

**Exploring affordances and hindrances when indigenous knowledge is
integrated in the topic on waves and sound in a Grade 10 Physical Sciences
township class**

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By

Xolani Justice Mayana

Supervisor: Prof Kenneth Mlungisi Ngcoza

Co-supervisor: Mrs Joyce Sewry

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Declaration of Originality

I, Xolani Mayana, declare that this thesis is my own original work that is submitted at Rhodes University and has not been submitted at any other university. Where I have drawn the words or ideas of other people, these have been acknowledged and indicated in the list of references.

Signature:

A handwritten signature in black ink, appearing to read 'Xolani Mayana', written in a cursive style.

Date:

January 2020

Abstract

The lack of interest and hence the decline in the number of learners doing Science in schools, is attributed in part to the decontextualised ways in which Science is taught. As an attempt to address this challenge, the new South African National Curriculum Policy Statement (CAPS) encourages Science teachers to use culturally responsive pedagogies through integrating local or indigenous knowledge (IK) in Science lessons to make it accessible and relevant to learners. But, it does not explicitly state how Science teachers should go about enacting this. It is against this caveat that this study aimed at finding out indigenous practices and knowledge in the community and from two community members that could be integrated into the topic on waves and sound in Grade 10 Physical Sciences lessons with the view to establishing its influence (or not) on learners' conceptions and dispositions towards Science.

The study was conducted at Buyelembo Combined School (pseudonym), a township school in the Sarah Baartman District, in the Eastern Cape in South Africa. The research participants were 18 Grade 10 Physical Sciences learners, two Physical Sciences teachers and two community members. Data were generated using the learners' group activity, discussions and presentations, observations (participatory observations and lesson observations), stimulated recall interviews and reflections. A thematic and inductive-deductive approach to data analysis was employed to come up with sub-themes and themes. Underpinned by an interpretivist perspective and informed by Vygotsky's socio-cultural theory, a qualitative case study approach was adopted. Additionally, Ogunniyi's Contiguity Argumentative Theory (CAT) was used as an analytical framework. The five cognitive states of CAT were employed to analyse data during the social interactions to surface any contradictions.

The findings from this study revealed that there are indigenous practices and knowledge in relation to the sea that can be integrated into the topic on waves and sound in Grade 10 Physical Sciences lessons. However, regarding relevance of those indigenous practices and knowledge to science, the study revealed that the learners found no relevance at all but discussions and argumentation were enhanced. In addition, findings from this study revealed that the learners' conceptions, dispositions, and sense-making in science were influenced positively through using hands-on

practical activities when teaching Science concepts. Lastly, the study revealed that the use of mother tongue by the community members, learners and the teachers together with the language of learning and teaching promoted learner talk. Based on the findings of this study, I recommend that there is a need to support teachers on how to integrate indigenous practices and knowledge in their teaching, particularly when teaching Physical Sciences.

Keywords: Physical Sciences, waves and sound, scientific knowledge, local or indigenous knowledge, conceptions, dispositions, socio-cultural theory, CAT

Dedication

I dedicate this project to the Almighty God, who has given me wisdom and strength, my better half Mrs Brenda (Bri) Mayana and our two sons, Abo and Khanya Mayana. Bri, thank you so much for your love, prayers, support and for encouraging me through this journey. I love you.

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First and foremost, I would like to thank the Almighty God for His grace, love and divine protection, and for being with me every step of the way.

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I wish to acknowledge and thank the department of education for granting me permission to work in one of their schools in the Sarah Baartman District, and for assisting me in paying my fees at Rhodes.

A big thank you goes to all the participants in this study. To the two community members, Sir Mba and Sir Mlo (pseudonyms), *ndiyabulela ngokusityebisela ngamava nangongolwazi lwenu lwemveli, kuyacaca nizizithandazwe, nangomso maxhegwam, fudula besenzanjalo obawomkhulu* (thank you for sharing your experiences and indigenous knowledge, truly it is clear that you love this nation, we will call on you again, my Elders, this is what our forefathers used to do).

To my co-researchers, the Grade 10 Physical Sciences learners of Buyelembo Combined (pseudonym), thank you so much for sacrificing your time and for your active participation during our project. Indeed, you are true researchers and I wish you all the best in your future studies. Blessings to you always.

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LIST OF ABBREVIATIONS AND/OR ACRONYMS

CAPS	:	Curriculum Assessment Policy Statement
CAT	:	Contiguity Argumentation Theory
CPTD	:	Continuing Professional Teacher Development
DBE	:	Department of Basic Education
EM	:	Electromagnetic
IK	:	Indigenous Knowledge
NCS	:	National Curriculum Statement
PD	:	Professional Development
SMT	:	School Management Team
SACE	:	South African Council for Educators
TMESD:		Transformative Model of Education for Sustainable Development
UNESCO:		United Nations Educational, Scientific and Cultural Organization
WMS	:	Western Modern Science
ZPD	:	Zone of Proximal Development

CHAPTER ONE: SITUATING THE STUDY

1.1 Introduction

The main goal of this study was to explore whether or not learners' dispositions, conceptions and sense-making are influenced by integrating local or indigenous knowledge when teaching the topic on waves and sound in a Grade 10 Physical Sciences township¹ class. In this chapter, the background of the study is presented followed by the statement of the problem and the significance of the study. A summary of the research goal and questions, and theoretical and analytical framework are highlighted, followed by the thesis outline. The chapter ends with a chapter summary.

1.2 Background of the Study

Based on my 21 years of teaching experience as a high school Physical Sciences teacher and 11 years as a headmaster of a combined school (Grade R-12), I have come to realise that the majority of the black township learners lack the necessary confidence to choose Physical Sciences in Grade 10. That is, in most cases the majority of learners lose interest in Grade 9, and as a result in Grade 10 they choose other subjects but not Physical Sciences and Mathematics. Agunbiade, Ngcoza, Jawahar and Sewry (2017) argue that one of the key challenges in the field of science education, globally and locally over the years, is the decline in learners' engagement in science, interest, achievement and retaining learners in the field of science. They emphasise that learners are more inclined towards pursuing subjects in the arts or social sciences, even if they performed well in

¹ In South Africa a township school is a school situated in an underdeveloped racially segregated urban area that, from the late 19th century until the end of apartheid, were reserved for Africans and Coloureds. Post 1994, the department of education refers to township schools as previously disadvantaged schools.

science. In addition, the number of learners changing from Physical Sciences in Grade 11 and 12 to other subjects, such as History, Tourism and Business Studies has increased since 1994.

Evidence from the Department of Basic Education's yearly reports (South Africa. DBE, 2014, 2015, 2016, 2017 & 2018) show that nationally, the quality of learner achievement in Physical Sciences is of grave concern. For instance, many of the learners that passed Physical Sciences achieved level 2 (+30%) or level 3 (+40%). This threatens the survival of Physical Sciences as a school subject.

Consequently, this could have serious implications in terms of South Africa not having enough scientists in the future. Among the reasons for this gloomy picture, could be that science is probably taught in decontextualised ways (Mothwa, 2011). According to Jegede (1999), any science curriculum that does not take particular account of the indigenous worldview of the learner risks destroying the framework through which the learner is likely to interpret concepts. This suggests that if the teacher does not take into consideration the learners' prior knowledge and socio-cultural background (Mavuru & Ramnarain, 2017), that teacher is likely to alienate those learners in a science class.

Accordingly, the new National Curriculum Policy Statement (CAPS) for Grades R to 12, gives expression to knowledge, skills and values that are regarded as worth learning. It emphasises that the curriculum ensures that learners acquire and apply knowledge and skills in ways that are meaningful to their lives. In this regard, "the curriculum promotes the idea of grounding knowledge in local contexts, while at the same time being sensitive to global imperatives" (South Africa. DoE, 2011, p. 5).

Admittedly, it is easier said than done, as the curriculum does not provide details on how this should be executed or enacted. It is against this background that in this study I sought to explore the effect of integrating indigenous knowledge (IK) in the topic on waves and sound in a Grade 10 Physical Sciences township class.

1.3 Curriculum Requirements on Waves and Sound

According to the new National Curriculum of South Africa, Curriculum and Assessment Policy Statement, commonly known as CAPS, there are six main knowledge areas that inform the subject Physical Sciences, namely, Matter and Materials; Chemical Systems; Chemical Change; Mechanics; Waves, Sound and Light; and Electricity and Magnetism (South Africa. DoE, 2011, p. 3).

The overview of the topic on waves and sound (South Africa. DoE, 2011, p. 9) in Grade 10 includes: Transverse pulses on a string or spring (pulse, amplitude superposition of pulses); Transverse waves (wavelength, frequency, amplitude, period, wave speed); Longitudinal waves (on a spring, wavelength, frequency, amplitude, period, wave speed, sound waves); Sound (pitch, loudness, quality (tone), ultrasound); Electromagnetic radiation (dual (particle/wave) nature of electromagnetic (EM) radiation, nature of EM radiation, EM spectrum, nature of EM as particle - energy of a photon related to frequency and wavelength). The topic on waves and sound is dominated by concepts and calculations, which more often pose a challenge for most learners.

Waves are a type of energy transmission that result from a periodic disturbance (vibration), and they are composed of a series of repeating patterns (Kadis, 2015). Figure 1.1 below shows a pattern of a transverse wave.

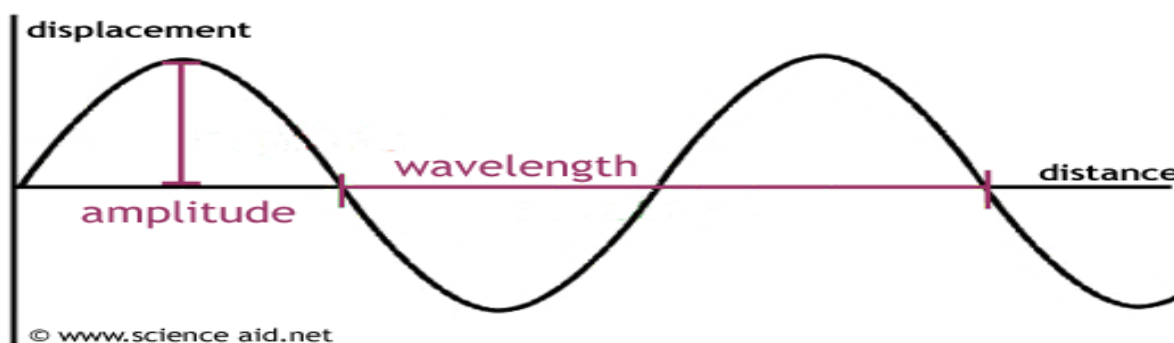


Figure 1.1: Wave pattern (source: <https://scienceaid.net/physics/waves/properties.html>)

This means that transverse waves are transmitters of energy that result from a periodic disturbance (vibration) and they are composed of a series of repeating patterns.

On the other hand, sound waves are longitudinal waves caused by vibrations that produce a regular variation in pressure in the medium.

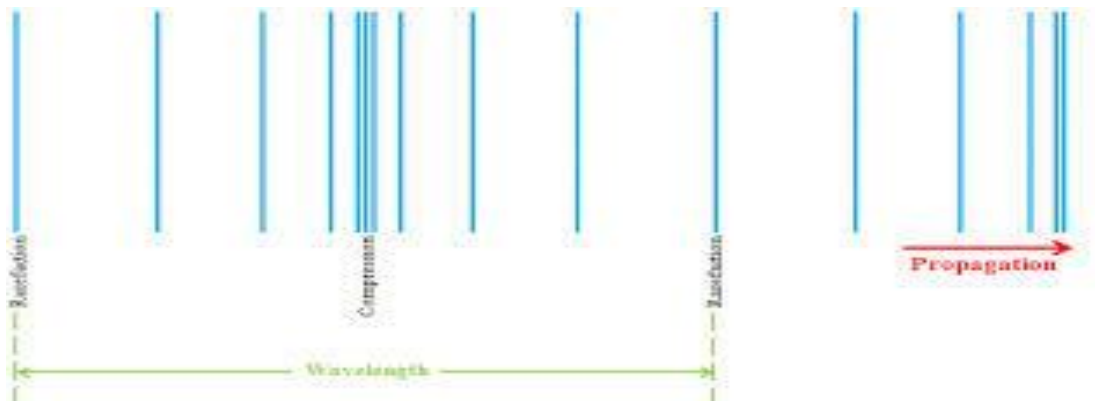


Figure 1.2: Longitudinal wave (source <https://scienceaid.net/physics/waves/properties.html>)

The wave representation shown above is an example of a longitudinal wave. That is, the particles in the medium move parallel (in the same direction as) to the motion of the wave.

Sound is the phenomenon we experience when our ears are disturbed by vibrations in the air or solid objects that surround us. For example, a *vuvuzela*² produces vibrations in the air which are a series of compressions and rarefactions (Broster, Horn, James, & Paarman, 2011). Simply put, sound is a pressure wave that passes from particle to particle in a medium. The pitch of a sound is how high or low it is and depends on the frequency of sound, whilst loudness is related to the amplitude and the sensitivity of the human ear. A sound with a larger amplitude sounds louder than one with a small amplitude.

² A vuvuzela, also known as lepatata, is a plastic horn, about 65 centimetres long, which produces a loud monotone sound, typically blown by South African fans at soccer matches.

In his study on traditional music and dance, Liveve (2017) emphasises that learners are expected to master a few key concepts in Physics, namely, propagation medium, amplitude and length, rarefaction and compression, vibration and resonance. He further concludes that traditional music and dance enables learners to make sense of these concepts from a Physics perspective. However, Liveve focused mainly on sound, thus, the need for this study to close that gap.

1.4 Statement of the Problem

The new South African CAPS document clearly states that indigenous knowledge (IK) should be integrated in Science lessons. This is reflected in Outcome 3 which states that:

Valuing indigenous knowledge systems: Acknowledging the rich history and heritage of this country as important contributors to nurturing the values contained in the Constitution. (South Africa, DoE, p. 5)

But it does not state how this should be done. Another challenge is that the curriculum assumes that all teachers understand how to integrate IK in their Science lessons. This assumption has thus led to little integration of IK in many science classrooms (Khupe, 2014). There is therefore a gap on the integration of IK when teaching science in most schools, thus a need for this study. There have already been a number of studies on the integration of IK into science teaching in Namibia and South Africa under the Rhodes University umbrella research programme. My study is part of this research programme.

1.5 Purpose and Significance of the Study

The purpose of this study was to explore whether or not learners' dispositions, conceptions and sense-making are influenced by integrating local or indigenous knowledge when teaching the topic on waves and sound in a Grade 10 Physical Sciences township class.

The study might provide some insights on how IK might influence the Grade 10 Physical Sciences learners' conceptions, dispositions and sense-making of the topic on waves and sound when the community members share their local or indigenous knowledge about the sea and related cultural practices. Furthermore, the findings of this study might equip me and the two science teachers participating in the study on how to integrate indigenous knowledge in our Science lessons, which

could ultimately contribute positively to learner engagement and interest in science. The study might contribute to improving teaching strategies, which could help learners' academic improvement and reverse the gloomy picture painted in the context section above. Lastly, the study might provide an opportunity for the community members to get actively involved during the teaching and learning process.

1.6 Theoretical and Analytical Framework

Central to this study was learning in *out-of-school* and *in-school* contexts. As alluded to earlier, the study essentially explored integration of local or indigenous knowledge when mediating learning of the topic of waves and sound in a Grade 10 Physical Sciences township class. Notably, the *out-of-school* context is associated with local or indigenous knowledge at home, community and environment, whereas the *in-school* context is associated with science knowledge at school. In hindsight, it could be argued that the practical implications (putting theory into practice) of what Aikenhead and Jegede (1999) elegantly refer to as 'border crossing', were addressed in this study.

It is against this caveat that the theoretical framework informing this study is Vygotsky's (1978) socio-cultural theory. In his seminal work, Vygotsky (1978) accentuates that learning is a social process in which both the individual and social planes are vital in fostering social interactions, a view supported by McRobbie and Tobin (1997). Likewise, language is critical during social interactions. It is recognised, however, that learning is a complex process characterised by contradictions or tensions, even more so when two thought systems interact, for example, local or indigenous knowledge and school science.

In response to this reality and to augment Vygotsky's (1978) socio-cultural theory, I used Ogunniyi's (2007) Contiguity Argumentation Theory (CAT) as an analytical framework. To Ogunniyi, CAT seems appropriate to use when two thought systems such as science and IK co-exist. Expanding on the seminal work of Ogunniyi, scholars such as Govender (2014) posit that argumentation advances knowledge. In the context of my study, it was thus hoped that CAT might provide valuable theoretical underpinnings to analyse the learners' arguments during the social interactions as espoused by Vygotsky (1978). Arguably, argumentation is regarded as a challenge

to township learners who are second language speakers of English. Accordingly, an in-depth discussion of these two theories is provided in my Chapter Two of this thesis.

1.7 Research Goal and Questions

In this section the research goal and research questions are outlined.

1.7.1 Research goal

The main goal of this study was to explore whether learners' conceptions, dispositions, and sense-making are influenced (or not) by integrating local or indigenous knowledge when teaching the topic on waves and sound in a Grade 10 Physical Sciences township class. To achieve this goal, the study was guided by the following research questions:

1.7.2 Research questions

1. What are the indigenous practices and knowledge that can be integrated into the topic on waves and sound in Grade 10 Physical Sciences lessons?
2. How do Grade 10 Physical Sciences learners interact, participate and learn (or not) during the presentations by the two community members?
3. How do lessons on waves and sound that integrate IK shift (or not) Grade 10 Physical Sciences learners' conceptions, dispositions, and sense-making?

1.8 Data Gathering Techniques

Four data gathering techniques were used to gather data for this study. These techniques were:

- A group activity;
- Observations and presentations;
- Stimulated recall interviews; and
- Journal reflections.

1.9 Definition of Key Concepts

Waves: Waves are a type of energy transmission that results from a periodic disturbance (vibration), and they are composed of a series of repeating patterns (Kadis, 2015).

Dispositions: Disposition is a behavioral tendency that endures over time, which can be developed and enhanced (Crick & Yu, 2008).

Conceptions: Conceptions are views that learners hold on a subject and what they believe is required in learning and doing the subject (Atallah, Bryant, & Dada, 2010).

Sense-making: Sense-making is when meaning materialises, which a crucial part of language, talk and communication (Nikodemus, 2017).

Prior knowledge: Prior knowledge is the learners' existing knowledge prior to instruction (Hewson & Hewson, 1988).

Practical activities: Hands-on practical activities are activities in which learners are working individually or in groups, handling and observing the objects or materials they are studying (Millar, 2010).

Indigenous knowledge: IK as a large body of knowledge and skills that has been developed outside the formal education system, and which enables communities to survive (Klein, 2011)

Social interaction: Social interaction is the basis of learning and development. Learning is a process of apprenticeship and internalisation in which skills and knowledge are transformed from the social into the cognitive plane (Vygotsky, 1978).

Self-regulation: Self-regulation as the learner's ability to regulate himself or herself and is essentially linked to social activity (Harrison & Muthivhi, 2013)

Zone of proximal development (ZPD): Vygotsky (1978, p. 86) defines zone of proximal development (ZPD) as, "the distance between the actual development level as determined by

independent problem solving and the level of potential development through problem solving under adult guidance or in collaboration with more capable peers”.

1.10 Thesis Outline

The study was conducted at Buyelembo Combined School (pseudonym), a township school in Sarah Baartman District, in the Eastern Cape, in South Africa, and consists of the following chapters.

