videos will not be published, they will only be shared with my supervisors, Mtembu and Ndlovu.

Please note that we would like to present ourselves as co-learners in this study and the purpose of this study is to generate something new and learn something that does not yet exist. Please do not hesitate to ask me for any clarification.

I henceforth request you to indicate your choice by making a tick (✓) in an appropriate box below.
Agree ☐
Not agree ☐
Signature:……..

Your consideration in this regard will be highly appreciated.

Yours Sincerely
Aswad Sibanda (Master's student/scholar, Rhodes University)

Rhodes University, Research Office, Ethics
Ethics Coordinator: ethics-commitee@ru.ac.za
Telephone: +27 (0) 46 603 7727 f: +27 (0) 86 616 7707Room 220, Main Admin Building,
Drostdy Road, Grahamstown, 6139

Appendix B5: Research Participant Informed Consent Letter

(PARTICIPANT)

PROJECT TITLE:

Bridging Traditions: Mobilising Indigenous Knowledge and Marine Biodiversity Conservation in Grade 11 Life Sciences.

Aswad Sibanda, currently Masters. student at Rhodes University, has requested my permission to participate in the above-mentioned research project.

The nature and purpose of the research project and of this informed consent declaration have been clearly explained to me in a language that I understand.

I am therefore aware that:

1. The purpose of this study is to mobilise marine Indigenous Knowledge to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation.
2. The researcher and I will be teaching the topic biodiversity conservation while integrating indigenous knowledge in our lessons. The lessons will be recorded for reflection purposes, but we will get permission from participants first.
3. I will observe the researcher and learners presenting, discussing, sharing ideas and debating while integrating IK in lessons. The lessons will take place during Life Sciences lessons and sometimes after school. I will work together with the researcher to adapt model lessons that include IK.
4. By participating in this research project, I will contribute to knowledge and understanding how the presentations have facilitated my knowledge which I will use to develop model lessons that contain IK.
5. My participation is entirely voluntary and should I at any stage wish to withdraw from further participation, I may do so without any prejudice.
6. I understand that participating in this study is voluntary and I will not be remunerated for participating.
7. There may be risks associated with my participation in the project. I am therefore aware that of the following steps:

    a) All information shared during the study is strictly confidential and will not be used for purpose other the above-mentioned research project.
    b) All the data collected will be kept in a locked office and electronic data will be kept in a computer only accessible through a secure password only known by the researcher and me.
    c) The researcher intends to publish the research findings in the form of a thesis towards a master's degree in Maths Education, and later present it in papers conferences or journal articles. However, confidentiality will be maintained.

8. Any further questions that I might have concerning the research or my participation will be answered by the Rhodes mater's student (aswadsibanda@gmail.com) or the supervisors Professor Kenneth Mlungisi Ngcoza(k.ngcoza@ru.ac.za) and Dr Chrispen Mutanho (Chrispenmutanho@gmail.com)

9. By signing this informed consent declaration, there are no legal implications.

10. A copy of this informed consent declaration will be kept in a safe place by the researcher.

I, ……have read the above information or confirm that the above information has been explained to me in a language that I understand. I am therefore aware of this document's contents. I have asked all questions that I wished to ask, and these have been answered to my satisfaction. I fully understand what is expected of me during the research.

I have not been coerced or pressurised in any way, and I understand that anonymity might not be possible because we will be co-creating knowledge in this study. I therefore voluntarily agree to participate in the above-mentioned research project.

…….. …….

Participant's signature Witness

Date …….. Date ……..

Rhodes University, Research Office, Ethics
Ethics Coordinator: ethics-committee@ru.ac.za
T: +27 (0) 46 603 7335 F: +27 (0) 82 739 4378
Room 220, Main Admin Building, Drostdy Road, Makhanda, 6139

Appendix B6: Letter To The Parent(S) / Guardian(S)

Enquiries: Aswad Sibanda
Email: aswadsibanda@gmail.com

Dear Sir/Madam

Re: Participation in research on the influence of indigenous knowledge (IK) on Grade 11 Life Sciences learners' sense making of marine biodiversity conservation.

I am Aswad Sibanda, a part-time student doing Master's in Science Education at Rhodes University and a former Life Sciences teacher at East London Science College. I hereby humbly request your permission to conduct a research study with your child who is studying at Ulwazi High School.

The purpose of this study is to mobilise marine Indigenous Knowledge to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation. Kindly be informed that participation in this study is voluntary. It is, therefore, the right of the parent(s) to decide whether his/her child should participate or not. Also, participants are free to withdraw at any time they wish to do so. The data that will be collected will not be used for other purposes apart from this study.

If you have any questions about the research, please feel free to contact me on: aswadwadsibanda@gmail.com or my supervisor Prof. Kenneth Ngcoza at k.ngcoza@ru.ac.za and Dr. Chrispen Mutanho at chrispenmutanho@gmail.com

Lastly, if you agree for your child to participate in this research, please complete the consent form below.

I.....(full name of parent/guardian, hereby confirm that I understand the contents of this document and the nature of the research. I hereby give permission to.....(name of the child) to participate in the study.

Yours Sincerely

Aswad Sibanda (Master's student/scholar, Rhodes University)

Rhodes University, Research Office, Ethics
Ethics Coordinator: ethics-committee@ru.ac.za
T: +27 (0) 46 603 7335 F: +27 (0) 82 739 4378
Room 220, Main Admin Building, Drostdy Road, Grahamstown 6139

Appendix B7: Letter to The Community Members

Enquiries: Aswad Sibanda
Email: aswadsibanda@gmail.com

Dear Sir / Madam

Re: PERMISSION LETTER: PRESENTATION AT ULWAZI HIGH SCHOOL
I am Aswad Sibanda, a part-time student doing a master's in science education at Rhodes University and a former Life Sciences teacher at East London Science College. I hereby humbly request your permission to be a research participant in my research project that I will be conducting with Grade 11 Life Sciences learners at Ulwazi High School. The focus of this study is to mobilise marine Indigenous Knowledge to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation. In this study you will be the bearer of indigenous knowledge.

I would like you to make a presentation on the traditional knowledge on marine biodiversity conservation. I would also like you to be part of interviews after the presentation on traditional techniques. These presentations will be videotaped. The purpose of this is to contextualise and enhance learning on the topic of biodiversity conservation. Informed consent will be sought from the learners and from the learners' parents or guardians. I plan to conduct research in August 2024.

Your participation in this study is completely voluntary and you can withdraw at any stage you wish. If you agree or not agree to participate kindly sign the consent form below. I am aware that there might not be complete anonymity because we will be co-creating knowledge with participants in this study, but I would like to reassure you that ethical standards will be upheld at all times

I request you to indicate your choice by making an (X) in the appropriate box below.

Agree ☐
Not agree ☐
Signature:……..

For surety you are free to contact my supervisor Prof. Kenneth M. Ngcoza at Rhodes University, email address (kngcoza@ru.ac.za)and my co- supervisor Dr Chrispen Mutanho email address (chrispenmotahno@gmail.com)

Your cooperation will be highly recommended in this regard.

Yours Sincerely
Aswad Sibanda (Master's student/scholar, Rhodes University)

Rhodes University, Research Office, Ethics
Ethics Coordinator: ethics-committee@ru.ac.za
T: +27 (0) 46 603 7335 F: +27 (0) 82 739 4378
Room 220, Main Admin Building, Drostdy Road, Grahamstown 6139

Appendix B8: Letter to Research Participants (Learner)

Dear Learner

My name is Aswad Sibanda a former Life Sciences teacher at East London Science College. I will be visiting your classroom together with three community members and your teacher to conduct a study on biodiversity conservation during Life Science Lessons.

The purpose of this study is to mobilise marine Indigenous Knowledge to support Grade 11 Life Sciences learners from a township school to talk and make sense of marine biodiversity conservation. This study is expected to commence in August 2024.This study is developmental as it involves mainly face-to-face sessions which include focus interviews, participatory lesson observation, learner's reflections and stimulated recall interviews. These procedures are scheduled to be conducted during and after school hours and only during Life Sciences lessons.

In some lessons I will be recording the proceedings so that I can review what happened in the lessons. The videos will not be published, they will only be shared with my supervisors, Mtembu and Ndlovu. You will be required to write reflections on each lesson. Also, as part of the research, I will be doing participatory observation where I will observe and record notes on what you will be learning on as well as asking you questions accordingly. Focus group interviews will also be employed but you will be required to be gender sensitive.

Please note that I will be a co-learner and the purpose of this study is to generate something new and learn something that does not yet exist. Please do not hesitate to ask me, community members or your teacher for any clarification during the study.

I henceforth request you to indicate your choice by making a tick (✓) in an appropriate box below.
Agree ☐
Not agree ☐
Signature: …….

Your consideration in this regard will be highly appreciated.

Yours Sincerely
Aswad Sibanda (Master's student/scholar, Rhodes University)

Rhodes University, Research Office, Ethics
Ethics Coordinator: ethics-commitee@ru.ac.za
Telephone: +27 (0) 46 603 7727 f: +27 (0) 86 616 7707Room 220, Main Admin Building,
Drostdy Road, Grahamstown, 6139

Appendix B9: Child Participant Assent Form

Appendix B9

CHILD PARTICIPANT'S ASSENT FORM

INFORMED CONSENT DECLARATION
(Child participant)

Project Title: Bridging Traditions: Mobilising Indigenous Knowledge and Marine Biodiversity Conservation in Grade 11 Life Sciences.

Researcher's name: Aswad Sibanda

Name of participant: _____

1. Has the researcher explained what s/he will be doing and wants you to do?

YES	NO

2. Has the researcher explained why s/he wants you to take part?

YES	NO

3. Do you understand what the research wants to do

YES	NO

4. Do you know if anything good or bad can happen to you during the research?

YES	NO

5. Do you know that your name and what you say will be kept a secret from other people?

YES	NO

6. Did you ask the researcher any questions about the research?

YES	NO

7. Has the researcher answered all your questions?

YES	NO

8. Do you understand that you can refuse to participate if you do not want to take part and that nothing will happen to you if you refuse?

YES	NO

9. Do you understand that you may pull out of the study at any time if you no longerwant to continue?

YES	NO

10. Do you know who to talk to if you are worried or have any other questions to ask?

YES	NO

11. Has anyone forced or put pressure on you to take part in this research?

YES	NO

12. Are you willing to take part in the research?

YES	NO

_____ _____

Signature of Child **Date**

Rhodes University, Research Office, Ethics
Coordinator: ethics-commitee@ru.ac.za
t: +27 (0) 46 603 7727 f: +27 (0) 86 616 7707
Room 220, Main Admin Building, Drostdy Road, Grahamstown, 6139

Appendix C: Proposed Time Frame

Table1: Proposed time frame for this study

Date	**Activity**
February 2022- March 2023	Research topic identification and writing of draft research proposal.
March - April 2022	Submission of first draft proposal for review.
May – July 2022	Amending the draft proposal.
August – September 2022	Submission of second draft research proposal.
January – February 2023	Submission of third draft research proposal.
March – May 2023	Submission of final research proposal. Designing of data gathering tools.
May -August 2023	Adjusting the proposal using feedback from EHDC. Resubmission of the research to the EHDC.
September- November 2023	Data collection and analysis.
December – January 2024	Discussion of findings.
January – February 2024	Data presentation, write-up, corrections, proofreading and submission of draft.
March 2024	Draft thesis submission to supervisors.
March –April 2024	Submission of final thesis.

Appendix D: Focus Group Interviews

Focus group interviews (Sharing Circles), questions and responses.

1. Why do you think your group chose you to represent them?
2. Why did you choose to do Life Sciences in Grade 11?
3. Tell me about your experiences of learning marine biodiversity conservation using a lesson module that integrates IK?
4. How is your knowledge from home related to science taught at school?
5. How best can Life Sciences teachers teach biodiversity conservation in your own opinion?
6. What else would you like to share with me regarding the integration of local knowledge in science?

Title: Bridging Traditions: Mobilising Indigenous Knowledge and Marine Biodiversity Conservation in Grade 11 Life Sciences.

Colour codes for sub-themes:

Sense making: Red

Value of native language in education: Blue

Social interactions: Grey

Linking Knowledge: Dark blue

IK Integration: Yellow

No shift in sense making: Pink

Understanding better: Turquoise

Positivity about learning science: Teal

Respect: Violet

Question 1: Why do you think your group chose you to represent them?	
Learner	**Responses**
L1DL	Because I show great leadership characteristics, and I know better than them.
L2MF	I am the best and I am confident with no stage fight.
L3BB	I show good leadership skills, and I am so dedicated to my schoolwork. I am also good at communicating with people.
L4RH	I am not afraid to stand in front of people as well as interacting with people.
L5MG	It is because amongst everyone in the group, I have better leadership skills and more confidence.
L6DL	Because I have deeper knowledge about marine life.