Chapter One: Chapter One outlined the background of the study, the statement of the problem, the significance of the study, and the research goal and questions. This chapter also highlighted the analytical and theoretical framework and provided the outline of chapters of the study and the chapter summary.

Chapter Two: This chapter reviews the literature relevant to the study, with an aim of highlighting what has been researched already and strengthens the importance of the study. In this chapter, literature around the concepts of waves and sound, indigenous knowledge, hands-on practical activities, and prior knowledge is discussed. In addition, the conceptual frameworks, theoretical frameworks and the analytical frameworks that underpinned the study are discussed.

Chapter Three: The third chapter discusses the methodological design of the study. The research paradigm, research method, research site and sampling are discussed, followed by the data generating techniques and procedures, and data analysis. Lastly, issues of validity and trustworthiness and ethical considerations are outlined.

Chapter Four: In Chapter Four, qualitative data generated from lesson observations of group activity and presentations by the two community members are presented, analysed and discussed with reference to the theoretical and analytical frameworks and literature.

Chapter Five: In this chapter, qualitative data from the practical activity and intervention lessons that integrate IK (videotaped lessons), as well as data from stimulated recall interviews and learners’ reflections are presented, analysed and discussed with reference to the theoretical, conceptual and analytical frameworks and literature.

Chapter Six: In this chapter the summary of the findings in relation to the research questions is discussed. Furthermore, recommendations, limitations, possible areas of future research and the reflections are provided. Finally, a conclusion is provided to this study.

1.11 Chapter Summary

In this chapter, I introduced the study and described the background of the study which triggered my interest to conduct this research with my learners. The statement of the problem, the significance of the study, the research goal and questions of the study were discussed. Lastly, I highlighted the data gathering techniques, and the theoretical and analytical framework of the study.

In the next chapter, I discuss the literature relevant to the study, as well as the conceptual, theoretical and analytical frameworks that underpin it.

CHAPTER TWO: LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Introduction

The aim of this study was to explore the effect of integrating indigenous knowledge into the design and delivery of lessons in the topic of *waves* and *sound* in Grade 10 Physical Sciences in a township school, and how this integration influences (or not) learners' conceptions, dispositions and sense-making in science. In the previous chapter, I discussed the context of this study. In this chapter, I therefore discuss the literature that informed the study.

Firstly, I discuss an overview of the international context and of the South African curriculum in particular, in relation to the study. Secondly, I discuss indigenous knowledge. Thirdly, I discuss hands-on activities and prior knowledge. This is followed by a discussion around the perspectives from literature that talk to the conceptual framework, the theoretical framework and the analytical framework. I used the three frameworks as a lens to analyse the data in this study.

2.2 Indigenous Knowledge

According to UNESCO (1999), indigenous knowledge (IK) refers to a large body of knowledge and skills that have been developed outside the formal education system, and which enable communities to survive. IK is closely related to survival, and in support of my statement, CAPS (South Africa, DoE, 2011, p. 8) declares that "Indigenous knowledge includes knowledge about agriculture and food production, pastoral practices and animal production, forestry, plant classification, medicinal plants, management of biodiversity, food preservation, management of soil and water, iron smelting, brewing, making dwellings and understanding astronomy".

Parallel to CAPS (2011), Klein (2011) considers IK as a large body of knowledge and skills that have been developed outside the formal education system, and which enables communities to survive. Mosimege and Onwu (2004, p. 2) posit that IK is an “all-inclusive knowledge that covers technologies and practices that have been and are still used by indigenous and local people for existence, survival and adaptation in a variety of environments”. Agreeing with Mosimege and Onwu, Dziva, Mpofu and Kusure (2011) accentuate that as a result of interacting with other knowledge systems, IK evolves and is dynamic rather than being static.

On the other hand, however, Nyika (2017) understands IK as knowledge that is unique to a society. Similarly, Kibirige and Van Rooyen (2006) view IK as a legacy of knowledge and skills unique to a particular indigenous culture and involving wisdom that has been developed and passed on over generations. They argue that in different settings, these systems of knowledge are given different labels, for instance, ‘indigenous knowledge systems’ (IKS), ‘traditional knowledge’ (TK), ‘traditional ecological knowledge’ (TEK), and other related terms. In this study, I have chosen to use indigenous knowledge (IK).

Naidoo and Vithal’s (2014) study revealed that there are three approaches to engaging IKS, which may be characterised as: an incorporationist approach that brings selected indigenous knowledge into science by seeking how ‘best IKS fits into science’; a separatist approach that holds IKS ‘side-by-side’ with scientific knowledge; and an integrationist approach that makes ‘connections’ between IKS and science. Similarly, Taylor and Cameron (2016) talk about three perspectives of the relationship between science and IKS (see Figure 2.1), namely, the inclusive perspective; exclusive perspective; and an intersecting perspective.

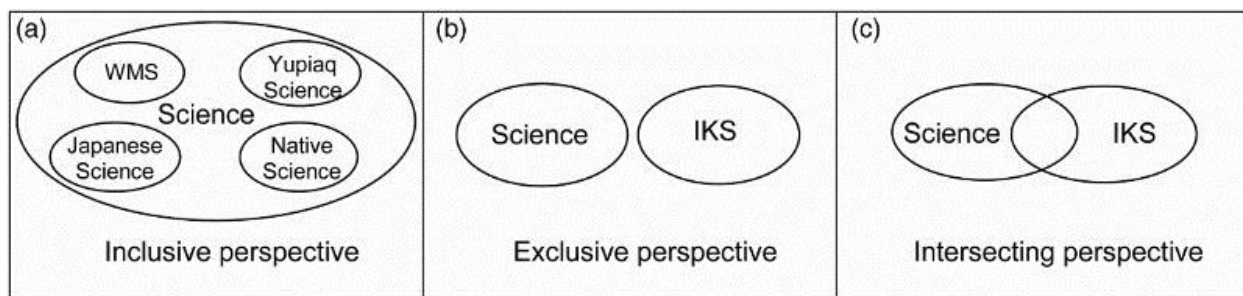


Figure 2.1: Three perspectives of the relationship between science and IKS (adopted from Taylor & Cameron, 2016, p. 36)

To Taylor and Cameron (2016), the inclusive perspective (Figure 2.1 a), holds that, if science is defined as the knowledge and understanding of nature, there can be no single way to do, or think about, science. In contrast, the exclusive perspective (Figure 2.1 b) regards science and IKS as fundamentally different knowledge domains, with IKS “better off as a different kind of knowledge that can be valued for its own merits” (Cobern & Loving, 2000, p. 50).

Taylor and Cameron (2016) further argue that both the inclusive and exclusive views do not regard Western Modern Science (WMS) as objective ‘truths’, but recognise that all knowledge is rooted in a particular worldview with particular beliefs about the world. They further argue that all these three perspectives (in Figure 2.1 c), acknowledge IKS as valid and useful ways of knowing, although they see their relationships with science differently. Moreover, these perspectives provide a framework for thinking about the place of IK in a school science curriculum. In this regard, I tend to agree with Taylor and Cameron and hence throughout this study I take that position, as I regard these knowledges as complementary rather than oppositional.

Following a similar line of argument, de Beer and Whitlock (2009) posit that by including indigenous knowledge in the science classroom, the social identities of learners can be acknowledged. Furthermore, learning might be turned into positive experiences and the attitude of learners towards science might change. Similarly, Cocks, Alexander and Dold (2012) emphasise that the integration of indigenous knowledge into the mainstream curriculum can promote conservation, as well as cultural revitalisation for the township learners.

In contrast, however, some scholars such as Southerland (2000) bemoan that forcing all forms of knowledge about nature and naturally occurring events into the construct of science, sets no boundaries for the limits of the discipline. Additionally, Horsthemke and Schafer (2007) reject the notion of ownership of knowledge along ethnic and indigenous divisions, and argue that the term indigenous knowledge has become a bandwagon-type concept that has been used uncritically by politicians to further their own agendas. Furthermore, these scholars warn against the assumption that anything using the label ‘indigenous’ should not automatically be accepted and embraced. This gives credence to Hodson’s (2009) caution that calling traditional knowledge science, can be a futile exercise.

However, despite these opposing views, Shizha (2007) argues that integrating indigenous science and western modern science liberates learners and teachers from cultural alienation. It is through the implementation and integration of IK in schools that learners, parents and communities can reclaim their *voices* in the process of educating the African child (Shizha, 2013). The time has come for science teachers, African teachers in particular, to reconsider the way they teach science to an African child; perhaps then more township learners would choose science and the declining trend would be a thing of the past. In support, Mhakure and Otulaja (2017) talk about culturally sensitive pedagogies, hence a need to explore the effect of integrating indigenous knowledge (IK) in the topic on waves and sound in a Grade 10 Physical Sciences township class.

2.3 Hands-On Practical Activities

Globally, practical activities are part of school curriculum and the National Curriculum of South Africa clearly stipulates that practical work must be part of teaching and learning, and assessment. In South Africa, of the 100 marks allocated for school-based assessment (SBA), 75 are allocated for assessing the theoretical content and 25 for assessing the practical work (South Africa, DoE, 2011). Practical activities are activities in which learners work individually or in groups, handling and observing the objects or materials they are studying (Millar, 2010). Similarly, according to Hodson (1990), practical work includes the science experiments or demonstrations selected for the learners to do or observe in class. It also includes the hands-on activities used to teach and learn the concepts and theories of physics.

Banu (2011) emphasises that many studies have shown that practical work plays a positive role in science teaching and learning by making it comparatively easier to understand; and that it can strengthen learners' content knowledge. Despite this advantage of using practical work, Banu (2011) posits that some findings of studies conducted indicate that most teachers use mostly transmissive pedagogy to assist learners to understand concepts and theories in physics. Among the many reasons for learners' poor content knowledge in science globally, and in developing countries like South Africa, some researchers have argued that lack of practical work is an important contributing factor. In contrast, some scholars have questioned the effectiveness of practical work (Abrahams & Millar, 2009).

However, Scanlon, Morris and Copper (2002) believe that practical work has an obvious role in developing science learners' conceptual and procedural understanding. Hence, in this study practical work was deemed relevant, as effective practical activities build a bridge between 'hands-on' and 'minds-on' activities (Woodley, 2009).

2.4 Prior Knowledge

According to Hewson and Hewson (1988), one of the factors affecting students' learning in science is their existing knowledge prior to instruction. They further argue that students' prior knowledge provides an indication of the alternative conceptions, as well as the scientific conceptions possessed by the students. This means that teachers need to have different strategies to work with learners as they come with various experiences. Agreeing with Hewson and Hewson, Roschelle (1995) posits that a large body of findings show that learning proceeds primarily from prior knowledge, and only secondarily from the presented materials. Roschelle (1995) defines prior knowledge as the learning experience that forces a theoretical shift to the viewing of learning as a 'conceptual change'; meaning that prior everyday knowledge is the base knowledge from which all learning must start. Roschelle (1995) seems to concur with Ausubel (1968), when he asserts that the most important single factor influencing learning is what the learner already knows, and teachers need to ascertain this and teach from that accordingly.

Prior everyday knowledge makes learners undergo all three types of visualisation, namely, mental representation, visualising by building up mental analogues, seeing the pattern of the concepts they constructed and relating them to their experiences, which in turn are useful as pedagogical content knowledge (Enghono, 2013). This means that learners actively construct their own new knowledge, and that they are ultimately responsible for their own learning (Magoon, 1977; Resnick, 1983). Similarly, Vygotsky (1978) argues that prior everyday knowledge is the kind of knowledge which the learners possess and explore through their social and material environment and learn through communication with others. To Roschelle (1995), neglect of prior knowledge can result in the learners learning something opposed to the educator's intentions, no matter how well those intentions are executed in a classroom. Put differently, new knowledge does not replace prior knowledge, rather new knowledge re-uses prior knowledge. Re-use is made possible by a process in which prior knowledge is refined and placed in a more encompassing structure. According to the National Curriculum Statement (NCS) learners bring valuable experiences into the classroom (South Africa. DoE, p. 11). The NCS asserts that the teacher's role is to initiate discussion and reflection, in which learners' prior knowledge is acknowledged, and then valued.

Unfortunately, I painfully remember my school days as a young boy in one of the primary schools in Grahamstown, this is due to the fact that most of the knowledge I had acquired at home was rendered useless by the teachers instead of refining it. For example, our English teacher would ask us to write an essay on a "Journey by train" or "The day at the beach" even though they lived next door to our home and that they knew very well that we never went on holiday, let alone being on a train nor at the beach, instead of asking us to write an essay on "Journey by a donkey cart to the forest" which was our daily experience. For me school was not really useful for practical life in the township and none of the kids in my township went outside Grahamstown. With this in mind, I agree with Caper and Leask (1993) when they concluded that learners bring their conceptions to the learning situation. In other words, learners come to class with different experiences and therefore with different understandings and knowledge. This was also observed by Stears, Malcolm and Kowlas (2003) when they emphasized that linking science to learners' every day prior knowledge provides the learners the appropriate platforms that enable them to be active as well as to participate socially in the community of practice. These communities of practice enable learners to make use of their everyday lives which include (past experiences,

interests and prior everyday knowledge) during classroom instruction, thus enhance meaning making to occur (Enghono, 2013).

More importantly, in science, most topics are related with what happens around communities and therefore teachers should try and find ways of eliciting prior knowledge from the learners and also integrate these in their lesson plans as it is intended in this study, wherein the learners who are my co-researchers will share their everyday experiences in class and these will be taken into consideration when designing lesson plans that integrate indigenous knowledge when teaching the topic on waves and sound.

2.4 Conceptual Framework

A conceptual framework is a system of concepts, assumptions, expectations, beliefs and theories that shape one's research. I now discuss the related concepts.

2.4.1 Conceptions

Tsai and Kuo (2008) view conceptions as the perceptions of learners toward learning. Concurring, Atallah et al. (2010) posit that conceptions are views that learners hold on a subject and what they believe is required in learning and doing the subject. To Thompson (1992), conceptions are mental structures that encompass beliefs, concepts, meanings, propositions, mental images and others. In this study, the intention was to expose the learners to various cultural beliefs and local knowledge about the sea and explore whether or not such exposure would have any influence on their conceptions of science. A number of research studies show that concepts are related to dispositions.

2.4.2 Dispositions

Atallah et al. (2003) point out that dispositions are associated with either positive or negative attitudes. To these scholars, both positive and negative attitudes can influence learning. On the other hand, Crick and Yu (2008) point out that disposition is a behavioral tendency that endures over time, which can be developed and enhanced. Concurring, Graven (2012) argues that disposition is the habitual tendency to act in a particular way when opportunity presents itself. The aforementioned researchers hold a common view that disposition is a learnable and changeable

human quality, that is not fixed, which develops through interaction with the world and in response to problems in social and physical environments. Agunbiade et al. (2017) pointed out that the literature reviewed showed that there is no consensus on the definition of disposition among researchers but emphasized that all researchers seem to agree that developing positive disposition is essential for success and achievement in learning. They further argued that in some of the literature reviewed, disposition is used synonymously with attitude, thus I will use the two concepts interchangeable. Essentially, in this study I explored whether or not there was a shift in learners' dispositions when integrating IK when teaching the topic on waves and sound.

According to Agunbiade et al. (2017), disposition towards science is considered one of the most important affective concepts in science education. Gardner (1975) defines attitudes towards science as a learned predisposition to evaluate in certain ways objects, people, actions, situations, or propositions involved in the learning of science. Furthermore, Gardner (1975) makes a clear distinction between the cognitive and affective domain as they relate to attitude. He affirms that the cognitive domain is described as 'scientific attitude', while the affective is 'attitude towards science'. In this study, I am interested in both the cognitive and affective domain, as according to Manzini (2000), learners show great interest in learning if what is taught is related to their socio-cultural setting (Mavuru & Ramnarain, 2017). The study hopes that the integration of IK in the topic on waves and sound might in some way contribute positively towards the learners' disposition towards science. It is also believed that conceptions and dispositions towards something or a certain situation, may also contribute to how one makes sense of that something or situation.

2.4.3 Sense-making

According to Wieck, Sutcliffe and Obstfeld (2005), sense-making involves turning circumstances into a situation that is comprehended explicitly in words and that serves as a springboard into action. Meaning, sense-making is a way of making circumstance understandable in clear words. Tsoukas and Chia (2002) argue that sense-making and organisation complement one another: "Organization is an attempt to order the intrinsic flux of human action, to channel it toward certain ends, to give it a particular shape, through generalizing and institutionalizing particular meanings

and rules” (Tsoukas & Chia, 2002, p. 570). Concurring, Wieck et al. (2005) posit that sense-making has to do with how people make sense of the world.

Similarly, Nikodemus (2017) emphasises that sense-making is when meaning materialises, which is a crucial part of language, talk and communication. He further argues that sense-making is retrospective in nature and occurs during socialisation. Equally important, Shizha (2013) emphasises that education is not limited to accumulating knowledge and skills; instead, it involves acquiring ways of interpreting and giving meaning to concepts, forming links and understanding ideas (p. 5). He further argues that education entails ways of knowing, perceiving and interpreting the world. In the context of this study, I explored learners’ sense-making of the new concepts on the topic on waves and sound, through the integration of the indigenous knowledge (South Africa, DoE, p. 11), when the community members shared their understanding of the sea and related cultural practices (Klein, 2011). This might also help determine how they make sense of the topic on waves and sound.

2.5 Theoretical and Analytical Framework

In this section I discuss the theoretical and analytical framework, which were used as a lens to analyse the data.

2.5.1 Theoretical framework: Vygotsky’s socio-cultural theory

The theoretical framework informing this study is Vygotsky’s (1978) socio-cultural theory. Vygotsky’s (1978) socio-cultural theory describes learning as a social process and the origin of human intelligence in a society or culture. Vygotsky (1978) believes that everything is learned on two levels, firstly, through interaction with others, and then integrated into the individual’s mental structure. He further argues that effective learning lies in the nature of social interactions between individuals and their peers (Vygotsky, 1978).

McRobbie and Tobin (1997) posit that a social constructivist perspective on learning, highlights the role of active involvement in tasks associated with making connections between experience and prior knowledge. Agreeing with McRobbie and Tobin (1997), Shizha (2013) points out that school knowledge has to express the social desires, anxieties, and socio-cultural needs for socio-

economic development. As a result, Shizha (2013) argues that school knowledge should align itself with learners' experiences that are characterised by their socio-cultural worldview. Aikenhead and Jegede (1999) refer to this as border crossing. The learners' use of everyday language, their learning to use the technical register of science in discussing and engaging in argument over the meanings they are giving to experiences, and the evidence relating to their knowledge claims are important components in making these connections.

Essentially, Vygotsky's socio-cultural theory focuses on children's learning which he believes precedes development. In contrast, in my study the focus was on learners who are also regarded as co-researchers as they were asked to find some information on IK in relation to the topic on waves and sound, and about science in general in the community.

Wells (1999) argues that being the medium of classroom learning/teaching, language plays a significant role in affecting the kinds of opportunities for knowing and coming to know, as well as in encouraging collaborative group work. Kozulin, Gindis, Ageyev and Miller (2003, p. 21) concluded that "teachers' lack of spontaneous mediation in the classroom points to the necessity of providing them with systematic training in both the general types of mediation and specific techniques appropriate for a given age and subject matter". This suggests that skilling of teachers is required if they are to be relevant in the classroom, in terms of them helping learners to achieve.

From the socio-cultural theory, three key concepts, namely, social interactions, self-regulation, and the Zone of Proximal Development (ZPD) were employed in this study.

2.5.1.1 Social interactions

To Vygotsky (1978), social interaction is the basis of *learning* and *development*. Learning and development is a process of apprenticeship and internalisation in which skills and knowledge are transformed from the social into the cognitive plane. To this end, Nyika (2017) argues that what happens outside the classroom constitutes the culture of a society. Furthermore, Thaman (2009) asserts that education should not exclude cultural knowledge because the content of education has value underpinning of a particular culture.

Along the same lines, Shizha (2013) argues that it is through the implementation of IK in schools that learners, parents and communities can reclaim their voices of educating the African child. In this study, I invited two local community members who are knowledgeable about the sea and related cultural practices (Klein, 2011), to share their local knowledge about cultural beliefs and cultural practices related to the sea. This created a platform for my learners to interact with them, in their own mother tongue isiXhosa. In my view, this resonates well with Vygotsky's belief that language plays a crucial role in fostering learning. In the meantime, an essential ingredient that will be required from each learner for effective learning during the interaction is self-regulation.

2.5.1.2 Self-regulation

Self-regulation is one of the essential tools required for our learners to achieve. Harrison and Muthivhi (2013) define self-regulation as the learner's ability to regulate himself or herself and is essentially linked to social activity, allowing for profound developmental activity because it provides opportunities to safely test new learning and to establish appropriate dialogue. In other words, self-regulation means that learners are actively involved in the co-construction of knowledge, and herein lies the importance for them to be co-researchers. In addition, during the social interaction, the learners will learn from each other or develop their zone of proximal development.

2.5.1.3 Zone of Proximal Development

Vygotsky (1978, p. 86) defines zone of proximal development (ZPD) as, "the distance between the actual development level as determined by independent problem solving and the level of potential development through problem solving under adult guidance or in collaboration with more capable peers". In other words, the ZPD is created in the space between the actual development and the potential development, which means the possibility for learning occurs once the ZPD comes into existence. Similarly, Stott (2016) argues that the ZPD is a symbolic space, which does not exist prior to the learning activity. Like Vygotsky, Stott (2016, p. 28) further argues that the "ZPD is created through the social interactions with others during the learning activities and depends on the active contributions of all the participants". She refers to this as a collaborative

ZPD borrowing words from Goos (2004) and emphasises that all participants learn or develop in the ZPD. This kind of ZPD, according to Stott (2016), has a two-way character and perhaps suggests a less restricted notion, as each partner possesses some knowledge and skills, but requires another person's contribution to make progress. Vygotsky (1978) stresses that learning and teaching do not coincide with development, but that the developmental process lags behind the learning process.

2.5.2 Analytical framework: Contiguity Argumentative Theory

Govender (2014, p.359) asserts, that “often African learners are taught science and other subjects in westernised classrooms in the absence or denial of their cultural and indigenous experiences”. Furthermore, Govender (2014) argues that the lack of understanding and the exclusion of learners' African knowledge pose learning difficulties for them, as it is difficult for them to make sense of abstract science in the way it is taught currently. Several other scholars such as le Grange (2007), Webb (2013) and Mhakure and Otulaja (2017) have called for the development of culturally-sensitive strategies that integrate western science and IK.

This caveat triggered my interest to use Ogunniyi's (2007) Contiguity Argumentation Theory (CAT) as an analytical framework. It was hoped that CAT might provide valuable theoretical underpinnings to analyse the learners' arguments during the social interactions. Argumentation is critical to producing, evaluating, and therefore, advancing knowledge (Govender, 2014). Ogunniyi's (2007) CAT is rooted in the Contiguity Theory, which asserts that one or two states of mind or two distinct co-existing thought systems such as science and IK, tend to readily couple with, or recall each other to create an optimum cognitive state (Ogunniyi & Hewson, 2008, p. 161). To Ogunniyi (2007), the five components of CAT, namely, Dominant – a powerful idea explains and predicts facts and events effectively; Suppressed – an idea becomes suppressed in the face of more valid evidence; Assimilated – a less powerful idea might be consumed into a more powerful one in terms of the persuasiveness of the dominant idea to a given context; Emergent – there may be circumstances where no prior knowledge exists and new knowledge has to be acquired or developed; and Equipollent – when two competing ideas have comparably equal intellectual force, the ideas tend to co-exist without necessarily resulting in a conflict; will be employed in this study

to analyse ideas that will emerge during the social interactions (Vygotsky, 1978). It is hoped that might help me understand the learners' input during interactions and when analyzing their journal reflections. According to Ogunniyi (2007), CAT is contextually-based and it can be applied to two or thought-systems. Thus, CAT is viewed as a relevant analytical framework for the study.

2.6 Chapter Summary

In this chapter, I discussed literature relevant to the study. Firstly, I discussed an overview of the international context and of the South African curriculum in particular, in relation to the study. Secondly, I discussed indigenous knowledge. Thirdly, I discussed hands-on activities and prior knowledge, followed by a discussion around the perspectives from literature that talk to the conceptual framework, the theoretical framework and the analytical framework. I used the three frameworks as a lens to analyse the data in this study. In the next chapter, I discuss the research design and methodology employed in this study.

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

In the previous chapter, I discussed the literature relevant to my study. This chapter deals with the research design and methods that were used to explore whether or not learners' dispositions, conceptions and sense-making are influenced by integrating local or indigenous knowledge when teaching the topic on waves and sound in a Grade 10 Physical Sciences township class.

The chapter starts with the research design and orientation where I explain an interpretive paradigm, the quantitative and qualitative approach and the case study research method in detail. It is followed by the research goal and research questions. Thereafter, I explain the research site and the selection of participants, as well as my role as the researcher. The data collection and methods of data analysis are explained in detail. Finally, the validity and ethical issues which were taken into consideration, as well as limitations of the study are discussed.

3.2 Research Design and Orientation

According to Bertram and Christiansen (2015) a research design is a plan of how the researcher will systematically collect and analyse data that is needed to answer the research question. In the following section, the research design and orientation of the study are discussed.

3.2.1 An interpretive paradigm

This study is located within an interpretive paradigm whose focus is to develop a greater understanding of how people make sense of contexts in which they live and work. Bertram and Christiansen (2015) assert that the way in which people respond to a given situation depends largely on their past experiences and circumstances; hence, the learners' prior knowledge and the

local knowledge of the two community members were deemed relevant in this study. Similarly, Cohen, Manion and Morrison (2018) posit that the interpretive paradigm views the social world as an emergent social process, which is created by the individuals concerned through experiences. The purpose of the study was to explore whether or not learners' dispositions, conceptions and sense-making are influenced by integrating local or indigenous knowledge when teaching the topic on waves and sound in a Grade 10 Physical Sciences township class.

Suitable data gathering techniques had to be adopted to achieve this purpose. According to Bertram and Christiansen (2015), in the interpretive paradigm, data is collected in real and authentic situations which leads to explanations of behaviours, motives, perceptions and experiences. In this study, I also observed the behaviour of the learners during the brainstorming session and when they interacted with the community members who shared their experiences about the sea and their knowledge about cultural beliefs and practices related to the sea.

3.2.2 A qualitative case study approach

To be able to achieve the main aim of the study, a qualitative case study approach was employed. A case study is a comprehensive investigation of a confined system (Creswell, 2008). Case studies look at what it is like to be in a particular situation, so they are generally descriptive in nature (Bertram & Christiansen, 2015). My case in this study was a Grade 10 Physical Sciences class from a township school in the Eastern Cape. Additionally, two community members who were knowledgeable about the sea were invited as participants and the two science teachers participated as my critical friends. Informed by Chikamori, Tanimura and Ueno's (2019) Transformative Model of Education for Sustainable Development (TMESD) framework, the study employed a participatory approach. The TMESD framework was deemed appropriate in this study since central to it is designing, implementing and improving IK integrated Science lessons. Chikamori et al. (2019) explain that the TMESD framework is composed of three learning sub-processes: 'knowing the present', 'past-present relationships' (focusing on the dependence of the present on the past) and the 'future-present'. These scholars refer to the process of studying the past-present relationships as *retroduction* and future-present relationships as *retrodiction* (see Figure 3.1) below.

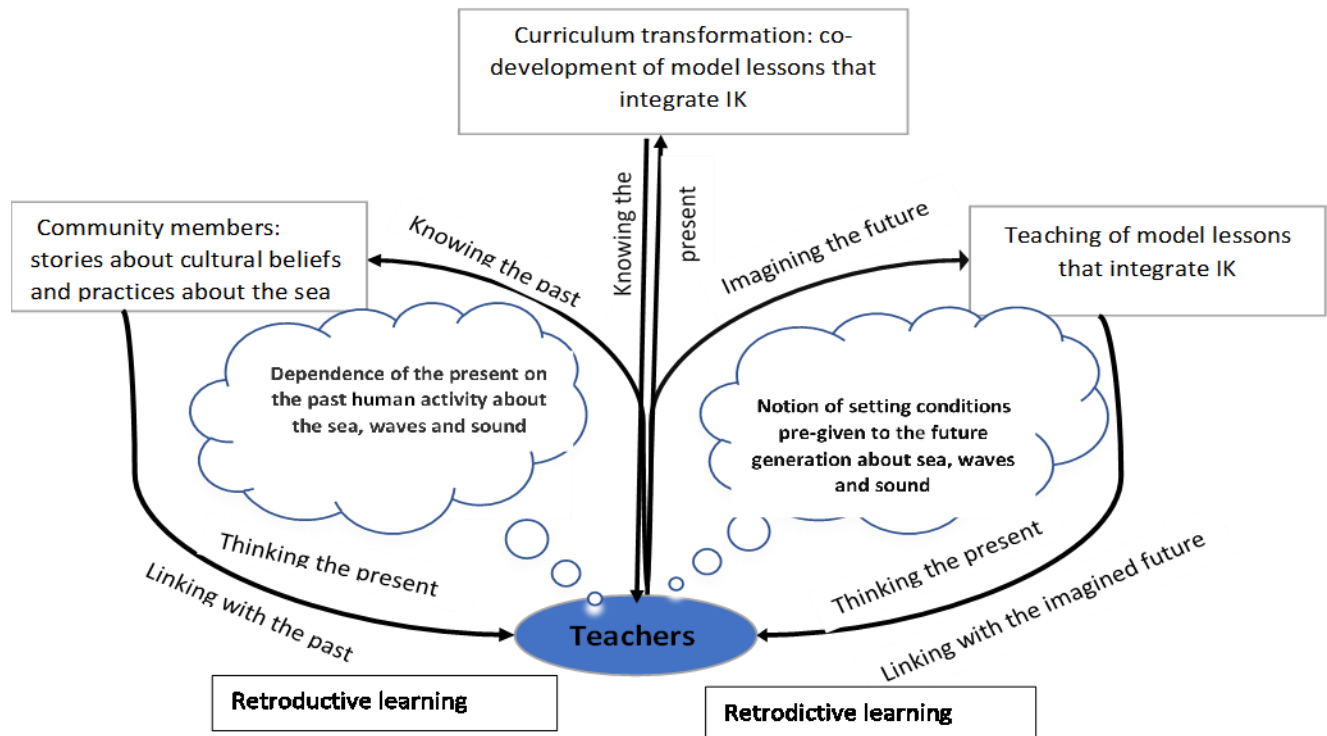


Figure 3.1: Shows learning process regarding the integration of IK in science lessons (adapted from Chikamori et al., 2019, p. 9)

In the context of my study, firstly, the past had to do with understanding the stories on cultural beliefs and practices about the sea. The sea in this study is used as a resource to enrich understanding of certain concepts in waves and sound. Secondly, the present had to do with integrating such local or indigenous knowledge in lessons on the topic on waves and sound, with the view to making science relevant and accessible to learners from an under-resourced township school. Thirdly, the future entailed enacting such lessons.

My unit of analysis was thus the learners’ interactions with each other, the science teachers and with the community members, and how they used the information on IK to make sense of science concepts. Learners’ arguments during the interactions were also recorded and analysed using CAT (Ogunniyi, 2007).

3.3 Research Goal and Research Questions

In this section I outline the goal of the study, the objective of the study and the research questions that guided the study.

3.3.1 Research goal

The main goal of this study was to explore whether learners' dispositions, conceptions and sense-making are influenced (or not) by integrating local or indigenous knowledge when teaching the topic on waves and sound in a Grade 10 Physical Sciences township class. To achieve this goal, the study was be guided by the following research questions.

3.3.2 Research questions

1. What are the indigenous practices and knowledge that can be integrated into the topic on waves and sound in Grade 10 Physical Sciences lessons?
2. How do Grade 10 Physical Sciences learners interact, participate and learn during the co-presentation by community members?
3. How do lessons on waves and sound that integrate IK influence (or not) Grade 10 Physical Sciences learners' conceptions, dispositions, and sense-making?

3.4 Research Site, Participants and Sampling

The study was conducted in an Eastern Cape township school in South Africa. Purposive sampling was used to choose the grade based on the fact that the topic on waves is taught in Grade 10 at high school level. For that reason, a Grade 10 science class from a township school was chosen. In addition, two community members (an elderly man from the community and a local fisherman), who are more knowledgeable about the local knowledge of the town and the sea (Vygotsky, 1978), were invited to share their experiences. Unlike in Hashondili's (2019) study, the two community members co-presented on cultural beliefs and practices about the sea. This they did on their own without me telling them how to present. I found this quite innovative on their part, as they complemented each other very well during the presentation. The Grade 10 science learners were co-researchers with their teacher. This means I conducted the research with my learners, and they were involved in the co-construction of knowledge. That is, I did the research *with* them rather

than *on* them (Ngcoza & Southwood, 2015). Additionally, two science teachers from my school were involved in this study as my critical friends, since it is impossible to observe your own practice.

3.4.1 Research site

In this section, the geography of the Sarah Baartman District, the profile of Buyelembo Combined School, and the language of the community of Buyelembo are discussed in detail.

3.4.1.1 The geography of Sarah Baartman District

Buyelembo Combined is one of the township schools in the Sarah Baartman District, in Port Alfred situated in Ndlambe and the participating school in this study. Sarah Baartman is one of the 12 districts of the department of education in the Eastern Cape.

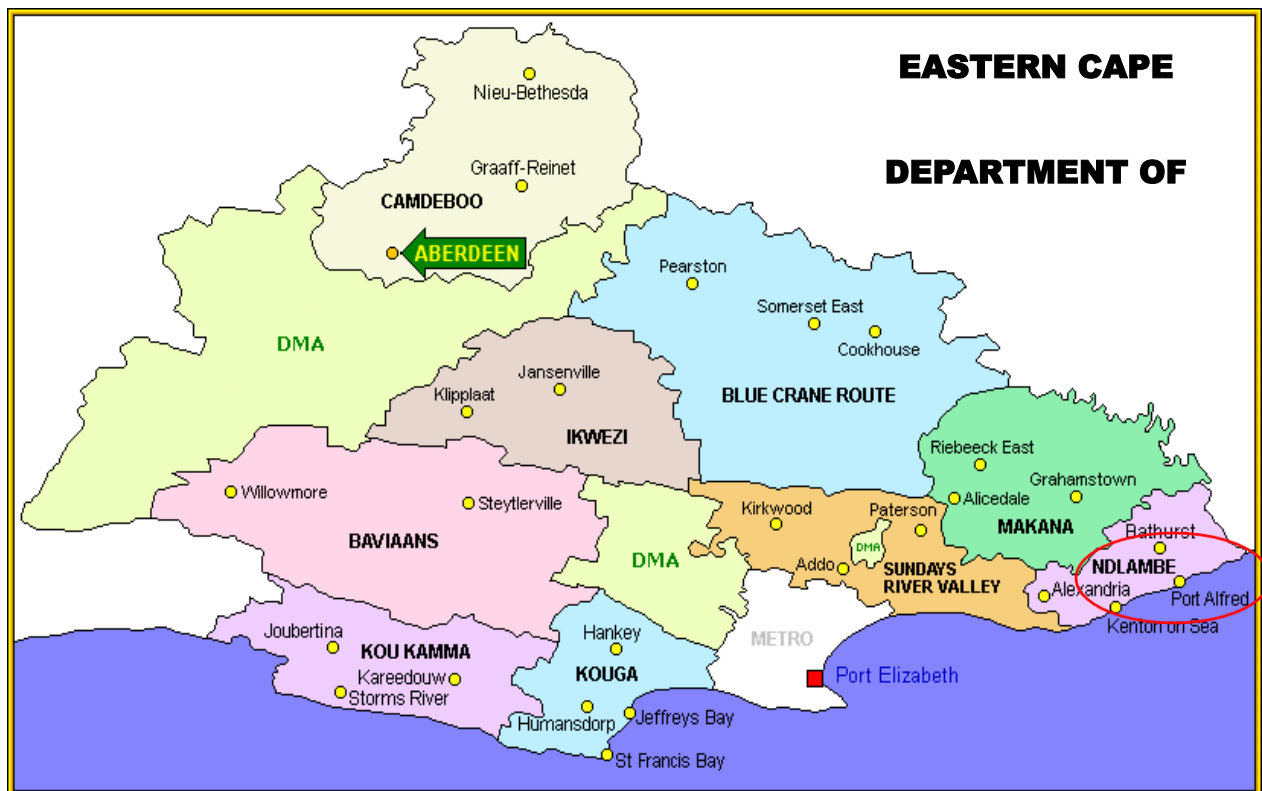


Figure 3.2: Map of Sarah Baartman District (<https://www.ecdoe>)

Table 3.1: Statistical information of schools in Sarah Baartman District
(<https://www.ecdoe>)

OVERVIEW - SARAH BAARTMAN DISTRICT				
Type Of School	GRT (34)	GHRT (22)	UIT (35)	TOTAL (91)
Primary	62	47	77	186
Secondary	13	10	12	35
Combined	3	11	6	20
Special	0	2	0	2
Independent	0	0	7	7
Pre-Primary	3	3	0	6
TOTAL	81	73	102	256 (165)

Sarah Baartman is a vast district which makes it difficult for the subject advisors to visit all the schools and assist the teachers. Most of the times, the teachers are left on their own to deal with subject related challenges. This therefore means every teacher has to come up with ways to address those challenges. Physical Sciences is one of those subjects with challenges, and it is hoped that the findings of this study might help the science teachers better understand these challenges and hopefully come up with possible solutions to some of them.

3.4.1.2 Buyelembo Combined School

There are 256 schools in the Sarah Baartman District, Buyelembo (Pseudonym) Combined (see Fig 3.3 below), the participating school, is situated in Port Alfred in Ndlambe municipality, a town near the sea. Buyelembo is a combined school meaning it starts from Grade R to Grade 12. It is a functional or a performing school in terms of Matric results. Generally, the teachers and the learners are usually at school and in class. In terms of discipline, the learners are well disciplined with isolated cases of minor misconduct. On average, the school achieves above 80% pass rate in all grades and was rated position five in the district in the 2018 Matric results.

The school is situated in an impoverished area known as Endlovini (squatter camp) location and the majority of the parents of the learners at Buyelembo are illiterate. The total enrolment of the school is 1357 learners, and the average number of learners in a class is 45. The school has a full complement of teaching staff, 37 teachers, two administrative clerks, two groundsmen and one admin cleaner. The school is well maintained, and the grounds well looked after, providing a promising environment for teaching and learning as seen in Fig 3.4 below – and is a beacon of hope for the Endlovini community.