L7MF	I have perfect qualities to represent.
L8MG	They trust me and they know I am more cultural than them.
L9MK	I am confident and friendly. I am also good at public speaking.
Question 2: Why did you choose to do Life Sciences in Grade 11?	
L1DL	Because my parents want me to be a dentist, they advised me to do it.
L2MF	I wanted to learn more about humans, animals and plants in order to understand things in the world.
L3BB	It teaches us about living and nonliving things around us.
L4RH	I want to be an Agri scientist.
L5MG	It is a great subject that teaches us about the environmental problems as well as how the body works as a system.
L6DL	I want to become a doctor.
L7MF	Growing up I always wanted to be a doctor and always wanted to know more about the human body.
L8MG	I love learning about plants and animals.
L9MK	I love science and I want to change the world for the better.
Question 3: Tell me about your experiences of learning marine biodiversity conservation using a lesson module that integrates IK?	
L1DL	I found it very engaging because it connected what we learn at home with what we are taught in class. It made the concepts easier to understand since I could relate them to my everyday life.
L2MF	Well, my experience was very breathtaking because I learnt a lot of things that I did not know about marine biodiversity. For example, myths that are said about mermaids prevent people from exploiting marine life.
L3BB	I appreciated how the lesson did not just focus on facts but also on how our traditions play a role in protecting marine life. It felt more relevant to me.
L4RH	It was interesting because it felt like I was learning science in a way that respects my culture and background. I now value IK and I will make better use of it in all my subjects, especially physical sciences.
L5MG	Integrating IK in that lesson helped me see the bigger picture. It was not just about marine biodiversity but also about how our actions, guided by our knowledge, can make a difference. For example, harvesting herbal marine plants sustainably.
L6DL	The lesson made science feel less distant and more like a part of my daily life. It connected the dots between what I knew and what I needed to learn. If science was always taught like this, I could get better grades.
L7MF	I felt more involved in the lesson because it included things I was familiar with, like the fishing practices my family talks about.
L8MG	It was eye opening.
L9MK	I liked the presentations; however, I did not see any worth; it was confusing me.

Question 4: What were the most interesting things that emerged from the presentations by the indigenous knowledge custodians?	
L1DL	Taking part of the harvested fish back to the ocean as a sign of thanksgiving to the ancestors.
L2MF	Not taking more than we need from the mother nature as there are consequences for our actions.
L3BB	I found it interesting how IKCs explained the natural signs they use to predict weather and fish behaviour. For example, the bird's behaviour and sprouting of certain plants.
L4RH	How Indigenous practices like rituals and cultural practices contributed to marine biodiversity.
L5MG	I was surprised to learn about the community practices that have been passed down for generations to protect marine life. For example, the water spirits which live in certain parts of the ocean.
L6DL	Belief that ancestors are in the sea, and they can go and consult when they are facing tough times.
L7MF	The idea that our traditional ceremonies have a role in conservation was very exciting.
L8MG	I enjoyed learning about how the IKCs use their knowledge to manage resources sustainably. For example, the availability of certain bird species when the marine life is at the peak.
L9MK	The most interesting thing was how they showed us that our culture already has ways of conserving the environment.
Question 4: How is your knowledge from home related to science taught at school?	
L1DL	At home, we have always been taught that certain times of the year are not good for fishing because the fish are either breeding or too young. This is like what we learned in school about breeding seasons and how overfishing during these times can deplete fish populations.
L2MF	My family has a rule about not taking more than we need from the sea. In class, we learned about sustainable use of resources, and it clicked that this is what my family has been practicing all along.
L3BB	The traditional practices I learn at home help me see the real-life application of scientific concepts.
L4RH	At home my grandfather told me that there were times whereby they were not allowed to catch fish. This is related to science taught at school about seasonal fishing.
L5MG	When we learned about marine ecosystems in class, I realised these stories were teaching us to be aware of how everything in the ocean is connected, just like in the food webs we studied.
L6DL	We have plants that are herbs at home which is also related to the marine plants that are also used for medicine.
L7MF	Home knowledge often explains the 'why' behind the science we learn in school.
L8MG	Both types of knowledge aim to protect the environment, just in different ways.

L9MK	My science from home and school is not related because in my household science was not done. I am the first person to do science in my family. It is different because we only learn about science at school and not at home.
Question 5: How best can Life Sciences teachers teach biodiversity conservation in your own opinion?	
L1DL	Using Indigenous Knowledge and teaching using our own language.
L2MF	By doing practical's and showing us areas that are involved in marine biodiversity conservation.
L3BB	Teachers could bring in more guest speakers, like the Indigenous Knowledge Custodians who spoke to us. Hearing from them made the lessons more real and showed us how our traditions contribute to conservation.
L4RH	taking field trips to local beaches or marine reserves. Seeing these places firsthand would help us understand why biodiversity conservation is important.
L5MG	Taking us to marine areas and showing us the importance of conserving marine life.
L6DL	By creating more group discussions and debates, like the role play we did. It helps us think critically about different viewpoints and understand the importance of biodiversity from multiple perspectives.
L7MF	I am not sure sir.
L8MG	I think teachers should use more local language in lessons, especially when explaining complex concepts. Sometimes, using isiXhosa terms for certain ideas would make it easier for us to grasp the material.
L9MK	By bringing environmental managers and conservationists to come and educate us.
Question 6: What else would you like to share with me regarding the integration of local knowledge in science?	
L1DL	IK should be included in classes so that we can preserve history and identity as Africans.
L2MF	Using more real-life examples from our culture to explain scientific concepts.
L3BB	Science lessons should include more stories and examples from our community's history.
L4RH	I would like to see more collaboration between our school and local elders to bring their knowledge into the classroom.
L5MG	Learning science in a practical way.
L6DL	Learners should interview community leaders for information.

L7MF	I suggest more discussions in class about how our cultural practices align with scientific ideas.
L8MG	I think integrating IK in more subjects would help us see the connection between what we learn in school and our lives.
L9MK	I have no idea sir. However, in my opinion this takes more time than expected.

Appendix E: Recall Interviews

Stimulated Recall Interview Prompts and Responses

The researcher is interested to find out the effect of integrating indigenous knowledge (IK) when teaching the topic marine biodiversity conservation.