Figure 3.3: Buyelembo Combined School – the participating school

3.4.1.3 The language of Buyelembo community

All the learners and the teachers, except Mr Y (pseudonym) are Xhosa home language speakers. The language of teaching and learning is English except in the Foundation Phase (Grades R-3). The majority of learners speak *isiXhosa* outside of the classroom, or sometimes mix *isiXhosa* with English. The role of language in social interaction and in relationships plays a vital role in learning (Vygotsky, 1978). While English may be the language for the global market and job opportunities,

isiXhosa underpins the participants' identity. The Xhosa culture and knowledge are best understood through the Xhosa language at Buyelembo and Endlovini Community.

I took a position to use both *isiXhosa* and English to communicate with the participants, as I understood that language influences the research process in many ways, and I am also an *isiXhosa* first language speaker myself. Ethically, as a researcher I had a responsibility to effectively communicate the aim of the study and expectation to all the participants. I had information and consent forms for participants in both *isiXhosa* and English. Communicating in *isiXhosa* had the potential benefit of generating rich data (Msimanga & Lelliot, 2014; Mavuru & Ramanarain, 2019), as participants often feel comfortable when they speak their own mother tongue. I am also mindful that language is an integral part of indigenous knowledge.

3.4.2 Participants and sampling

The sample size in this study was relatively small because the study was not aimed at generalisation of the findings of the study (Bertram & Christiansen, 2015), but was rather to explore whether or not learners' dispositions, conceptions and sense-making are influenced by integrating local or indigenous knowledge when teaching the topic on waves and sound in a Grade 10 Physical Sciences township class. I now discuss the participants in the study and how they were sampled, and my positionality.

3.4.2.1 The grade 10 Physical Sciences learners

Purposive sampling was used to select the class based on the fact that the topic on waves and sound is only taught in Grade 10 at high school level. The class consists of 18 learners, consisting of four boys and 14 girls. The learners participated as co-researchers in the study, meaning I researched *with* them and not *on* them. All the learners opted to participate in the study and written consents from the learners and their parents were sought.



Figure 3.4: Shows the two community members, the learners and teacher at the beach

3.4.2.2 Community members

Two community members participated in the study and they gave me their verbal willingness to participate based on *ubuntu*³ principles. However, to comply with ethical requirements of the study of this nature written consents were sought, which they gladly signed after I explained to them why I needed written consent.

Community member 1 is a 66 years old called Sir Mba (pseudonym), a former groundsman of the school who is now on retirement. He was also chosen purposefully because during his time at Buyelembo, he used to share stories with me and other teachers about life in Port Alfred and Xhosa traditional beliefs and practices. Sir Mba is a knowledgeable *isiXhosa* speaking man and has lived most of his life in Port Alfred except when he had to go and work at the coal mines in Durban. Sir

³ Ubuntu is underpinned by a concern for the welfare of others, manifesting among others, respect, communalism, kindness, generosity, honesty, caring for others, and participation for the common good (Hamming, 2005).

Mba and I had a close relationship when he was still working at Buyelembo as the school groundsman and I have learnt many interesting African stories from him. In addition, he showed keen interest towards the education of the black child and was always willing to share his experiences and knowledge with the learners, and on many occasions, he has accompanied teachers when they took learners on various excursions. Sir Mba has Standard 4, but he is fluent in English and can speak Afrikaans, *isiZulu* and *Sesotho* well. He is very fond of education and is a keen motivator.

Community member 2 is Sir Mlo (pseudonym) who is a 57 year old Xhosa man and a neighbour of Sir Mba. He was born and bred in Port Alfred and has never gone to the big cities, and I got to know him through Sir Mba. He is an experienced local fisherman and was willing to share his knowledge with the learners. In terms of education his highest standard is Standard 5, and he can speak English. He uses his rod to fish and has fished in various places such as the Great Fish River, Kenton on sea. He boasts of catching the finest and some of the biggest fish in the area.

3.4.2.3 The two physical sciences teachers and myself

Mr Y and Miss S (pseudonyms) are the two science teachers who participated in the study. Mr Y is a 43 year old African male and is originally from Cameroon. He is the deputy principal of the school and the Head of the science department at Buyelembo. He has a BSc degree and majored in Physics and Mathematics, and has a Higher Diploma in Education. He has been teaching at the school for the past eight years and has been living in South Africa for the past 12 years. He is now a South African citizen and can speak *isiXhosa* fluently. Miss S is a 37 year old African female. She grew up in Port Alfred and studied at Buyelembo, before going to Fort Hare University. She is a BEd (Science and Maths) graduate and has been teaching at Buyelembo for the past six years. I am also a Physical Sciences teacher at Buyelembo and the researcher in the study. During the presentations by the two community members, I was a participatory observer. The two science teachers and I have formed a community of practice at Buyelembo, where we share resources, information and practice team teaching. This means we all teach grades 10-12. Each teacher is given a topic in Physics and a topic in Chemistry to teach in that particular year by Mr Y.

Over the years we have established a good working relationship amongst ourselves and we trust each other completely. The two science teachers served as my critical friends in the study and also helped in the co-planning of model lessons that integrated IK. In this regard, the participation of the two science teachers contributed positively towards their professional development, wherein they would be allocated points by the South African Council for Educators (SACE) towards a programme known as Continuing Professional Teacher Development (CPTD). SACE will issue a Certificate of Achievement to each teacher who achieves the target number of professional development (PD) points within the three years starting from 2018. The South African Council for Educators (SACE, 2013) emphasises that teachers need to grow their knowledge and skills through their careers like all professionals. The outcome of the study will help me develop confidence in Physics and maybe improve my teaching strategy.

Table 3.2: Background information of the two science teachers

Pseudonym	Age	Gender	Academic/ Professional qualifications	Place of Birth	Teaching experience	Number of years at Buyelembo
Miss S	37	Female	BEd (Science and Mathematics methods)	South Africa	6	6
Mr Y	43	Male	BSc (Physics & Mathematics majors); HDE	African Country	12	8

The background of the two science teachers indicates that they are both well qualified science teachers with teaching experience of more than five years each. In addition, Mr Y is our Physics specialist with indigenous knowledge from an African Country.

3.4.3 My positionality

Since I was conducting the study in my own classroom, the issue of positionality and power relations were expected to arise. Thomas (2013) argues that interpretive researchers (like me) have an undeniable position in the research process and this position affects the nature of the observations and interpretations that they make. This suggests that the issue of positionality, power, and representation play a role in conducting research. Firstly, I addressed the issue of positionality by ensuring that all the participants in this study were not forced or obliged to participate in it.

Secondly, I positioned myself as a co-learner when the community members were doing their presentations, and I acknowledged that they are the custodians of these cultural heritages or are regarded as knowledgeable others as proposed by Vygotsky (1978). Put differently, that their inputs will broaden my understanding of IK in relation to the sea and related cultural beliefs. Thirdly, I spoke to the Grade 9 parents during the meeting for subject choices for Grade 10 this year, and I informed them about my research study at Rhodes University and that I was interested in developing my academic understanding of how best to integrate IK in my Science lessons especially on the topic on waves, and that I would like to work with their children in my project, and they agreed. But as I discussed in the ethics form, I followed this up with the informed consent letters written in *isiXhosa*.

Furthermore, I highlighted that I would like to strengthen my Physics which is part of Physical Sciences as I majored in Chemistry at university. I therefore felt that this study might open up an opportunity for me to have a better understanding of science. I was upfront about this to my learners so that they could see that I was a co-learner during this study. Additionally, written consent was sought from all relevant stakeholders. Lastly, I acknowledged that being a principal of the school put me in a challenging position as my participants might find it difficult to say no, but I also believed that I had earned their trust over the years and that I would do everything in my power to ensure that their dignity was not compromised in any way, and that no coercion of any form would take place.

3.5 Data Generation

In order to answer the research questions and realise the main goal of the study I needed data. I used various data collection techniques as discussed below.

3.5.1 Data generation techniques

Group activity, observations, stimulated recall interviews and learners' journal reflections were used as data generation techniques in this study. I believed the use of a variety of data generation techniques would enable me to gather enough data to answer the research questions and help to triangulate the data for validation purposes. I now discuss each of the data generation techniques below.

3.5.1.1 Group Activity

The rationale for using a group activity in this study was twofold. Firstly, to create a relaxed and non-threatening environment for the learners. Secondly, to reduce risks as these are minors and while at the same maximise active participation (Sedlacek & Sedova, 2017) and social interactions (Vygotsky, 1978). Learners were divided into three groups of six (mixed boys and girls) to find information in the community, for example, on cultural beliefs and practices associated with the sea and waves. The class were numbered from 1 to the last learner number 18 so that each learner had a number. These numbers were their pseudonyms and were used throughout as a label for activities. The groups were given about 10-15 minutes to discuss the following questions:

1. What cultural beliefs related to the sea and waves have you heard of?
2. What cultural practices related to the sea and waves have you heard of?
3. What relevance have these cultural beliefs and practices in science?

The group discussions were recorded on newsprint which learners used to make presentations to the entire class. I planned 60 minutes for the presentations, but we went beyond time by 30 min, as the learners requested to go on until they finished the task. Learners in this study were therefore viewed as co-researchers as they were given an opportunity to find information in relation to the sea and related cultural practices from their community, something that resonates well with

Vygotsky's (1978) socio-cultural theory, my chosen theoretical framework for this study. Throughout the group activity, I noted that learners' interaction and participation were very high.

Data from the group activity informed the co-planning of a model lesson that integrated IK. Subsequently, the two Science teachers and I sat down and co-planned and developed a lesson plan, which I then taught to the class while the two Science teachers observed. Co-planning and subsequent discussion helped us to get a better understanding of indigenous knowledge related to waves and sound. In addition, I learnt so much from the learners' brainstorming and presentations and the good work they produced. I was motivated by the learners' enthusiasm and encouraged by their request that we should go beyond the scheduled time. To me this suggested that they were enjoying the activity and had a positive attitude which is vital for effective learning.

3.5.1.2 Observations and presentations

In this study, I observed how learners interacted with the community members and how they responded to the input on IK during the presentations by the two community members. To Maxwell (2012), observation provides a direct and powerful way of learning about people's behaviour and the context in which this occurs. With the permission of the participants, all lessons and presentations were video recorded, and with the help of the two Science teachers, were transcribed at a later stage. Also, I took some notes during the presentations. Observations were done in four phases.

Phase 1 – Learners (my co-researchers) went out to the community to find information through interviewing some community members about IK and cultural practices related to waves and the sea. I then organised a brainstorming session where the learners reported back on their findings. Their information was presented on newsprint.

Phase 2 – I identified two community members, a local fisherman and an elderly man from the community who used to work at our school as our groundsman (who showed keen interest in education) although he is now on retirement. The two community members co-presented their experiences and knowledge about waves and cultural practices to the Physical Sciences Grade 10 learners during our outing to the sea.

Phase 3 – A lesson on practical activities on waves and sound prior to the intervention was presented, wherein learners were actively involved. Practical activities are activities in which learners are working individually or in groups, handling and observing the objects or materials they are studying (Millar, 2010).

Phase 4 – The two science teachers and I then co-planned a lesson plan that included IK. I then taught the topic on waves and tried to integrate IK during my Science lessons and asked the two Science teachers from the participating school to be my critical friends. The lesson was video recorded.

During the presentations by both the learners and the two community members I positioned myself as a co-learner. Indeed, I learnt a lot during the process, and I was humbled by the knowledge the two community members had about cultural beliefs and practices associated with the sea and waves. I realised that they were more knowledgeable (Vygotsky, 1978) than I was, and in essence their presentations made me realise that we were taking the community to the science classroom, as the interactions between the community members and the learners were on a very high note. Similarly, the presentations by the learners were very informative and interesting, it was clear to me that the learners took their role as co-researchers very seriously and they certainly earned my respect. I am happy to say I was doing a research with these learners rather than on them (Ngcoza, 2007). The smiles on the learners' faces and the level of participation indicated to me that they were enjoying this study.

3.5.1.3 Stimulated recall interviews

During stimulated recall interviews, participants are afforded an opportunity to clarify their thoughts (Gass & Mackey, 2017). In this study I used focus group stimulated recall interviews, meaning I interviewed learners in their groups. The reason for doing group interviews was that I wanted to create a relaxed environment for the learners. The main aim of the stimulated recall interviews was that I wanted to have a deep engagement with the learners, and I wanted to use the opportunity to get a better understanding of the learners' conceptions, dispositions and sense-making of the topic on waves and sound. We (the two Science teachers, the learners and myself),

watched the videotaped lessons and I asked the learners some questions (see Appendix G). For example, I asked the learners their thoughts about cultural beliefs and practices after watching the presentations by the community members. Also, I looked at their gestures or facial expressions during the presentation on the video and asked them to express their feelings in words.

This method was used to check the accuracy of my observations and to get an in-depth understanding of those gestures. The stimulated recall interviews proved to be a very effective data gathering tool as I got rich data from the learners and a better understanding of their reactions demonstrated during the lesson presentations. However, some learners responded by giving short answers during the interviews, so I was pleased when some learners requested to respond to the questions in writing. I was pleased because that suggested to me that they had grown in confidence in their journal writing skills and they were willing to share their feelings with me. Also, the stimulated recall interviews afforded me an opportunity to listen to the learners as they made sense of the topic on waves and sound.

3.5.1.4 Learners' journal reflections

The reflective journals are personal artefacts, however, I discussed with my learners and their parents and we reached an agreement that each learner should have a special reflective journal for Physical Sciences, whereby they reflected on how they found the lessons, what areas of the lessons they did not understand, which sections they understood and which sections they felt they needed help with from the teacher. Put differently, journal reflection provides learners an opportunity to express their attitudes, and to critically reflect on the activities they are engaged in. The learners also agreed to share their experiences with the class that is before the start of the next lesson. Learners were therefore afforded an opportunity to read out what they had written about the previous lesson.

I had learnt this technique from Rhodes University, and I have adopted it for all my subjects. Not only does it help me understand the challenges the learners experience during Science lessons, but it also helps me reflect on my teaching practice, and it also helps the learners improve their critical writing. I have been using learner reflective journals to improve my teaching methodology for the

past three years (not for research purposes though) and have found it to be an effective tool. Journal reflection plays a major role in enabling learners to identify and record their experiences and beliefs about Science itself, and learning of Science (Towndrow, Ling, & Venthan, 2008).

At the beginning of the year in 2019, I introduced my learners on how to write reflections and I guided them in order to reduce the pressure and the difficulties associated with writing. During my data generation process, I then asked them (the learners) to reflect in their journals after each activity and lesson (see Appendix G). McMillan and Schumacher (2014) posit that journals are a personal account of the learning experienced. The journals proved to be a powerful source of data, which gave me an in-depth understanding of the learners' conceptions, dispositions and sense-making. Nine learners' journal reflections were analysed because only nine learners submitted their journals.

In this study, journal reflections gave me access to learners' experiences and dispositions on the integration of indigenous knowledge when teaching the topic on waves and sound. I also discovered that the majority of the learners preferred to write in English as opposed to writing in *isiXhosa* their mother tongue, even though they were given permission to write in either English or *isiXhosa*. Secondly, I noticed that the most of the learners battled to write in detail, but rather used simple expressions to express their feelings, for example they used expressions such as “the lesson was fun” or “I enjoyed the lesson” or “the topic was interesting”. Despite this shortcoming, the journal reflections overall proved to be a useful source of data.

3.6 Qualitative Data Analysis

After collecting data, the next step is to analyse data. Miles and Huberman (1994) define data analysis as consisting of three flows of activity: data reduction, data display and conclusion drawing and verification. Concurring, data reduction to Bertram and Christiansen (2015, p. 116) “is the process of selecting, focusing, simplifying, abstracting and transforming data that appear in written-up field notes or transcriptions”. The section below discusses how the qualitative data were analysed.

An inductive-deductive approach was used to analyse the data. Data was coded and analysed inductively through putting it into categories, then combining similar categories to form themes. Socio-cultural theory was used to analyse the learners' learning in social interactions, based on their experiences, knowledge, feelings, arguments and input. Vygotsky's (1978) concept of social interactions, self-regulation, and ZPD was used as a lens to analyse the data. Additionally, the five components of CAT, namely, dominant, suppressed, assimilated, emergent and equipollent ideas (Diwu & Ogunniyi, 2012), were employed as an analytical tool.

During the group activity, I used field notes and the learners' newsprints. The community members' presentations were videotaped, which were then transcribed into stories word by word, so that the information was not lost or distorted during the transcribing process. From the stories, colour coding was used to highlight similar statements, from which themes emerged. The literature reviewed and the theoretical framework were then used to analyse the data. Similarly, stimulated recall group interviews were audio taped, and then were transcribed word by word into notes.

I used these and the field notes taken during the interviews, as well as the written responses from the learners (some learners requested to write down their responses as they felt they could elaborate more). These and the learners' journals were collated and colour coded to identify emerging themes. The data were then analysed using the theoretical and conceptual framework and Ogunniyi's (2007) CAT as the analytical framework. The interactions among the learners during the group activity, and the interaction between the two community members and the learners, and the interaction between myself and the learners during the intervention lessons, enabled me to observe the influence of IK when teaching and learning the topic on waves and sound.

3.7 Validity and Trustworthiness

Mathison (1988) posits that good research practices require researchers to use a variety of data sources. Cohen et al. (2018) refer to this as triangulation, a process essential for validation and trustworthiness of data. In light of this, in this study, I used a group activity (brainstorming) by the learners, observations of learner presentations on newsprint, co-presentations by the two community members on cultural beliefs and practices associated with the sea and waves, and my intervention lesson presentations which were videotaped. In addition, journal reflections and

stimulated recall interviews were employed to gather more in-depth data and clarity from the learners; furthermore the two Science teachers served as my critical friends and helped with member checking and validation of the data. The use of more than one data collection instrument ensured that the generated data was accurate and reliable. Cohen, Manion and Morrison (2011) argue that triangulation in the data gathering process helps to improve the trustworthiness of the data obtained. Also, the presentations by the two community members gave us first-hand information from the custodians of the indigenous knowledge, and the fact that they were video recorded offered me an opportunity to transcribe accurately. After writing down their presentations, I checked with the two community members to verify if I captured their inputs correctly.

3.8 Ethical Considerations

As a researcher, I am well aware of the importance of adhering to ethical principles when one conducts a study of this nature. According to Bertram and Christiansen (2015), ethics is an important consideration in every research. If the ethical issues are not maintained while doing a study, the findings might be questionable, and the rights of the participants may be violated in the process. In this study, research ethics were adhered to throughout the research process. Before embarking on this study, I sought the ethical approval of the Rhodes University Ethics Committee. After obtaining the clearance letter from Rhodes University, I sought and obtained ethical approval from the Director of the Sarah Baartman District since the participating school is in that district. In this section, I highlight how ethical principles were addressed with the participants in this study.

3.8.1 Negotiating access and getting informed consent

My engagement with the two Science teachers and Grade 10 Physical Sciences learners of Buyelembo Combined had the approval of the head of the Sarah Baartman District who had delegated powers to represent the Provincial Department of Education. This approval was in writing. I then sought and obtained written consent from the Deputy Principal of Buyelembo Combined School. The letter gave me access to Buyelembo Combined; however, the letter did not mean that the teachers and the learners were obliged to work with me. This meant I had to develop

trust with the parents of the learners first. Now I outline how I developed trust with the parents and the learners.