Researcher: How was your experience of learning marine biodiversity when IK is integrated?	
Learner	**Responses**
L1DL	I felt more connected to the lesson because it related to what I already knew from home. It wasn't just about facts from a textbook; it was about things that are important to my community.
L2MF	It was eye opening. I never realised how much our Indigenous Knowledge overlaps with what we learn in science.
L3BB	I appreciated how the lesson did not just focus on facts but also on how our traditions play a role in protecting marine life. It felt more relevant to me.
L4RH	Honestly, I found it confusing. The mixing of traditional knowledge with scientific concepts made it harder for me to focus.
L5MG	I found it educational. The integration of IK made the lesson more meaningful because it connected science with our cultural practices.
L6DL	The lesson was very engaging. The lesson became more interactive and connected to our everyday lives.
L7MF	I did not expect to see so many connections between what I learn at home and what I learn at school.
L8MG	The lesson felt more meaningful because it connected with my cultural background and what I already knew.
L9MK	I did not enjoy it as much. It felt like the lesson was more about cultural stories than actual science.
Researcher: What are the reasons for your experiences that you have just mentioned?	
L1DL	I think it is because the integration of IK made the lesson more relevant to my life. Learning about marine biodiversity through the lens of our traditions made the information stick better.
L2MF	The experience was new for me because I'm used to learning science in a very Western way. Integrating IK made it feel more personal and relevant.
L3BB	The integration of IK made the lesson more relatable. It connected my cultural background with what I am learning in school, making it easier to understand.
L4RH	Bringing in Indigenous Knowledge felt like it was diluting the science and made it harder to separate what's scientifically proven from what's cultural belief.
L5MG	It helped me see how my culture contributes to conservation.
L6DL	The integration of IK made the lesson more practical.
L7MF	Not quite sure.
L8MG	I do not understand the question.

L9MK	I felt like the focus on Indigenous Knowledge took away the scientific learning.
Researcher: What have you learnt from presentation by the community members?	
L1DL	I learned that our traditional practices have a lot in common with scientific conservation methods. For example, the way our elders manage fishing seasons is similar to the scientific concept of sustainable fishing.
L2MF	Our ancestors had their own ways of conserving marine life, which are still effective today. It showed me that science is not the only way to understand the world.
L3BB	I learned that our traditional knowledge is very practical and has been developed over generations.
L4RH	Some interesting things about our traditions, but I am not sure how they fit into what we are supposed to learn in science.
L5MG	It made me realise that our ancestors were scientists in their own way.
L6DL	Traditional practices are based on respect for nature and understanding of the ecosystem.
L7MF	IK has been developed over generations and is based on a deep understanding of the environment.
L8MG	I learned that our traditional practices are based on a deep understanding of the environment and have been effective in conserving marine life for generations.
L9MK	Our culture has a lot of knowledge about the environment, but I do not see how it fits with what we are supposed to learn in science.
Researcher: Did you find anything interesting from their presentation?	
L1DL	Yes, the elders spoke about the spiritual connection our people have with the sea. It made me realise that conservation is not just about science, but also about respecting nature.
L2MF	How the IKCs explained the reasons behind certain traditional practices, like not fishing during certain months. It's something we do, but I never knew the deeper reasons until now.
L3BB	Using specific plants to protect marine life. I did not know that our traditional practices were so closely linked to conservation.
L4RH	It was interesting to hear about the customs and practices of our ancestors.
L5MG	The spiritual connection between our people and the sea made me see conservation as something that goes beyond just protecting marine animals.
L6DL	Linking certain practices, like seasonal fishing restrictions, with modern conservation techniques. It made me see the connection between our culture and science.
L7MF	It was interesting how they explained the reasoning behind certain practices, like why we only fish in certain areas. It gave me a new perspective on the importance of these practices.
L8MG	Certain traditional practices, like why we only fish in certain seasons.
L9MK	Not really. I found it a bit off-topic from what I think we should be learning in science class.
Researcher: Is there anything that you would like to suggest to whoever is responsible for science curriculum, which in your opinion could help other Life Sciences learners to better understand the subject?	
L1DL	I would suggest including more lessons that integrate Indigenous Knowledge into the curriculum. It makes learning more meaningful and helps us see the relevance of science in our own lives.

L2MF	I think it would help if science teachers were trained to integrate Indigenous Knowledge into their lessons. It would make the lessons more inclusive and help students connect with the material.
L3BB	The curriculum should more examples of Indigenous practices and how they relate to scientific concepts. It would help students see the value of both types of knowledge.
L4RH	I think the curriculum should keep Indigenous Knowledge separate from the science topics.
L5MG	More content on how Indigenous Knowledge contributes to scientific understanding should be included in the curriculum.
L6DL	The curriculum to be more inclusive of Indigenous Knowledge.
L7MF	We should have more hands-on activities that incorporate Indigenous Knowledge.
L8MG	No, thank you Sir.
L9MK	Science lessons should stick to scientific content. If we want to learn about Indigenous Knowledge, it should be in a different class so that those who are interested can choose to learn about it without confusing it with science.

Appendix F: Observation Schedule

Observation schedule (adapted from Nicodemus, 2017)

Observation Date ……Name of the researcher: ……

Subject: ……... Number of participants: ……

Lesson Topic: ……. Observer: …….

Social interaction	**Remarks**
The participation of learners during presentation by community members.	
The interaction of learners with the community members.	
The interaction of learners with one another.	
How community members take learners' views?	
How are learners motivated in the presentation.	
learners' courage to respond to their peers' thought and discussion.	
Language	**Remarks**
The use of mother tongue and how it impacts learner participation.	
How learners' everyday experiences and ways of talking and knowing expressed during the presentation by community members.	
Learners' engagement and sense making	**Remarks**
Learners' questioning invites thinking.	
Learners' interpretations of concepts and ideas emerging from the presentation by community members.	
Learner's sense making shifts or (not) because of the presentation and discussion.	
The involvement of learners in active learning and willingness in presentations.	

Appendix G: Learners' Journals

Learners' Journal Reflections Colour-coded

Question	L1J	L2J	L3J	L4J	L5J	L6J
1.What have you learnt from interactions with the community members?	Elders have a deep understanding of the environment and marine life. Their knowledge has been passed down through generations.	There is a lot of wisdom in our traditional ways that we often overlook.	Our traditions are more connected to the environment than I thought. The community members have a deep respect for nature.	I learned about traditional practices, but I am still not sure how they relate to what we are supposed to be learning in science.	our traditional knowledge has practical applications in protecting the environment.	our elders have a deep respect for marine life and that their practices are designed to protect it
2.What have you enjoyed (or not) in these presentations from community members?	I really enjoyed hearing the stories and the traditional practices they shared.	I enjoyed the way they told stories and made the lessons more interactive. It was different from just reading a textbook.	I appreciated how the lesson didn't just focus on facts but also on how our traditions play a role in protecting marine life. It felt more relevant to me.	The presentations were interesting, but I didn't enjoy how they seemed to take away from the scientific focus of the lesson.	I enjoyed how the presentations brought our lessons to life. It made the concepts of conservation more real and relevant.	I enjoyed learning about the traditional practices, but I felt that the lesson was trying to combine too many things at once
3.Have the presentations offered you (or	Yes, they helped me see how our cultural	Yes, I think the presentations helped	Yes, the presentations made it easier to	Not really. I found it more confusing	Yes, they helped me understand how	They did help me understand, but I still think the science

not) an opportunity to better understand the concepts of marine biodiversity conservation?	practices can contribute to conservation efforts. It connected what we learn in class with real-life practices.	me see the bigger picture of conservation.	understand because they linked what we were learning to our own cultural practices.	because it mixed cultural stories with science, and I struggled to see the connection.	traditional practices can contribute to modern conservation efforts.	should be taught separately to avoid confusion
4.Explain your thoughts on the integration of IK in science teaching.	I think it's a good idea, but it should be balanced. We need to understand the science, but it's also important to know how our traditions can play a role.	It is interesting, but it can be confusing at times. I think it needs to be done carefully so that we don't mix up scientific facts with cultural beliefs.	I think it is a valuable addition. It brings a new perspective to science and makes it more relatable to our daily lives.	I think it is important to learn about our culture, but it shouldn't be mixed with science. They should be taught separately so that the scientific concepts remain clear.	I think it's a great idea because it bridges the gap between our cultural heritage and scientific knowledge. It makes learning more holistic.	I appreciate the value of Indigenous Knowledge, but I believe it should be presented in a way that doesn't complicate the science we are learning
5.What relevance does IK have in biodiversity conservation?	IK is very relevant because it includes practices that have been sustainable for generations.	IK is relevant because it's based on practices that have been sustainable for a long time. It	IK is very relevant because it offers sustainable ways of living that have been proven over time. It's a	IK has relevance, especially in how it's helped sustain our environment, but I'm not sure how it fits into the	IK is very relevant because it is based on centuries of experience in living sustainably with nature.	IK is relevant because it's based on sustainable practices, but I think it should be taught as a complement to science, not as part of it

		shows us another way to protect the environment.	practical approach to conservation.	scientific study of biodiversity.		
6.Does the integration of indigenous knowledge improve (or not) your sense making of marine biodiversity conservation?	It does improve it for me because it makes the concepts more relatable and grounded in my own experiences.	It helps, but it also makes me question how we can blend the two without losing the clarity of scientific concepts.	Yes, it improves it for me. It makes the concepts more tangible and easier to understand.	For me, it doesn't improve my understanding. It makes it harder for me to focus on the scientific aspects.	Yes, it improved my understanding by showing that science and tradition can work together to solve environmental issues.	It helps in some ways, but it also makes me worry about mixing different types of knowledge that might not always align
7.Any other comments/suggestions on the integration of IK in science lessons.	I think it would be helpful if we had more examples of how IK and science can work together.	I think there should be more clarity on how IK fits into the science we're learning. Maybe separate lessons on IK could help.	I would suggest continuing to integrate IK but also provide clear explanations on how it complements scientific knowledge. This balance is important.	I suggest that we keep IK as a separate subject or class.	I think we should continue integrating IK, but also include more examples of how it complements scientific methods.	I suggest having separate sessions for IK so that we can focus on science without distraction

Question.	L7J	L8J	L9J	L10J	L11J.	L12J.

1.What have you learnt from interactions with the community members?	Our cultural practices have been protecting marine life for generations.	Different ways our ancestors have been protecting marine life.	I learned that our traditions include many practices that are designed to protect the environment.	I learned about some traditional practices related to marine life	I learned about our cultural practices and how they relate to the environment.	I learned how our traditional knowledge has been used for generations to protect marine life.
2.What have you enjoyed (or not) in these presentations from community members?	I enjoyed how the presentations brought in real-life examples from our own culture. It made the lesson more engaging.	I enjoyed the storytelling aspect of the presentations. It was a different way of learning that made the concepts more memorable.	I enjoyed learning about our cultural heritage and how it relates to conservation. It was different from our usual lessons, and I found it refreshing.	I appreciated hearing about our cultural traditions, but I didn't enjoy how it seemed to distract from science	I thoroughly enjoyed the way the elders spoke about the ocean as a living being that we must respect.	I really enjoyed hearing the personal stories in my mother tongue and the passion the elders have for preserving the ocean.
3.Have the presentations offered you (or not) an opportunity to better understand the concepts of marine biodiversity	Yes, they helped me see how our traditions are connected to conservation, which made the scientific concepts easier to grasp.	Yes, they helped me understand that conservation isn't just a modern idea.	Yes, the presentations helped me see the connections between our cultural practices and the scientific concepts we're learning.	Not really. I think the presentations were more about culture than science	Yes, the presentations helped me understand marine biodiversity in a new way. The community members' stories and knowledge gave	Absolutely, the presentations made the concepts of marine biodiversity conservation much clearer and easy to understand.

conservation?					context to the scientific concepts we learn in class, making them easier to grasp and remember.	
4.Explain your thoughts on the integration of IK in science teaching.	I think it's a good approach because it makes the lessons more relevant to our lives.	I think it's important because it shows us that science and culture can work together. It makes the lessons more comprehensive.	I think it's a valuable approach because it shows us that science and culture are not separate.	Science relies on facts and evidence, while IK is based on beliefs and traditions. Mixing the two can be confusing	I believe integrating IK into science is essential. This approach makes learning more inclusive and relatable.	It bridges the gap between traditional and modern knowledge, giving us a more complete understanding of conservation. It also makes the lessons more engaging and relevant to our lives.
5.What relevance does IK have in biodiversity conservation?	IK is very relevant because it's based on a long history of sustainable practices. IK is very relevant because it's based on a long history of sustainable practices. It shows us how to live in harmony with nature.	IK is very relevant because it's based on practices that have been proven to work.	IK is very relevant because it's based on practices that have been sustainable for generations.	IK has relevance in its own context, especially in traditional communities, but in a scientific setting, I think it's important to stick to evidence-based practices	These practices have stood the test of time and can complement modern conservation efforts, making them more effective and culturally sensitive.	These practices are sustainable and have been used successfully for centuries, showing that they can play a significant role in today's conservation efforts.