3.8.1.1 Developing trust with the parents and the learners

I spoke to the Grade 9 parents during the meeting for subject choices for Grade 10 in 2018, and I informed them about my research study at Rhodes University. I explained to them that I was interested in developing my academic understanding of how best to integrate IK in my science lessons especially on the topic on waves, and that I would like to work with their children in the study, pending the approval by the Higher Degrees Committee. I informed the parents about my reasons for such a study, which are the same as those outlined in Section 1.5 of this study.

In 2019 after receiving approval from the Higher Degrees Committee from Rhodes University, I requested another meeting with the parents and the Grade 10 Physical Sciences learners in the presence of the school management team (SMT) and the Grade 10 class teachers. I informed the parents that I had received written permission from Rhodes to go ahead with the study, and I showed them the letter and explained to them the contents of the letter in *isiXhosa* in order to make sure that they all understood the contents of the letter.

Then I explained the purpose of the study in detail and the possible benefits of the study. I explained in *isiXhosa* that they were under no obligation to give me permission to work with their children in the study if they did not feel like it, and I also explained that the study was not going to interfere with normal teaching and learning, but rather it was going to be done after normal school hours. This was to ensure that the learners who opted not to take part in the study were not disadvantaged in any way. In addition, I told the parents and the learners that those who chose to participate had the right to withdraw from the study at any time should they see the need to do so.

Furthermore, I told them that all observations would be videotaped and used for the purposes of the study only and complete anonymity would be guaranteed. This would be ensured by the use of pseudonyms within the write up of the thesis. We then left the parents in the room to discuss it with their children and requested that they send one of the learners to call us once they had reached their decision. All the parents gave me their verbal consent that their children were willing to

participate in the study with me as my co-researchers, which is a common practice in Xhosa culture, where your word means everything. I then explained to the parents that without undermining their cultural practice of verbal consent, I needed written consents from them in order to comply with the ethical requirements at Rhodes University. The parents gladly signed the letters that I had written in *isiXhosa* outlining the study in detail and clearly stating the roles of the learners. They also gave me consent that I could use the photographs of their children only for the purposes of this study. To achieve the goal of the study I needed the two community members as participants.

3.8.1.2 Developing trust with the two community members

As I have explained in Section 3.4.2, two community members (elders) participated in the study. One of those members was Sir Mba (pseudonym). Sir Mba and I have a long history, as we worked together for nine years. Sir Mba worked as a groundsman at Buyelembo Combined before going on retirement in 2018 and during his time at Buyelembo we had a good relationship based on trust and mutual respect. He used to accompany the teachers when they took learners out on various educational excursions, and all the teachers, myself included, used to marvel at Sir Mba's knowledge of the history of the town and his knowledge of the Xhosa culture and local knowledge in general; as well as how fond he was of education, and his willingness to share his knowledge with both the teachers and the learners.

During his farewell speech he indicated his willingness to continue to help the school in any way he could, and I used that offer for this study. I approached him and explained to him what the study was all about and asked if he was willing to take part in the study. He was more than willing to participate in the study, and I asked him if he knew any local fishermen, as I was also interested to find out more about the sea and related cultural practices. Sir Mba recommended a local fisherman (Sir Mlo, pseudonym) his next-door neighbour, and suggested that we should approach him together. We went to Sir Mlo's house, and Sir Mba introduced me and explained the purpose of our visit. Before I could say anything, the two gentlemen had agreed that they were going to participate in the study as co-presenters. Therefore, this study benefitted from mutual relationships that were established long before its conception.



Figure 3.5: I am on the left, Sir Mba in the middle and Sir Mlo on the right and then the learners

Both community members gave me their verbal willingness to participate based on *ubuntu* principles. However, to comply with ethical requirements of the study of this nature written consent was sought, which they gladly signed after I explained to them why I needed written consent. I was also respectful of their culture and positioned myself as a co-learner in the study. The two community members also gave me consent for their photographs to be used in this study since they were part of the study. I felt that the study would be incomplete without the participation of the Science teachers in the school. I now outline how I negotiated with the two Science teachers.

3.8.1.3 Developing trust with the two science teachers

Fortunately, at Buyelembo Combined we have a community of practice as the Science and Maths teachers, and we are all concerned with the decline in learners' performance. The two Science teachers volunteered to participate in the study after I had shared with them what I had learnt about indigenous knowledge and science in our last contact session of the BEd (honours) programme at

Rhodes University. They encouraged me to study further and enrol for the master's programme and I did. I was also honest with them that I was not that comfortable with some of the Physics topics and that I also wanted to improve my teaching pedagogy of Physics in particular. We all agreed that this study might open up an opportunity for all of us to improve our teaching practice, and hopefully we might gain new insights on the integration of indigenous knowledge when teaching science.

3.9 Chapter Summary

In this chapter, I discussed the research design and orientation where I explained an interpretive paradigm, and the quantitative case study research method in detail. This was followed by the research goal and research questions. Thereafter, I explained the research site and the selection of participants, as well as my role as the researcher and my positionality. The data collection and methods of data analysis were explained in detail. Finally, the validity and ethical issues which were taken into consideration were discussed.

CHAPTER FOUR: DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.1 Introduction

The main goal of this study was to explore whether learners' conceptions, dispositions, and sense-making are influenced (or not) by integrating local or indigenous knowledge when teaching the topic on waves and sound to a Grade 10 Physical Sciences township class. In the previous chapter, I presented the research design and methodology informing this study. In this chapter, I thus present, analyse and discuss data generated from observations during the learners' group activity and the presentations made by the two community members. The data presented here were aimed at addressing my research questions one and two:

- What are the indigenous practices and knowledge that can be integrated into the topic on waves and sound in a Grade 10 Physical Sciences lessons?
- How do Grade 10 Physical Sciences learners interact, participate and learn (or not) during the presentations by community members?

4.2 Summary of the Qualitative Data Generated During the Group Activity

This section begins by presenting the biographical information (Table 4.1) of the Grade 10 Physical Sciences learners of Buyelembo Combined School who participated as my co-researchers in this study. This is followed by Table 4.2 which shows codes and pseudonyms used in the discussion of data.

Table 4.1: Profile of the Grade 10 Physical Sciences learners

Biographical information	Categories	Learners' code	Total number
Age	15	L1F, L2F, L3F, L8F, L9F, L12F, L15M	7
	16	L4F, L7F, L10F, L11F, L13F, L16M, L18F	7
	17	L5F, L6F, L14M, L17M	4
Gender	Male	L14M, L15M, L16M, L17M	4
	Female	L1F, L2F, L3F, L4F, L5F, L6F, L7F, L8F, L9F, L10F, L11F, L12F, L13F, L18F,	14
Mother tongue	IsiXhosa	L1 – L18M/F	18

Table 4.2: Keys and pseudonyms used in data discussion

Learner 1-18 Male/Female	L1 – L29M/F
Group 1-3	Power Rangers (PR), Super Natural (SN), Ezendalo (E)
Reflection Learner 1-18	RL1 – RL18

In this group activity, learners were divided into three mixed groups of six (boys and girls) to find information in the community on cultural beliefs and practices associated with the sea and ocean. To ensure that the data generated from the group activity were relevant to the study, learners were given three guiding questions to focus on and direct their discussions in their groups. The three guiding questions were:

1. What cultural beliefs related to the sea and waves have you heard of?
2. What cultural practices related to the sea and waves have you heard of?
3. What relevance have these cultural beliefs and practices in science?

The learners were then given time to write down their findings on newsprint in class and to discuss them in their groups. After the group discussions, each group presented their findings to the entire class as shown in Figure 4.1 below.



Ezendalo (E) presenting



Twins (L5 and L6)



Ezendalo brainstorming



Power Rangers (PR) brainstorming



Super Natural (SN) brainstorming

Figure 4.1: Shows learners brainstorming in groups and presenting to the entire class

Thereafter, the class was given about five minutes for questions and answers. It is worth noting that I had planned about one hour for the presentations, but we went beyond this time by 30 minutes as the learners themselves requested to go on until they finished the task. It could be deduced that this was an indication that learners had an interest in what they were doing.

All three groups gave presentations, and data from all presentations were used in this analysis process. The groups were given codes as shown in Table 4.2 above, for example, PR refers to group one, known as the Power Rangers, SN refers to group two, known as Super Natural and E refers to group three, known as Ezendalo. These codes are used throughout this data analysis. The learner presentations were on newsprint as shown in Figures 4.2, 4.3 and 4.4, and the presentations were in accordance to the guiding questions given to the learners beforehand.

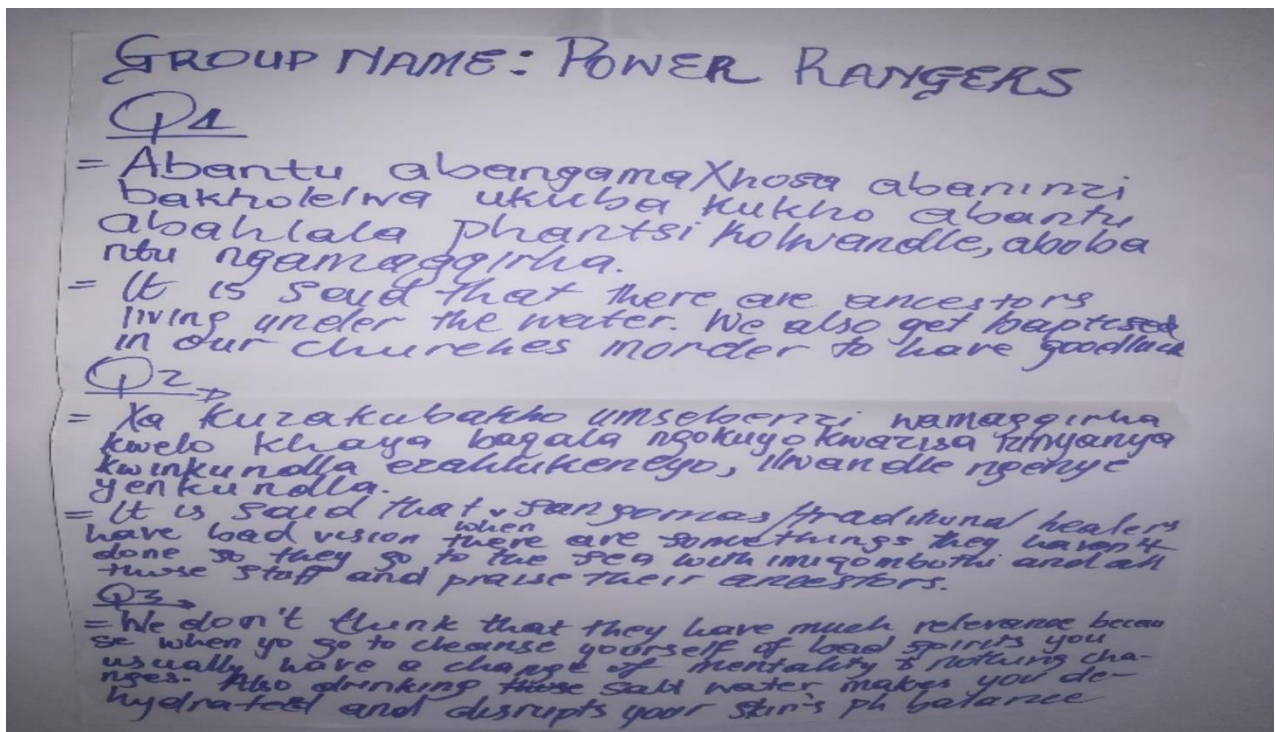


Figure 4.2: Newsprint presented by Power Rangers

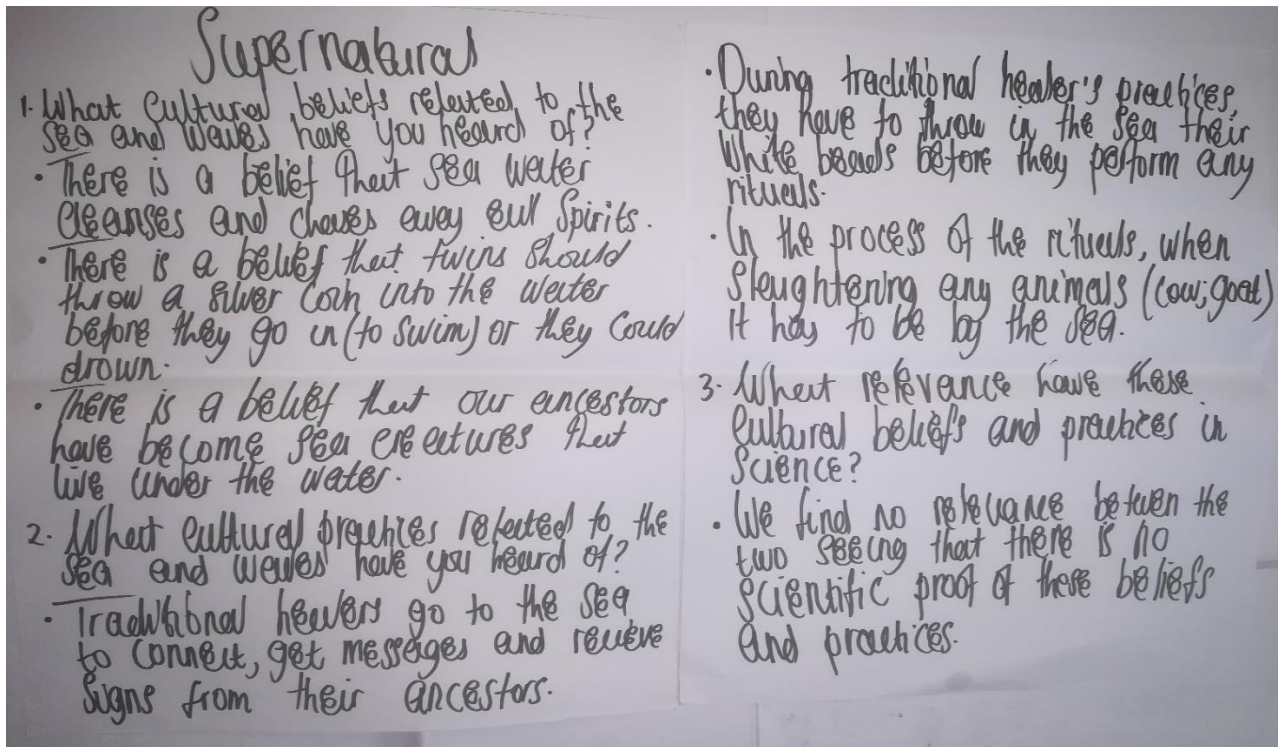


Figure 4.3: Newspaper presented by Super Natural

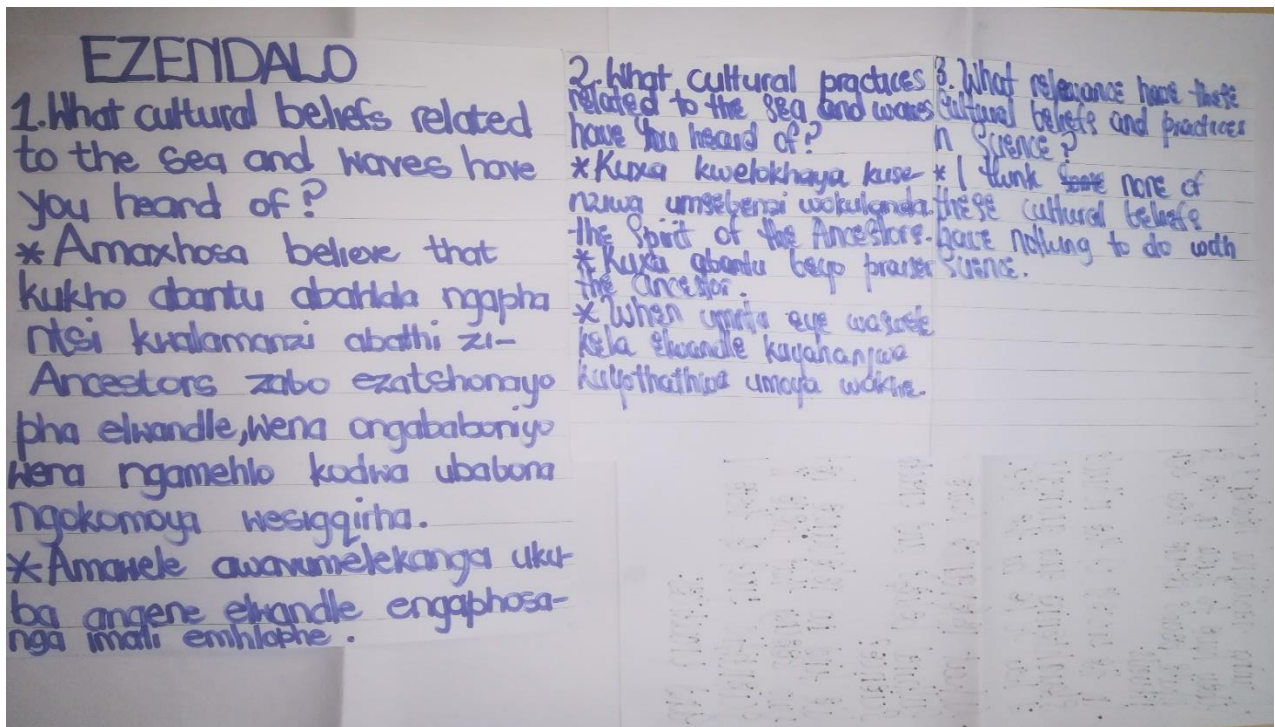


Figure 4.4: Newspaper presented by Ezendalo

From the learners’ presentations, three themes emerged: Cultural beliefs related to the sea; Cultural practices related to the sea; and Relevance (or not) of cultural beliefs and practices to science. These themes were then used to discuss data in order to answer research questions one and two of the study. I went through the three presentations of the learners and summarised them which is presented in Table 4.3 below.

Table 4.3: Showing a summary of group responses from the group activity

From guiding questions	Groups		
	Power Rangers	Super Natural	Ezendalo
	Code (PR)	Code (SN)	Code (E)
Theme 1: Cultural beliefs related to the sea and waves	<ul style="list-style-type: none"> • It is said that there are ancestors living under water • We also get baptised in our churches in order to have good luck 	<ul style="list-style-type: none"> • There is a belief that sea water cleanses and chases away evil spirits • There is a belief that twins should throw a silver coin into the water before they go into the sea or they could drown • There is a belief that our ancestors have become sea creatures that live under the water 	<ul style="list-style-type: none"> • The Xhosa people believe that there are ancestors who live below in the sea • There is a belief that you don’t see these ancestors with a naked eye but with a spiritual eye associated with the traditional healers • Twins are not allowed to go into the sea without throwing a silver coin first
Theme 2: Cultural practices related to the sea and waves	<ul style="list-style-type: none"> • Traditional healer/ Sangomas go to the sea when they have bad 	<ul style="list-style-type: none"> • Traditional healers go to the sea to connect, get messages and 	<ul style="list-style-type: none"> • When in that particular home they perform a ritual to collect

	<p>dreams with ‘<i>unqombothi</i>’ and praise their ancestors</p>	<p>receive signs from the ancestors</p> <ul style="list-style-type: none"> • During traditional healer’s practices they have to throw in the sea their white beads before they perform any ritual • In the process of the rituals, when slaughtering any animal (cow, goat) it has to be by the sea 	<p>the spirit of the ancestors</p> <ul style="list-style-type: none"> • When people go to praise the ancestors • When a family member died in the sea the family will go and collect his/her spirit
<p>Theme 3: Relevance to science</p>	<ul style="list-style-type: none"> • We don’t think they have much relevance • Also drinking salt water makes you dehydrated and disrupts your skin pH balance 	<ul style="list-style-type: none"> • We find no relevance between the two seeing that there is no scientific proof of these beliefs and practices 	<ul style="list-style-type: none"> • None of these cultural beliefs have anything to do with science

To further make sense of this data, I applied Ogunniyi’s (2007a) Contiguity Argumentative Theory’s (CAT) five cognitive states: Dominant, Suppressed, Assimilated, Emergent and Equipollent (see Section 1.6). From Table 4.3, all three groups indicated that there is a belief among the Xhosas that there are ancestors who live in the sea [Dominant]. For example: SN: *“There is a belief that our ancestors have become sea creatures that live under the water”*.

According to SN, the belief is that the ancestors have become sea creatures that live under the water in the sea. In addition, E explained that there is a belief that we cannot see the ancestors with a naked eye, but they can be seen with a spiritual eye [Suppressed]. This cultural belief might contrast the scientific view causing, according to Le Grange (2007), cognitive dissonance. During the presentations, some learners asked questions, for example, L14 asked, “*How the ancestors breathe under water, and what do they eat*”? [Suppressed]. The response from E was that the ancestors were spiritual beings and that they do not eat or drink [Equipollent].

Secondly, SN and E mentioned that there is a belief that when twins go to the sea, they had to throw in a silver coin before going into the water. The two groups explained further that if the twins do not throw in the silver coin as a sacrifice to the ancestors, they could drown in the sea [Dominant]. This explanation sparked discussions among the learners, probably because there were twins in this Grade 10 Science class. The twins in my class agreed that they were aware of the belief, explaining that they were told by the parents, and that when they go to the sea they throw in the silver coins. This confirms that local knowledge is passed on orally from generation to generation (Kibirige & Van Rooyen, 2006). L1 enquired from the groups why the twins had to throw in a silver coin, and not a brown coin or paper money. L5 quickly responded and said:

Utamkhulu wam wathi kum kudala babembalwa abantu abamnyama abanemali engamaphepha, yilonto imali yesilivera yayinexabiso elikhulu kwaye isisipho esinexabiso kwizinyanya (My grandfather told me that in the olden days, very few black people had paper money, and that the silver coin was regarded as a precious offer for the ancestors).

L1 remarked and said: “*So they want money or expensive gifts*”. L8 responded and said: “*No they want respect*”. L2 gave an interesting explanation and said:

Nokuba bebenayo imali yamaphepha ibizakumka nomoya ingafiki kwizinyanya, okanye mhlawumbi imali esiliva ireflekta ilanga, ze izinyanya zisebenzise obobushushu ukukhanyisa (Even if they had paper money it would be blown away by the wind before it reached the ancestors, and maybe the silver coin reflects more light that was used by the ancestors as a solar energy) [Emergent].

Some learners laughed at this explanation; some nodded their heads as a sign of agreeing with this explanation. Some learners disagreed and said, “*Izinyanya yimimoya azixhomekekanga kukukhanya*” (Ancestors are spiritual beings they do not need any light). I observed that their

emerging arguments (Ogunniyi, 2007) and their interaction seemed to cause learners to think deeply about these beliefs, and that they tried to make sense of these beliefs; at the same time, other learners seemed to be not convinced at all that there were ancestors living in the sea – herein lies the importance of using CAT as an analytical framework and a lens to analyse data.

For instance, L4 asked, “*Why do the ancestors want the twins to throw in the silver coin, and not other people*”? L8 who seemed to be more knowledgeable (Vygotsky, 1978) about the beliefs regarding twins, explained that twins were rare to find and were regarded as special people. She further explained that besides this belief, there is also a belief that if one of the twins died, the twin that is still alive had to get into the grave before they put in the coffin with the dead twin. She further explained that if this act was not done the living twin would die immediately after the burial of their twin. The twins in our class did not seem surprised at this belief nor did they appear disturbed by it.

Also, PR indicated that people get baptised in the sea in order to have good luck. SN added that there is a belief that the sea water cleanses and chases away evil spirits. Responding to this, L6 commented and said: “*It is because the sea water has this power because it is from the ancestors, and ancestors do not like evil spirits*” [Dominant]. To me this emphasises the importance of considering the learners’ socio-cultural background when teaching science as espoused by Mavuru and Ramnarain (2017). L10 seemed to support L6’s statement and explained that the sea waves get rid of all the dirt which is associated with evil spirits. The rest of the class seemed to show no interest in this discussion as they did not contribute.

Regarding cultural practices associated with the sea and waves, two groups, PR and SN mentioned rituals performed by the traditional healers in the sea (Keane, Khupe, & Muza, 2014). For example, according to PR, traditional healers/Sangomas go to the sea carrying ‘*umqombothi*⁴’ when they have bad dreams and praise their ancestors. Agreeing with PR, SN mentioned that traditional healers go to the sea to connect, get messages and receive signs from the ancestors. They further

⁴ Umqombothi, from the Xhosa and Zulu language, is a traditional drink prepared from fermenting grains (maize, maize malt, and sorghum malt, and has a low alcohol content of less than 3%.

explained that during traditional healers' practices, they have to throw in the sea some white beads before they perform any ritual. Also, in the process of the rituals, when slaughtering any animal (cow, goat) it has to be by the sea. One learner asked: "*How do the traditional healers know if their offerings to the ancestors have been well received by the ancestors?*" L8 responded that he was told that the animal had to make a sound when slaughtered, if it kept quiet that meant something was wrong and the offering was not welcomed by the ancestors. E indicated that some families perform a ritual to collect the spirit of the deceased family members in the sea. L15 asked "*How do they do that?*" Members from SN responded and said that "*the ritual must be performed by the traditional healers, and that when they do it they must slaughter an animal at the sea, and the animal must cry with a loud sound*" [Dominant]. This corroborates with Govender (2014) who concludes that Africans in Africa still practice their traditional culture consisting of art forms such as dance, rituals, healing and worship. Regarding relevance to science, all three groups indicated that they found no relevance at all.

Accordingly, I observed that throughout the group activity session, learner participation (Sedlacek & Sedova, 2017) was very high, indicating positive dispositions. This resonates well with Vygotsky (1978) who argues that learners learn best through social interactions. The level of engagement, for example, the questions and answers and the arguments that emerged during the session, provided a learning opportunity for the learners (Ogunniyi, 2007a), and clearly demonstrated that the learners' conceptualisation and sense-making of waves and sound was positive.

Worth noting, is that I observed that even learners who are usually quiet in class and hardly ask questions were participating during the group activity. I viewed this as an indication that the learners found the environment less threatening and that contributed to effective learning. Throughout the group activity all the learners showed keen interest and willingness to learn, this proved that Vygotsky (1978) was correct when he emphasised the role of social interactions during teaching and learning.

4.3 Presentations by the two Community Members

This section begins by presenting the profile (Table 4.4) of the two community members who were invited to present a lesson to the Grade 10 Physical Sciences class of Buyelembo Combined School on indigenous knowledge on cultural beliefs and practices associated with the sea and ocean. The knowledge from the presentation by the two community members was then used to co-develop a lesson plan that integrated indigenous knowledge.

Table 4.4: Profile of the two community members

Pseudonym	Age	Gender	Education	Home language	Place of Birth	Other languages	Occupation
Sir Mba (Community member 1)	66	Male	Standard 4	IsiXhosa	Port Alfred	English, Afrikaans, IsiZulu and Sesotho	Retired (Former groundsman)
Sir Mlo (Community member 2)	57	Male	Standard 3	IsiXhosa	Port Alfred	English	Local fisherman



Figure 4.5: Showing the two community members (Sir Mba on the right and Sir Mlo on the left)

Figure 4.5 above shows the two community members who co-presented their experiences and knowledge about waves and cultural beliefs and practices to the Physical Sciences Grade 10 learners. They were given pseudonyms, for example, community member 1, is Sir Mba, and community member 2 is Sir Mlo. The pseudonyms are used throughout the entire thesis.

The background of the two community members indicates that there were both similarities and some differences between them. They both are *isiXhosa* home language speakers. Both are males born and bred in Port Alfred. Their ages are different – Sir Mba is nine years older than Sir Mlo. They have different occupations – Sir Mba is a retired groundsman of Buyelembo Combined School, whereas Sir Mlo is a local fisherman. He has been a fisherman for more than 35 years and was inspired by his late father who was a well-known fisherman in Port Alfred. Sir Mlo's highest education is a Standard 3, and he speaks both *isiXhosa* and English fluently, as opposed to Sir Mba who has a Standard 4 and speaks five different languages, namely: *isiXhosa*, English, Afrikaans, *isiZulu* and *Sesotho*, as explained in the methodology section (see Section 3.4.2.2). Sir Mba, has spent some time in Durban, and Sir Mlo has never been to any other city; he has spent his entire life in Port Alfred and surrounding areas, this probably accounts for the difference in the number of languages that Sir Mba can speak.

Following is the summary of the presentations made by the two community members.

4.3.1 Summary of the presentations by the two community members

In this section I present the summary of the presentations by the two community members which was videotaped with permission from the participants. I then transcribed the video into a story. I now present, analyse and discuss the data from the various episodes from the story.

From the two community members and the group activity, and learners' written reflections, I extracted some episodes and I then combined common sub-themes to form themes in relation to theory or literature. Themes and sub-themes are showed in Table 4.5 below.

Table 4.5: Shows themes emerged from the data and supporting theory or literature

Themes	Sub-themes	THEORY	
		Literature review	Frameworks
Theme 1: Nature of interactions	Learner talk Asking questions Listening attentively	Lemke (1990)	Vygotsky (1978)
Theme 2: Level of participation	Explaining Elicitation of prior knowledge Promoted arguments and dialogue	Sedlacek & Sedova (2017) Roschelle, 1995; Kuhlana, 2011; Mavhunga & Rollnick (2013)	Vygotsky (1978) CAT
Theme 3: Nature of learning opportunities	Promotion of border crossing Promoted arguments and dialogue Using language as a resource Showing understanding	Aikenhead & Jegede (1999) Ogunniyi (2007); Govender (2014) Msimanga & Lelliot (2014); Mavuru & Ramnarain (2019)	CAT Vygotsky (1978) Vygotsky (1978)

4.3.1.1 The two community members interacting with the learners

The two community members co-presented a lesson on cultural belief and practices associated with waves and sound at the sea to the Physical Sciences Grade 10 class of Buyelembo Combined. From my observation, I could see that the learners looked relaxed and were looking forward to the presentation as they had smiles on their faces. Sir Mba started the lesson by asking if any of the

learners knew how waves were formed in the sea (see Fig. 4.56). He asked the learners “*Enziwa yintoni amaza*”? (How are waves formed?). Scholars such as Roschelle (1995), Kuhlana (2011) and Mavhunga and Rollnick (2013) refer to this as elicitation of prior knowledge. One of the learners L3, explained and said, “*Amaza ayathyalana ngoba ene enegi*” (Waves were moving because they were pushing each other from behind because they had energy). Sir Mba smiled and said that’s right, “*Unyanisile*” (You are telling the truth) and explained further and said, “*Kukho into ewatyala ngasemva lamanzi, ebangela ukuba ahle enyuka*” (There was a force which caused the water to move up and down). I also contributed to this discussion and explained that waves are created by energy passing through water, causing it to move in a circular motion, I did this to make sure that there were no misconceptions in terms of scientific explanation.

Sir Mlo added by showing with his hands how the waves move and, explained that, “*Athecwaka xa ekude kodwa xa esondele enza ingxolo enkulu*” (They are quiet when far away, but as they get closer, they make a loud sound). He asked the learners why was that the case. Before the learners could answer the first question, he asked three more questions: “*Niyawabona lamaza avelaphi*?” (Do you see where the waves come from?) “*Avelaphi*?” (Where do they come from?); and “*Enziwa yintoni*?” (What causes this wave motion?).

The entire class responded and said, “*Ewe siyabona avelaphi, avela enzulwini*” (Yes we see where the waves come from, they come from the deep of the sea). L1 further responded to the second and third questions and said: “*Enziwa luphazamiseko lwamanzi*” (The waves are caused by the disturbances (pulses) in the water). Sir Mlo nodded his head indicating that he was happy with the learners’ answers. Sir Mba asked a question: “*Niyaluva ulwandle*?” (Do you hear the sound made by the sea?). We all responded and said “*Ewe*” (Yes); then he explained and said, “*Yindlela ulwandle eliphefumla ngalo olu*” (The sound made by the sea indicated that the sea was breathing). I must indicate that I realised that this might create a misconception and to avoid that, I addressed it during my presentation on the lesson that integrated IK when teaching the topic on waves and sound. Sir Mba added: “*Lengxolo ikwaxela ukuba ulwandle luyacoca lukhuphela ngaphandle izinto ezimdaka*” (The sea is also removing the dirty things that is why it is making the sound). The learners seemed very interested and listened attentively to Sir Mba (Figure 4.6).



Figure 4.6: Showing an interaction between the two community members and the learners

4.3.1.2 Indigenous practices and knowledge associated with the sea

During the presentation I was a participatory observer (see Section 3.4.2.3). That is, I assumed a role of asking questions from the two community members to get a better understanding of what they were presenting, in relation to the purpose of the study and clarifying where there were misconceptions. According to Cohen et al. (2018), quality observations are more than just looking, but rather the researcher should closely monitor facts and practices of the target groups without attempting to change them. For example, I asked them to explain any cultural beliefs and practices associated with the sea.

In response to my request, Sir Mba responded by asking if there were twins in the group: “*Ngubani iwele apha?*” (Who is a twin here?) and he continued and said, “*Maweze ngaphambili*” (Let the twins come forward). Before Sir Mba could explain, one learner, L7 commented “*Azaku tshona*”

(meaning the twins were going to drown in the sea). This suggested to me that L7 had prior knowledge from home about beliefs around twins and the sea (Roschelle, 1995). Sir Mba quickly responded by providing an explanation that the twins had to throw a coin in the sea before going in to swim otherwise they could drown, and that the people that were with the twins were not safe either if the twins do not throw in the coin. Sir Mlo added, that even if their twin was dead, if the remaining twin did not throw a coin, they had to pull hair from their head and throw it in the sea. This, he said, is a sign of respect to the ancestors who live in the sea – he explained further and said “*Awuzotshona*” (You will not drown).

The twins looked relieved when Sir Mba and Sir Mlo explained how the twins could avoid drowning in the sea and the other learners listened attentively. Then, Sir Mba demonstrated how this act was done. He removed his hat as a sign of respect (he told us) – in a Xhosa culture this talks to values which are part of IK – he stepped into the water, and the learners including the twins followed. The water waves calmed down as he entered the sea. Sir Mba told the learners that the calmness of the sea was a sign that the ancestors were happy. At this point I took a deep breath, and I believe everyone was amazed to see how the sea reacted to this act – it might have been a coincidence we just do not know. I was particularly impressed with the practical demonstration by Sir Mba, simply because even though he is not a trained teacher *per se*, he applied the curriculum principle which says: “Practical work must be integrated with theory to strengthen the concepts being taught” (South Africa. DoE, 2011, p. 11). Agreeing with this principle, Banu (2011) argues that hands-on practical activities play a positive role in Science teaching and learning by making it comparatively easier to understand and can strengthen learners’ content knowledge.

I noticed that the two community members were engaging the learners by asking them questions throughout their presentations and that they were complementing each other. I noticed that this style of presentation kept the learners attentive during both presentations and forced them to think, thus this talks to sense-making, which is also in line with Vygotsky’s (1978) notion of social interaction. Secondly, I realised that the two community members were using prior knowledge of the learners as a stepping stone (Roschelle, 1995; Kuhlane, 2011). Even though the two community members are not trained teachers, their ability to engage learners made me reflect on my own teaching methods. There is definitely a lot that I need to improve on.

Sir Mlo took us back to the belief about twins and further explained that the twins had to take silver coins and throw them in the sea, as brown coins were not accepted, and he asked our twins to throw in the silver coins. The twins boldly moved to the sea to throw the coins, but the sea became boisterous, and they stepped back. Sir Mlo encouraged them not to fear as nothing was going to happen to them and he offered to go with them. The twins took comfort in his support and they stepped in and threw in the coins, and the class applauded. At this stage the learners were excited to go into the sea. Sir Mlo explained that the fact that the sea had calmed down was an indication that the twins were welcomed and all of us were now safe to go into the sea.

In my view, it could be argued that the two community members were using a learner centred approach (South Africa, DoE, 2011) in every step in their presentation and they tried to capture the learners' attention and involve the learners in the teaching and learning process. Secondly, the fact that we (the two Science teachers and I) were also there, did not bother the two community members at all, which was an indication that they knew what they were talking about, meaning they were the more knowledgeable others (Vygotsky, 1978). This encouraged us as Science teachers to continue with our community of practice and team teaching at Buyelembo Combined School.

According to the two community members, some people drown in the sea, but some are taken in by the ancestors to become *Sangomas* (traditional healers). Sir Mba explained that there are two different processes: "*Ukuthwetyulwa*" (to be taken in) and "*Ukurhaxwa okanye ukutshona*" (to drown or to sink in the sea). Sir Mba explained that the difference was that when one was taken in by the ancestors, they are usually picked out among the crowd and taken into the sea. He explained that when that happened, a person normally walks into the sea, people watching them going in until they disappear from their sight.

One learner L3 asked and said "*Awutsarwa*"? (Are you not going to be shocked?). Sir Mba responded and said, "*Hayi*" (No) if you are called in by the ancestors. He further explained that the belief was that when one is called in, their family members were not allowed to cry, or that person would die in the sea. He continued to explain that if the family members do not cry then

that person would come back as a *Sangoma*. I observed that the learners battled to understand how this was possible, but they did not argue further with the old man, showing him some respect.

After Sir Mba's explanation there was a momentary silence. One learner, L18 asked a question, "*Kuzakwenzeka ntoni kuwe xa ulwandle lukuthathile?*" (What would happen to you if the sea took you in?). Sir Mlo explained that "*Uyathwetyulwa*", meaning you are taken by the ancestors as the Xhosa's believe, your family must not cry, but wait for you to come back – if they cried, the person that was taken in would come back dead. He told a story of people who were taken in by the sea, and the learners asked, where do those people stay in the sea? And how do they stay there? He explained that there were unseen places inside the sea where they lived. The learners laughed at his explanation showing disbelief (respectfully disagreeing with his explanation). The learners seemed not convinced by his explanation, as one learner asked: "*Uphefumla njani phantsi kwamazi?*" (How do you breathe inside the sea?), but Sir Mlo responded and insisted, "*Kukho abantu phantsi kwamanzi*" (There were people living inside the sea). I noticed that the learners were curious to know more as they were asking more questions. For example, L12 asked, "what about the gravitational pull when people were called in by the ancestors?" Sir Mlo explained that when "*amagqirha*" (the traditional doctors) perform their rituals in the sea, they offer some gifts to the ancestors, such as "*umqombothi*" (African traditional beer) in a metal container and other things but those things do not sink, they float until they get to a certain point in the sea and then, they sink well into the sea. He explained that those containers would come back later empty or with beads and roots as a sign that the gift had been accepted. At this point he caught the attention of the learners.