6.Does the integration of indigenous knowledge improve (or not) your sense making of marine biodiversity conservation?	Yes, it improved my understanding by making the lessons more relatable and grounded in my own experiences.	Yes, it improves my understanding by showing that there are different ways to approach conservation, not just through science.	Yes, it improves my understanding by making the lessons more relatable to my own experiences and cultural background.	For me, it does not improve my understanding. It makes it harder to focus on the scientific concepts because the lessons become a mix of different types of knowledge	It improved my understanding. By combining IK with what we learn in class, I can see how conservation is a shared responsibility that involves both science and cultural wisdom.	The integration of IK provided a broader perspective, helping me see how different forms of knowledge can work together to solve environmental issues.
7.Any other comments/suggestions on the integration of IK in science lessons.	I think we should continue to integrate IK, but also make sure that we understand how it complements what we learn in science.	I think the integration of IK is a good thing, but it should be done in a way that complements the science we're learning. It shouldn't be seen as something separate.	We should have a discussion on how IK fits with what we learn in science.	IK be taught as a separate subject so that we can appreciate it without it interfering with the scientific content	It would be great to have projects that allow us to apply both IK and scientific knowledge in real-world scenarios.	Maybe we could have more field trips where we can see these practices in action.

Appendix H: Role Play Summary

A Summary of the Role Play

Group	Comments
Fishermen (G1F)	We are here today to discuss the proposed no-fishing zone. As fishermen, our livelihoods depend on fishing. This no-fishing zone will severely reduce our income, and it will be difficult for us to survive. We rely on fishing to support our family needs. We understand the need for conservation, but a total ban will be really difficult for us. We suggest alternative measures that would balance conservation and our needs. Such as regulated fishing seasons and sustainable fishing methods.
Conservationists (G2C)	Thank you, **G1F**. We, as conservationists, support the establishment of a no-fishing zone. Studies show that such zones are crucial for marine biodiversity. They allow ecosystems to recover, leading to healthier fish populations that can benefit closest fishing areas through the net movement of fish from marine reserves to the remaining fishing grounds. Protecting marine biodiversity ensures long-term sustainability for both the environment and the fishermen. We believe this zone is a necessary step towards preserving our marine resources for future generations.
Indigenous Leaders (G3IL)	As Indigenous leaders, we bring a viewpoint embedded in centuries of traditional knowledge. Our ancestors have always practiced sustainable fishing, understanding the importance of respecting marine life. We support the no-fishing zone if it supports our traditional practices and helps protect our sacred areas. However, we insist that our cultural practices be recognised and allowed within the zone. We propose a co-management approach where Indigenous communities and conservationists work together.
Tourists (G4T):	Good afternoon. From a tourist's perspective, a no-fishing zone can significantly boost the tourism experience. Healthy and diverse marine ecosystems attract more visitors for water-based activities. Sustainable tourism can become a major revenue source, creating jobs without depleting natural resources. We believe that this no-fishing zone can position our area as a leading ecotourism destination, benefiting the entire community in the long run.
Contradictions	
G1F	**G2C**, we understand the evidence from studies, but what about our immediate needs? Our families cannot wait for long-term benefits. We need support and reasonable solutions that consider our economic reality. Can we find a balance that allows limited, regulated fishing?

G2C	**G1F**, we acknowledge your concerns. We propose an adaptive management strategy, where the no-fishing zone's impact is regularly assessed, and adjustments are made. We also support providing financial assistance and job training programmes for affected fishermen.
G3IL	We appreciate the conservationists' efforts. However, it's crucial that our traditional practices are respected. Our people have lived sustainably for centuries. Can we include specific provisions that allow for cultural exceptions within the no-fishing zone?
G4T	**G3IL**, respecting cultural practices is essential. From a tourism viewpoint, integrating Indigenous knowledge and traditions can enhance the visitor experience. Guided eco-tours highlight these practices can attract more tourists and raise awareness about marine conservation.
	Discussion
G1F	If we agree to a no-fishing zone with regular assessments and financial support, can we have a say in the decision-making process? We need assurance that our voices will be heard.
G2C	Definitely, **G1F**. We propose a co-management approach where fishermen, conservationists and Indigenous leaders work together. This way, we can ensure that all views are considered and that the zone is managed effectively.
G3IL	Co-management sounds promising. It is important that our traditional knowledge is integrated into the management plan. We can contribute valuable awareness into sustainable practices.
G4T	Co-management also benefits tourism. Involving the local community and highlighting their traditions can enhance the authenticity of the tourist experience. We can work together to promote sustainable tourism that respects both the environment and cultural heritage.
Class Vote	
Shumba	Based on the arguments and compromises presented, let's vote on the establishment of the no-fishing zone with the proposed trial period and co-management approach.

Appendix I: Codes

Codes from group activities and meanings

G1TME: The Marine Explorers: This is a creative English name reflecting curiosity and adventure in marine exploration.

G2IS: Isizwe Sikaqamatha: This isiXhosa phrase means "The Nation of Qamatha", referring to a significant deity or ancestral figure in Xhosa myths.

G3FML: Flowless Marine Life: Likely a play on "Flawless", referring to the beauty and perfection of marine ecosystems.

G4IY: Inzalela Yomlambo: This isiXhosa phrase means "Offspring of the River", symbolising a deep connection to water sources.

G5U: Umdawu: In isiXhosa, "Umdawu" refers to a traditional healer or spiritual figure.

G6M: Mates: A simple English term emphasising solidarity and friendship.

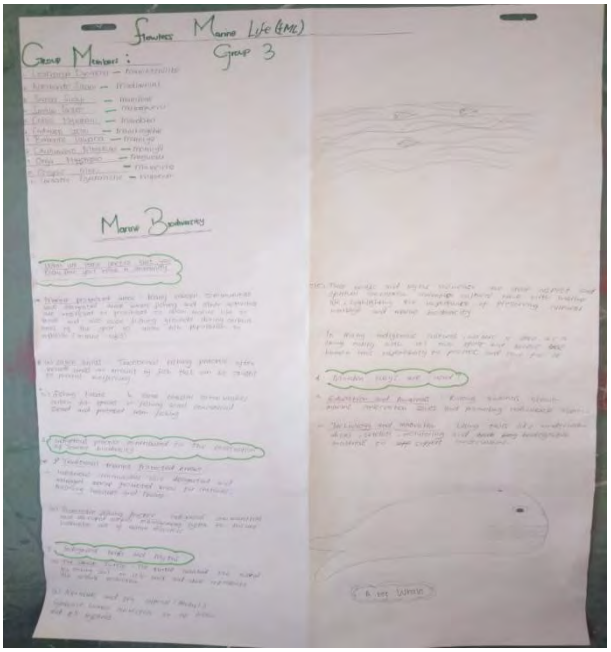
G7INY: Imivuyo Nembali Yolwandle: an isiXhosa phrase that translates to "Joys and History of the Ocean", symbolising the cultural and historical ties to the sea.