Another learner, L13, asked what causes the waves to be big or small? Sir Mba responded and said: "*Enziwa ngumoya, xa umkhulu umoya amaza aba makhulu nawo*" (They are caused by the wind, stronger the wind the bigger wave), and Sir Mlo concurred with this explanation. Even though the two community members did not give the learners the answer that is in the textbook, their explanation provided space for discussion, as I heard the learners talking among themselves about constructive and destructive interference. I observed that there was interaction between the learners and the two community members, and interaction among the learners, but I also observed that the two community members were complementing each other during the presentations.

In addition, I noticed that the learners' interest during the presentations were positive and their level of participation was high; they seemed to want to know more and they were also trying to make sense of the given explanations provided by the community members. This is in agreement with Govender (2014), when he posits that indigenous knowledge is a valuable teaching resource for motivating township learners to participate actively in the education process, as well as to engage critically in science-IKS issues. I also noticed that the learners were arguing among themselves about the explanations provided by the two community members, applying CAT classification. I also observed that the learners did not agree with the two community members on everything that was presented, without being rude or insensitive they asked more questions to get a better understanding. I have learnt so much from the interaction between the learners and the community members; the way the community members inspired the learners to ask questions indicated to me that learning was taking place and I believe that some of the practices that I have learned will help me improve my teaching strategy. Sir Mlo showed us his fishing spot (by pointing with his hand – the place was about 50 metres away from us) and asked, “*Niyafuna ukuya khona?*” (Would you like to go there?) and we all said “*Ewe*” (Yes).

4.3.2 Practical demonstration by the two community member

After the first co-presentation by the two community members, Sir Mlo took us to his fishing spot. The main purpose for this presentation was to explain the various concepts such as crest, trough, sound waves, etc., and how these affected fishing times. At the fishing spot, Sir Mlo demonstrated (see Figure 4.7) how he used his fishing rod to catch some fish, thus enhancing meaning making to occur (Enghono, 2013). He showed us how to put the bait in the hook at the tip of his fishing rod and explained the purpose of the bait. He cautioned that no one should stand behind him as he was about to throw the rod into the water. He continued to explain the dangers of standing behind him. For me, this demonstrated that he cared about the learners and secondly, this also talks to the precautions or safety measures that one must consider when doing a practical activity.

After the demonstration, he asked if the learners wanted to experiment with his fishing rod. All the learners said yes, and they took turns trying to catch some fish, but they seemed to battle to get the fishing technique right. One of the learners, L17, knew how to fish using a fishing rod (prior knowledge) and willingly showed others how it was done (learning through social interaction) (Vygotsky, 1978). At this stage he was a more knowledgeable other (Vygotsky, 1978), confirming Stott's (2016, p. 28) argument that the "zone of proximal development is created through the social interactions with others during the learning activities and depends on the active contributions of all the participants". During all this time the learners marvelled at L17's skills; this had a positive impact on L17 (who is repeating Grade 10) and boosted his confidence – I saw a smile on his face which I have never seen before.



Sir Mlo showing the art of fishing



Sir Mlo guiding one of the learners

Figure 4.7: Sir Mlo showing the learners how to fish

I asked: "*Kengoku aba baloba nge bowuthi bangena xa kutheni?*" (At what time or weather conditions do those boats/ships that fish go into the sea?). I asked that question in an attempt to solicit more information from Sir Mlo, with the hope that he was going to share his fishing experiences in relation to waves and sound. He responded and said: "*Xa ulwandle luzolile*

kungekho moya, naxa liphumayo” (They go into the sea when the sea is calm and not windy in the sea). I was pleasantly surprised when Sir Mlo explained about the low and high tides in terms of the size of the moon. According to him, when it is a quarter moon, that is an indication that there will be wind or it will be windy; secondly, he explained further that if in the morning during sunrise you see the moon behind the sun, surely it will be windy; thirdly Mr Mlo explained that if there is full moon at night there will be low tide, but if the moon is up before sunrise, there will be high tide.

In my understanding, Sir Mlo had some scientific understanding of how low and high tides occur. However, some misconceptions were identified in his explanation, as the moon size remains constant. But for ethical reasons, I later explained this to the learners. According to science, tides are caused by the moon, whereby the moon’s gravitational pull generates something called the tidal force. The tidal force causes the Earth and its water to bulge out on the side closest to the moon and the side farthest from the moon. When you are not in one of the bulges, you experience a low tide. The learners were fascinated by his explanation, and some asked how he knew all of this. He laughed and said he was taught that by his late father who was also a fisherman, and further explained some of the things he learnt from observations and asking other fishermen over his 35 years of fishing. I realised that the literature that says IK is passed on from generation to generation is true (Kibirige & Van Rooyen, 2006).

Regarding fishing times, Sir Mlo explained that it is best to fish during the night because according to him there are more fish to catch at night than during the day. He explained further that this was because the water is warm at night. This is, however a misconception because fish become active at night because the water temperature begins to cool off and there were fewer disturbances such as boats and surfers. He added that it is the time where fish eat more at the shore, hence there are more chances of catching fish at night. After that wonderful experience, we broke for lunch and thanked the two community members for sharing their knowledge with us, and we went home. I was humbled by the knowledge that those two community members had and the manner in which they shared that knowledge with us. This experience triggered a greater desire for me to close the gap between classroom science and the community, what Aikenhead and Jegede (1999) refer to as border crossing.

4.4 Chapter Summary

In this chapter, I presented, analysed and discussed data generated from observations during the learners' group activity and the presentations made by the two community members. The data presented here were aimed at addressing research questions one and two of the study. Data generated from the participatory observations showed that learners' participation and learning through social interactions was very high and that the learners were interested and engaged in the cultural beliefs and practices associated with the waves and sound. Furthermore, data showed that the involvement of two community members promoted learner talk (Lemke, 1990), argumentation (Ogunniyi, 2007) and effective usage of mother tongue as a tool for learning (Vygotsky, 1978; Msimanga & Lelliot, 2014; Mavuru & Ramnarain, 2019). It also enabled the learners with learning opportunities.

In the next chapter, I present, analyse and discuss data from lesson observations, stimulated recall interviews and learners' journal reflections.

CHAPTER FIVE: DATA PRESENTATION, ANALYSIS AND DISCUSSION

5.1 Introduction

In the previous chapter, I presented, analysed and discussed data generated from observations during the learners' group activity and the presentations made by the two community members which were aimed at addressing research questions one and two. The data generated from lesson observation, stimulated recall interviews and learners' journal reflections are discussed in this chapter. The lessons were videotaped with the permission of the participants. The data generated sought to answer the following research question:

How do lessons on waves and sound that integrate IK influence (or not) Grade 10 Physical Sciences learners' conceptions, dispositions, and sense-making?

Below I give an overview of lesson observations, stimulated recall interviews and journal reflections. Thereafter, I discuss in detail the themes that emerged from the data.

5.2 Analysis of Qualitative Data

Data generated from lessons on hands-on practical activities and a lesson that integrated IK were analysed (see Section 3.6). In addition, nine learners' journal reflections were analysed as well as transcripts from the three focus group stimulated recall interviews. In order to make the analysis and discussion easier, the data were coded, as shown in Table 5.1 below.

Table 5.1: Data gathering tools and codes used in data discussion of data in this section

Data gathering tools	Codes used in data discussion of data
Lesson on practical activities	L1PA – L18PA
Lesson that integrated indigenous knowledge	L1LIK – L18LIK
Learners’ journal reflections	L1J, L2J, L5J, L6J, L9J, L10J, L11J, L12J, L16J
Focus group stimulated recall interviews	FGSRI
Focus groups codes were	SNSRI, PRSRI, ESRI

Data from observations of the lesson on hands-on practical activities were coded as follows: L1PA – L18PA, where L1PA refers to learner 1 practical activities, L13PA is learner 13 practical activities and so on. Similarly, data from observation of lessons that integrated indigenous knowledge were also coded as L1LIK – L18LIK, where L10LIK refers to learner 10 lesson on IK and so on.

Nine learners’ journal reflections were analysed as indicated in Table 5.1 above since only nine learners submitted their journal reflections. Learner data was coded, for instance L6J is learner 6 journal reflections and L16J refers to learner 16 journal reflections.

After watching the videos on lesson presentations, the learners were interviewed in their groups, namely, Super Naturals (SN), Power Rangers (PR), and Ezendalo (E). FGSRI is the code for focus groups stimulated recall interviews; thus, the groups were coded as follows: (SNSRI) refers to Super Natural stimulated recall interviews, (PRSRI) Power Rangers stimulated recall interviews, and (ESRI) refers to Ezendalo stimulated recall interviews. The learners were given codes (see Section 4.2) that are used throughout the thesis. This made it easier to present, interpret and discuss the data from the focus groups stimulated recall interviews. These codes are used throughout the data discussion in this thesis.

Firstly, all the qualitative data (from observations, journal reflections and focus groups stimulated recall interviews) were colour coded in order to identify themes (see Appendices M & G2). After

identifying similarities from the observations, journals and interviews, the description of marked texts from the learners' responses and sub-themes were constructed and are presented in Table 5.2.

Table 5.2: Shows the description of marked texts, sub-themes and their sources

Description of marked texts	Sub-themes	Data sources
Asking questions/ commenting/discussing	Positive dispositions	Observations
Learning with understanding	Linking IK with science	Observations, Journals
Facilitation of learning through experiments	Sense-making using practical activities	Observations, Journals, Interviews
Learning through participation	Social interactions	Observations, Journals, Interviews
Dispositions of learners towards the integration of IK	Attitude towards the involvement of community members	Observations, Journals, Interviews
Using learner existing knowledge to facilitate learning	Learners' prior knowledge Using language as a tool	Observations, Journals Observations

Subsequently, common sub-themes were collated, and this resulted into main themes as shown below:

- Construction of knowledge, and
- Promotion of learning through social interactions and participation.

Thus, the above-mentioned themes were presented in a table form with relevant theory and literature as highlighted in Table 5.3 below.

Table 5.3: Showing themes and supporting theory/literature

Themes	Theory/Literature
<p>Construction of knowledge</p> <ul style="list-style-type: none"> • Sense-making using practical activities • Facilitation of learning through experiments • Using learners’ prior knowledge • Learning with understanding 	<p>Magoon (1977); Resnick (1983); Scanlon, Morris, & Copper (2002); Wieck, Sutcliffe, & Obstfeld (2005); Woodley (2009)</p>
<p>Promotion of learning through social interactions and participation</p> <ul style="list-style-type: none"> • Learners’ engagement • Dispositions of learners towards the integration of IK • Learner talk • Using language as a tool • Linking IK with science 	<p>Vygotsky (1978); Resnick (1983); Lemke (1990), Kibirige & Van Rooyen (2006); Mhakure & Otulaja (2017)</p>

Outlined below is the overview of the lessons that were conducted. In my discussion of data, I interwove the literature presented in Chapter Two, as well as supporting statements from the participants.

5.3 An Overview of the Lessons

In this section, I outline an overview of my observations and at the same time I highlight how I enacted border crossing from the knowledge from the sea to my intervention lessons. As highlighted in Table 5.3 above, two themes emerged, and these are interwoven in the discussion that follows.

5.3.1 Data generated from a lesson on hands-on practical activities

I presented a lesson on practical activities on waves and sound prior to the intervention lesson that integrated IK, wherein learners were actively involved. According to CAPS, teachers are expected

to use prescribed practical work for teaching the Physical Sciences content, in this case the Physics content. In addition, there are prescribed practical tasks for formal practical assessment that are practical tests that contribute 25% of the learners' year mark. We first did the practical activity taken from our textbook, wherein the learners were required to make a string telephone as shown in Figure 5.1 below.

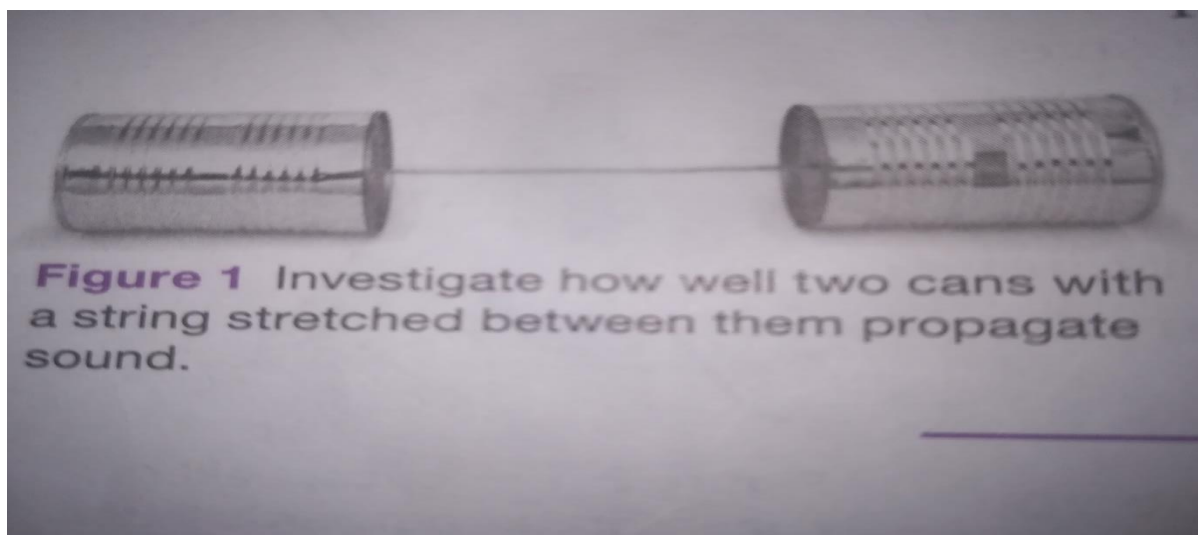


Figure 5.1: Practical activity from Grade 10 Physical Sciences Learner's Book (p. 92)

The practical activity required the learners to construct their own string telephones in their various groups as shown in Figure 5.1 above. Each group had to make a string telephone using, two 340ml cooldrink cans, a tin opener, a nail, hammer and 4m of string, and bring the telephone to class the next day. The reason they had to do it during their own time after school, was that we were trying to save time. I observed as each person held one end with the string stretched tightly as shown in Figure 5.1 above. One person spoke into the can while the other listened. The aim of the practical activity was twofold:

- (1) To see if using the string telephone helped them hear better; and
- (2) To discuss how the string telephone transmits the sound waves from the one person to the other.

I noticed that the learners seemed to enjoy the telephone conversations. The social interactions (Vygotsky, 1978) during the practical activity seemed to have a positive impact on the learners' dispositions, as I heard some learners saying, "*Imnandi le lesson*" (This lesson is fun); some said, "*this is exciting*", and others said "*Ndiyayithanda*" (I like this). After the learner talk (Lemke, 1990), all the learners agreed that you hear the other person better with the string telephone than without it – this was in response to the first aim of the activity. Responding to the second aim, the learners agreed that they felt the vibrations as one person was talking, but they emphasised that the string had to be stretched tight. The learners could not explain further and they asked me to explain to them, and this gave me an opportunity to teach them Physics. Firstly, I explained to the learners how we used to enjoy making our string telephones as little boys in the township, even though we did not really understand the science behind this game.

Accordingly, I explained that sound is a pressure wave that passes from particle to particle of a medium, and that the properties of the particles affect how well and how fast sound travels through it (Broster et al., 2011). I asked the learners about the sound made by the sea when the waves are far and when they are nearer. I did this as an attempt to link my explanation with their out-of-school context at the sea, what Aikenhead and Jegede (1999) refer to as border crossing. This question triggered a positive reaction from the learners as I observed they nodded their heads and said: "*Iyavakala kengoku*" (Now that makes sense).

Thereafter, I explained further that in solids such as the cans and the string, the particles are close together and transmit sound well. In our case, the vibrations of the speaker's voice make the end of the can vibrate. I noticed that the learners listened attentively and that they seemed to conceptualise as I was explaining. I further explained that the string transmits the vibration along the string to the other can which produces sound waves in the air that the listener can hear (Kadis, 2015). I was pleasantly surprised when the learners applauded after I had given them my explanation. I asked them why they were applauding, and they responded and said: "*Mfundisi, uyicacise kakuhle kakhulu, siyayiva ke ngoku*" (Sir, you have explained it so well and now it makes sense). At this stage I felt good about my teaching ability of Physics, and my confidence level increased, as it was the first time I had seen my learners so happy when I taught Physics. I therefore realised that hands-on practical activities play a positive role in Science teaching and learning

(Maselwa & Ngcoza, 2003; Asheela, 2017). Also, I felt that one of the purposes of doing this study, which was that the study might contribute to improving teaching strategies, was being realised at this point.

Motivated by the learners' response and positive interactions during the first practical activity, I decided to give the learners a second experiment which is not prescribed by the department of education. The second practical activity involved exploring with a slinky and a tuning fork and working with various music instruments such as drums⁵, *Vuvuzela*⁶ and a radio. Similarly to Liveve's (2017) study conducted in Namibia, the purpose of the hands-on practical activity was to help the learners make sense of concepts, such as frequency, pitch, tone, and to create a learning environment through social interaction (Vygotsky, 1978).



Figure 5.2: All smiles! Grade 10 Physical Sciences learners during the second practical activity and the teacher

The learners were given different musical instruments to play in class (as shown in Figure 5.2 above); for example, they played the drums using their hands, wooden sticks and metal sticks, to distinguish the different sounds produced. Those that were not playing the instruments were

⁵ Drums are percussion instruments sounded by being struck with sticks or the hands, typically cylindrical, barrel-shaped, or bowl-shaped, with a taut membrane over one or both ends (Liveve, 2017).

⁶ A Vuvuzela (see Section 1.3).

required to listen to the various sounds made (a technique I learnt from Sir Mba who asked the learners at the sea to listen to the various sounds made by the sea and comment on the differences in the sounds heard) and comment on the differences in the sounds heard. This is in line with CAPS (2011) which emphasises that science practical work is an essential part of Science teaching and learning, for developing learners' scientific content knowledge.

I observed that the learners listened attentively to the various distinct sounds made when using different objects to play the drums, and during their discussions they seemed to understand the difference between tone and pitch. For example, L16 said: "*Ndiyawuqonda umehluko ngoku phakathi kwe tone ne pitch*" (Now I understand the difference between tone and pitch) and the rest of the class said, "*yes it makes sense now*". Likewise, we did the same with a *Vuvuzela*, which the learners were to blow. The learners seemed excited to take turns blowing the *Vuvuzela*. L3 commented and said: "*I have never tried it, I just seen people on TV blowing it during soccer and rugby matches*". L15 agreed and said "*Nam*" (Me too).

Also, I noticed that the boys were assisting the girls on how to blow the *Vuvuzela*. According to Vygotsky (1978), in this case they were the more knowledgeable others and helped the girls to move from their present zone of proximal development with some kind of assistance, until they were able to do it on their own without help. The interactions among the learners were positive; for example, L1 commented and said: "*This is fun, I didn't know I could do this*" – meaning she could not blow the *Vuvuzela* on her own. Learners make sense of science taught when they are actively involved in the construction of knowledge (Millar, 2004). I noticed that the learners showed high interest and the smiles on their faces suggested that they were enjoying the practical activity and were in fact learning. Agreeing with this observation is Liveve (2017), who concluded in his study that learners' sense-making and disposition towards Science were positively influenced through traditional music and dance (as shown in Figure 5.3 below).