G8ME: Marine Experts: An English name reflecting expertise and knowledge of marine life.

G9TSM: The Super Marios: A playful reference to the video game characters, indicating fun and teamwork.

Appendix J: Newsprints

Newsprints presented by different groups



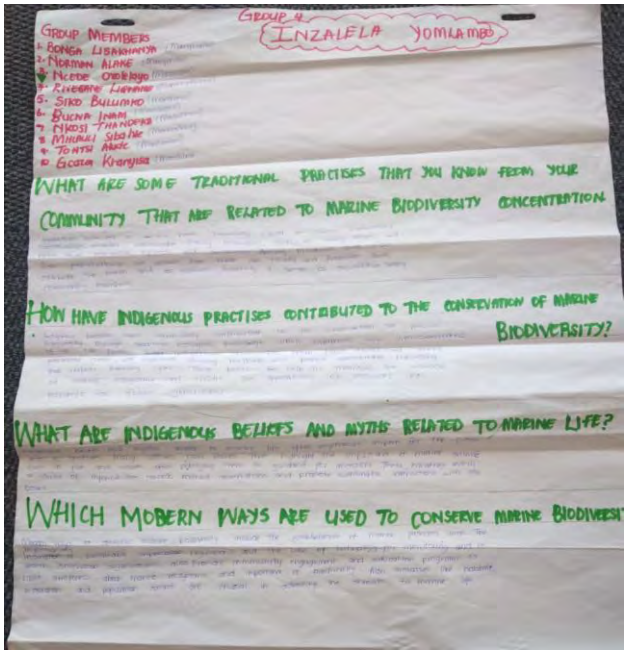


Figure 5.3: Newsprint presented by G3FML Figure 5.4: Newsprint presented by G4IY

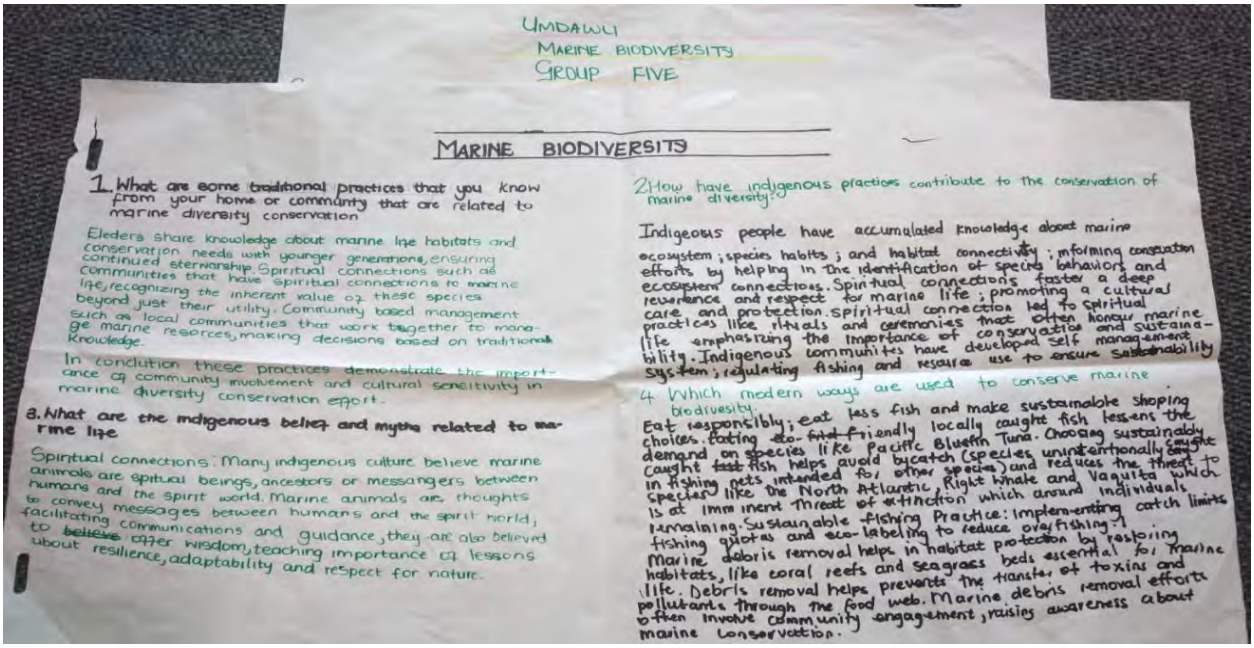
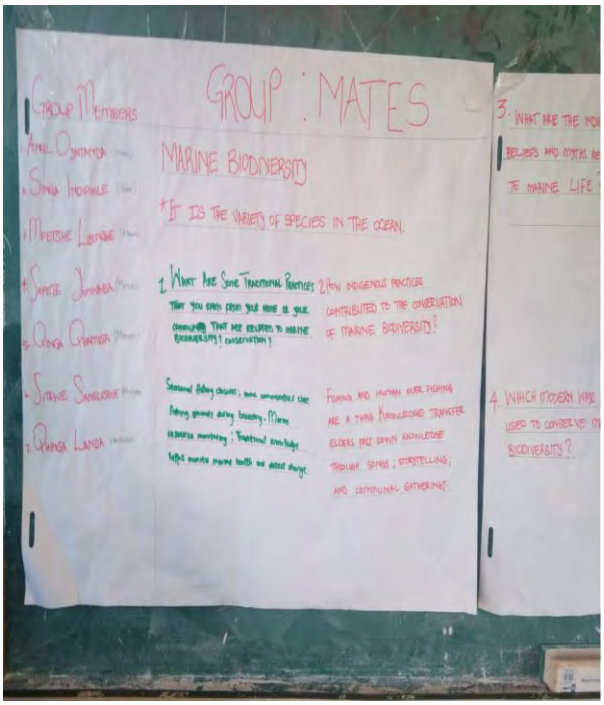


Figure 5.5: Newsprint presented by G5U



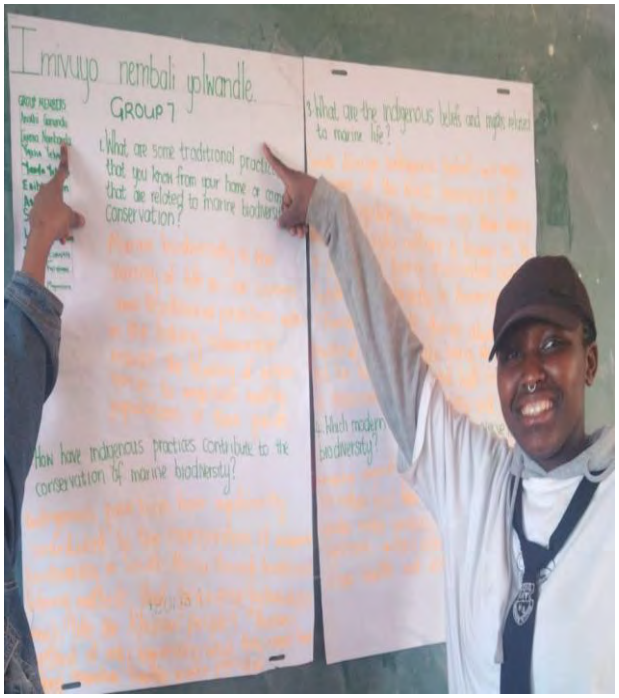


Figure 5.6: Newsprint presented by G6M [3]Figure 5.7: Newsprint presented by G7INY

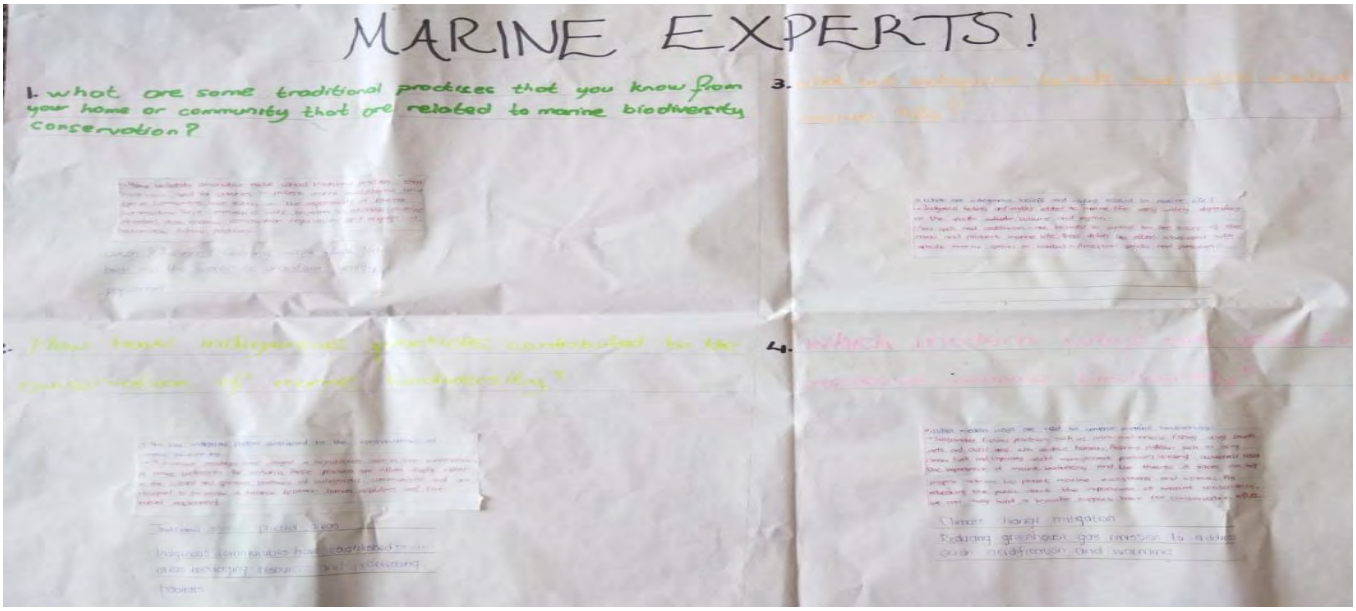


Figure 5.8: Newsprint presented by G8ME

[3] This learner requested that his face should not be blurred.

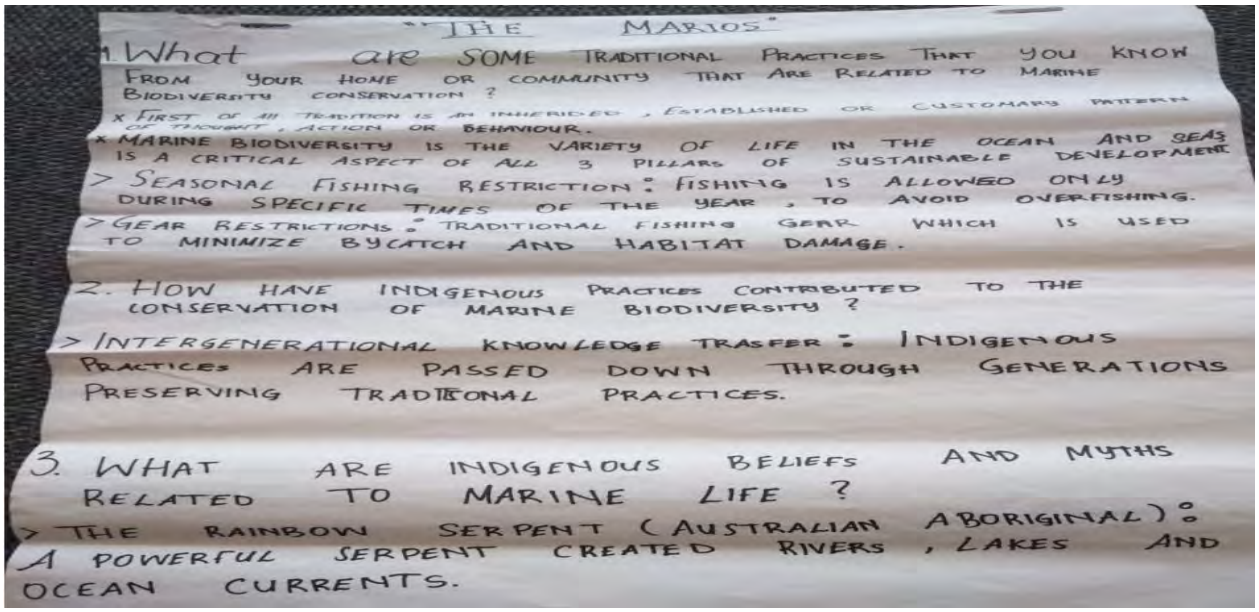


Figure 5.9: Newsprint presented by G9TSM