Figure 5.3: Learners’ interactions during practical activity, playing drums and Vuvuzela

More interactions were observed when I gave the learners the slinky to experiment with; the purpose of this activity was to try and explain concepts such as, wavelength, amplitude, crest, trough, compressions and rarefaction (see Figure 5.4).



Demonstrating a transverse wave



Demonstrating of a longitudinal wave

Figure 5.4: Learner 1 (L1) exploring with a slinky

L1⁷ is seen in Figure 5.4 demonstrating a transverse pulse and a longitudinal wave, using a slinky as a tool (Vygotsky, 1978). During the demonstration, concepts such as pulse, trough, crest, transverse wave, longitudinal wave, wavelength, and amplitude of a wave were discussed. One learner reflected that: “*Ndiyayibona ke ngoku*” (I see it now) and some were saying: “*Hayke ndiyayi understanda*” (I understand). L16 said: “*Iyaqala ukwenza isensi kum, andizophinda ndiyilibale*” (It is starting to make sense now to me, I will not forget it).

It seems that the practical demonstration provided a learning space for the learners to conceptualise waves, as the above comments made by the learners suggest that their ZPD shifted positively (Stott, 2016). Also, language was used as a tool to communicate and make sense of what was happening; in this case, the learners seemed comfortable using their mother tongue to express their feelings. That is, it could be hypothesised that using a home language is a resource to stimulate learning rather than a hindrance (Msimanga & Lelliot, 2014; Mavuru & Ramnarain, 2019).

5.3.2 Data generated from a lesson that integrated IK

Lesson plans should be developed with an intention to help learners acquire knowledge, skills and values that are regarded as worth learning and educators should use creativity and originality when interpreting how and what to teach (South Africa. DoE, 2011). In this regard, “the curriculum promotes the idea of grounding knowledge in local contexts, while at the same time being sensitive to global imperatives” (South Africa, DoE, 2011, p. 5).

After the presentations by the two community members, we (the two Science teachers and I) co-developed a lesson plan that integrated IK when teaching the topic on waves and sound; that is, using some ideas from the community members and our own ideas. I then taught the topic on waves and sound and asked the two Science teachers to videotape my presentation and observe my lesson, as it is impossible for one to observe themselves. Kibirige and Van Rooyen (2006)

⁷ L1 represented Sarah Baartman District in a public speaking and debate competition held in Cape Town in 2019, and she placed 3rd position nationally, and was awarded by the Minister of Sport, Arts, Recreation and Culture and the Mayor of Ndlambe Municipality for her performance. Coincidentally, the debate topics were culturally related.

argue that teachers should develop skills on how they will integrate IK during teaching, for them to share IK through communication and practice.

During my lesson presentation, I introduced the lesson and asked: “*Which concepts can you remember that are found on the topic in waves and sound?*”. The learners responded by shouting out the concepts, for example, wavelength, amplitude, frequency, and others.

The learners seemed excited, I then asked: “*Can you define the concepts you mentioned?*”. Some learners defined the concepts and some learners explained the concepts. At this point I realised that I had to explain the difference between *define* and *explain*, and I explained the difference. I heard some learners say: “*Now I get it*”. This response points to sense-making by the learners. It became clear to me that as teachers we need to explain the different types of terms used by examiners when they ask questions.

My observation is also supported by the examiners’ diagnostic reports (South Africa. DBE, 2015, 2016, 2017, & 2018). I assured the learners that we were going to work on these areas to demystify the misunderstandings that exist, and that I was going to assist them every step of the way, but that they also needed to put in some effort. The learners seemed relaxed after I made this commitment, and they promised that they were going to work hard (see Figure 5.5 below).



Learners discussing the relevance of IK in science



Teacher presenting a lesson

Figure 5.5: Teacher presenting a science lesson that integrated IK

I then asked the learners their views about high and low tides in relation to Sir Mlo's explanations. Thus, I enacted border crossing from the knowledge from the sea to my intervention lessons through asking questions and elicitation of prior knowledge, mindful of the fact that one of the factors affecting students' learning in science is their existing knowledge prior to instruction (Hewson & Hewson, 1988). None of the learners responded to my question, I then asked them to discuss my question among themselves before giving me an answer. I did this because I wanted to break the ice and get them to talk and also, I had hoped that their arguments were going to help us to go forward. Indeed, it turned out that my strategy worked, as I noticed that the learners were arguing. After about three minutes I asked for volunteers who wanted to respond to my question.

L2 responded and said: "*I have done my own research and I think Sir Mlo was right*". L1 asked: "*How did Sir Mlo know so much about waves seeing that he is not that much educated?*" L1's question gave me an opportunity to explain to the learners that in an African culture, children learn through storytelling and observing nature. Similarly, in western science, observations form part of learning and knowledge construction. L6 argued that they did not believe that everything that was taught by Sir Mlo and Sir Mba had any relevance in science. L12 said: "*But some people believe in those things*". I agreed with the learners, that not everything that is IK is true or has relevance in science. I further explained that it was our duty to question statements and not just accept everything we are told, and where possible, prove if they are scientific or not. I added that it is our responsibility as Science scholars to clear any misconceptions that are out there in our communities, and where there is truth, we also need to acknowledge and accept it. Involving indigenous knowledge to teach Science emphasises the importance of identifying cultural beliefs and practices and prior everyday knowledge for their possible value to the curriculum. I then concluded the lesson by giving the learners some homework (see Appendix R).

From my presentation I picked up that the learners were critical about IK and Science, however, I was pleased with the level of engagement and participation during the lesson. Furthermore, I noticed that the learners wanted to make sense of what was being taught in class. Since I have provided an overview of the lessons that were carried out, I now discuss each of the themes below.

5.3.3 Construction of knowledge

During the intervention lesson that integrated indigenous knowledge, I asked the learners the concepts in the topic on waves and sound. The learners mentioned various concepts, and this provided an opportunity for us (the teachers and the learners) to create a mind map of the scientific concepts as shown in Figure 5.6 below.

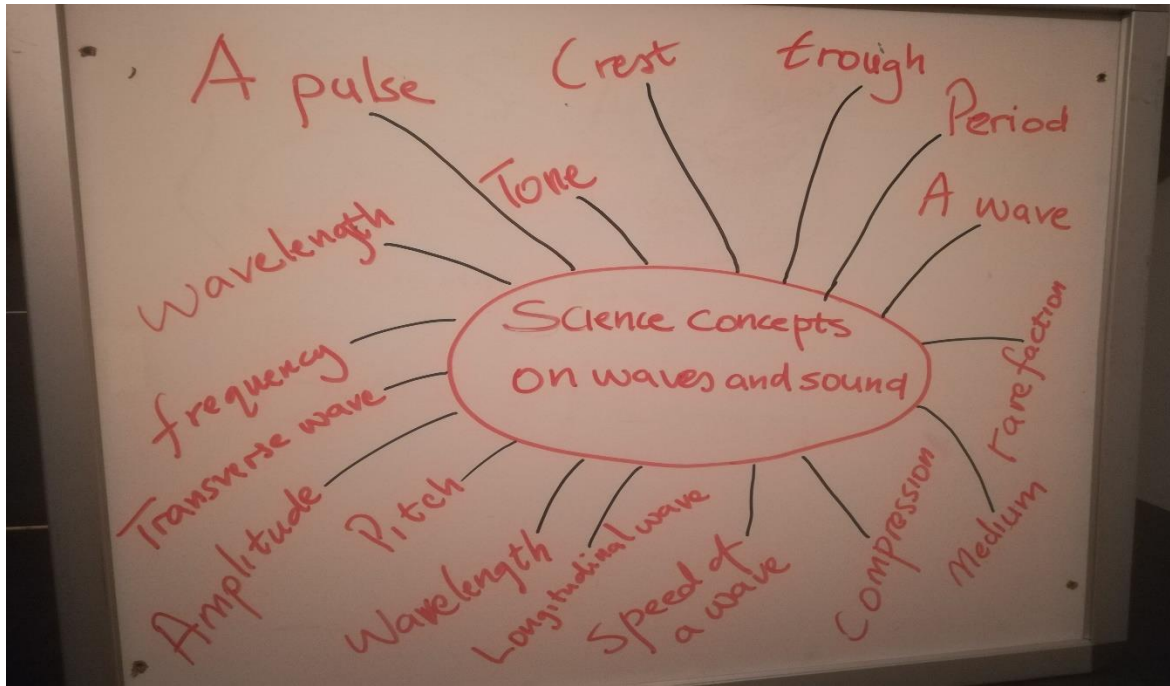


Figure 5.6: Showing a mind map of scientific concepts that emerged

Also, this activity provided the learners an opportunity to think and construct their own knowledge. In addition, I observed that the learners enjoyed participating in this activity, as I heard the learners saying, “*This is fun*”. Roschelle (1995), Kuhlane (2011) and Mavhunga and Rollnick (2013) refer to this teaching strategy as elicitation of prior knowledge.

Prior knowledge is the base knowledge from which learning must start (Roschelle, 1995). Agreeing with Roschelle, Resnick (1983) indicates that there is a widespread belief that prior knowledge influences learning and that learners construct concepts from prior knowledge.

Thereafter, we worked on the definition of these concepts, after I had explained the difference between *define* and *explain*. The examiners reports (DBE, 2014, 2015, 2016, 2017 & 2018) indicate that most learners battle to differentiate between the two terms; therefore in hindsight, this concern was addressed and hopefully we will see improvement in terms of learner performance.

Similarly, during the practical activity I noticed that the learners seemed to enjoy the telephone conversations. The social interactions (Vygotsky, 1978) during the practical activity seemed to have a positive impact on the learners' dispositions, as I heard some learners saying, "*Imnandi le lesson*" (this lesson is fun); some said, "this is exciting", and others said "*Ndiyayithanda*" (I like this). After the learner talk (Lemke, 1990), all the learners agreed that you hear the other person better with the string telephone than without it – this was in response to the first aim of the activity. Responding to the second aim, the learners agreed that they felt the vibrations as one person was talking, but they emphasised that the string had to be stretched tight. The learners could not explain further and they asked me to explain to them, and this gave me an opportunity to teach them Physics. Firstly, I explained to the learners how we used to enjoy making our string telephones as little boys in the township, even though we did not really understand the science behind this game.

Accordingly, I explained that sound is a pressure wave that passes from particle to particle of a medium, and that the properties of the particles affect how well and how fast sound travels through it (Broster et al., 2011). I asked the learners about the sound made by the sea when the waves are far away and when they are nearer. I did this in an attempt to link my explanation with their out-of-school context at the sea, what Aikenhead and Jegede (1999) refer to as border crossing. This question triggered a positive reaction from the learners, as I observed they nodded their heads and said, "*Iyavakala kengoku*" (Now that make sense).

5.4 Chapter Summary

This chapter discussed the three main themes emerging from the data sources and their contexts – observations, focus group stimulated recall interviews and journal reflections: Construction of knowledge; Promotion of learning through social interactions. The themes clarified factors influencing learners' conceptions, dispositions, and sense-making in science. The emerging

themes were discussed in support or dissimilarities to the literature reviewed. In the next chapter a summary of findings, recommendations and conclusions are made.

CHAPTER SIX: SUMMARY OF FINDINGS, RECOMMENDATIONS, AND CONCLUSION

6.1 Introduction

The main goal of this study was to explore whether learners' conceptions, dispositions, and sense-making are influenced (or not) by integrating local or indigenous knowledge when teaching the topic on waves and sound in a Grade 10 Physical Sciences township class. I employed a qualitative research design to generate data using a variety of methods. I used a group activity, observations (participatory observation and lesson observations), stimulated recall interviews and journal reflections. Data in this study were analysed using an inductive-deductive approach and the discussions were made using relevant literature, Vygotsky's socio-cultural theory, and Ogunniyi's Contiguity Argumentative Theory (CAT) as an analytical framework. A thematic and inductive approach to data analysis was employed to come up with sub-themes and themes.

To achieve the main goal of this study, the following research questions were addressed:

1. What are the indigenous practices and knowledge that can be integrated into the topic on waves and sound in Grade 10 Physical Sciences lessons?
2. How do Grade 10 Physical Sciences learners interact, participate and learn (or not) during the presentations by the two community members?
3. How do lessons on waves and sound that integrate IK shift (or not) Grade 10 Physical Sciences learners' conceptions, dispositions, and sense-making?

In the previous chapter, I presented, analysed and discussed data generated from the lesson presentation on practical activities on waves and sound and the intervention lesson that included IK when teaching the topic on waves and sound, as well as stimulated recall interviews and journal reflections. Thus, in this chapter, I present a summary of findings, recommendations, suggested

areas for future research, limitations to the study and reflections. This chapter ends with a conclusion.

6.2 Summary of Findings

In this section, I present my findings in relation to my three research questions. In doing this, I highlight to what extent these were answered.

6.2.1 Research question one

What are the indigenous practices and knowledge that can be integrated into the topic on waves and sound in Grade 10 Physical Sciences lessons?

The data responding to this research question were also presented in Chapter Four (see Sections 4.2 & 4.3). The findings from this study revealed that there are indigenous practices and knowledge that can be integrated into the topic on waves and sound in Grade 10 Physical Sciences lessons. For instance, the study revealed that there is a belief that when twins go to the sea, they must throw in a silver coin or pull hair from their head and throw it into the sea before going into the water or they could drown in the sea. The twins in the Grade 10 Physical Sciences class of Buyelembo Combined confirmed that they are aware of that belief, they explained that they were told by their parents, and that they practice that belief, meaning when they go to the sea they throw in a silver coin before they go into the water. None of the participants could offer a convincing argument why the twins had to throw in a silver coin, or hair before going into the water [Suppressed].

However, discussions around this belief revealed two things to me: (1) that prior this study the learners, my co-researchers had prior knowledge about this belief, which is part of IK. According to Hewson and Hewson (1988), learners' prior knowledge provides an indication of the alternative conceptions as well as the scientific conceptions possessed by them. (2) That it is true indigenous knowledge is passed on orally from generation to generation (Kibirige & Van Rooyen, 2006)

The study also revealed that there is a belief among the *Xhosas* that there are ancestors who live in the sea. Based on the discussions around this belief (see Section 4.2), it was revealed that this belief is based on *spirituality* and that there is no scientific evidence to support this belief.

Nonetheless, I believe that the discussions about the existence of this belief promoted arguments (Ogunniyi, 2007a) and hence critical thinking, which is one of the aims of teaching Physical Sciences (South Africa. DoE, 2011).

Furthermore, the study also revealed that there is a belief among the *Xhosas* that traditional healers (*Sangomas*) go to the sea to connect with their ancestors. It is believed that the *Sangomas* perform rituals and offer gifts such as *umqombothi*, to the ancestors by the sea. In his study, Webb (2013) revealed a similar belief about *Sangomas*. The study also revealed that there is another belief related to this, and the belief is that some people are taken in “*Ukuthwetyulwa*” and come back as *Sangomas* provided their families do not cry during the period in which they are taken in.

Regarding relevance of those beliefs to science, the study revealed that the learners found no relevance at all. Nonetheless, discussions and arguments were enhanced.

Lastly, the study revealed that there was indigenous knowledge that was explained by one of the two community members about low and high tides. The community member explained how low and high tides are formed in the sea. His explanation attracted the attention of the learners as he explained in terms of the size of the moon and the wind. This experience triggered a further desire for me to close the gap between classroom science and the community, what Aikenhead and Jegede (1999) refer to as border crossing.

6.2.2 Research question two

How do Grade 10 Physical Sciences learners interact, participate and learn (or not) during the presentations by the two community members?

The data responding to this question were presented in Chapter Four (see Section 4.3). The study revealed that there was a positive interaction between the learners and the two community members. The study showed that the interactions were mainly characterised by questions and answers. It was revealed in the study that the community members were probing the learners by asking more questions, what Mavhunga and Rollnick (2013) refer to as elicitation of prior knowledge – this was evident throughout the presentations by the two community members even

though they are not qualified teachers. The study also revealed learner talk which is a feature of learning in social contexts as espoused by Lemke (1990). I also observed that the learners were listening attentively to the presentations and that indicated to me that they were interested and internalising the presentations.

The study also revealed that participation by the learners during the presentations was very high. For example, on the belief about twins and the sea, the level of participation was very high. It was also my observation that the level of participation was high, partly due to the fact that there were twins in the science class who also showed keen interest in the discussion, and also due to the fact that most learners had prior knowledge around the belief about the twins and the sea. My observation was that the study afforded the learners an opportunity to build on their prior knowledge as emphasised by Kuhlane (2011). The study also revealed that the learners were smiling, laughing and asking questions and responding to questions asked by the two community members.

Also, the study revealed that the learners looked relaxed and were enjoying the presentations by the two community members as they had smiles on their faces. For example, some learners wrote: *“The lesson was fun”* or *“I enjoyed the lesson”* in their journal reflections. The study also revealed that the learners were learning during the presentations. For instance, I heard some learners talking about constructive and destructive interference. To show that learning was taking place, I observed the learners arguing among themselves about the explanation provided by the two community members. I also observed the two community members showing the learners how to fish using the fishing rod and L17 (using prior knowledge) assisting his classmates, confirming Stott’s (2016) argument that the “zone of proximal development is created through the social interactions with other during the learning activities and depends on the active contributions of all the participants”.

The study revealed that language plays a crucial role in teaching and learning, and that it stimulated learners to interact, participate and learn during the presentations by the two community members, and it encouraged discussions among the learners.

6.2.3 Research question three

How do lessons on waves and sound that integrate IK shift (or not) Grade 10 Physical Sciences learners' conceptions, dispositions, and sense-making?

Findings from this study revealed that the learners' conceptions, dispositions, and sense-making in science were influenced positively through using hands-on practical activities when teaching science concepts. This resonates very well with Woodley (2009) and CAPS (2011), where practical activities engage learners, helping them to develop scientific skills, understand the process of scientific investigation and develop an overall understanding of scientific concepts. Furthermore, the findings of this study revealed that the use of prior everyday knowledge served as a useful teaching strategy, for instance, the learners and the teacher generated a mind map, and this shows that learning with meaning took place. Also, the study revealed that the use of their mother tongue by the learners and the teachers, together with the language of learning and teaching, promoted learner talk. This is in line with Lemke (1990) and Vygotsky (1978) who point out that language is the most important tool for thinking, the most important means of communication and assists in sense-making.

6.3 Recommendations

In this study, the learners – my co-researchers, went out to the community to find information through interviewing some community members about IK and cultural practices related to waves and the sea. I then organised a brainstorming session where the learners reported back on their findings. Their information was presented on newsprint. The presentations by the learners were very informative and interesting, and it was clear to me that the learners took their role as co-researchers very seriously and they certainly earned my respect. I am happy to say I was doing a research with these learners rather than on them (Ngcoza, 2007). The smile on the learners' faces and the level of participation indicated to me that they were enjoying this study. The study thus recommends that learners be given an opportunity to participate in knowledge construction, through group activities.

Also, I identified two community members, a local fisherman and an elderly man from the community who used to work at our school as our groundsman. The two community members co-presented their experiences and knowledge about waves and cultural practices to the Physical Sciences Grade 10 learners during our outing to the sea. I noticed that the community members were engaging the learners by asking them questions throughout their presentations and that they were complementing each other. I noticed that this style of presentation kept the learners attentive during the entire presentations and forced them to think, thus this talks to sense-making, in line with Vygotsky's (1978) notion of social interaction. Secondly, I realised that the two community members were using prior knowledge of the learners as a stepping stone (Roschelle, 1995; Kuhlane, 2011). Even though the community members are not trained teachers, their ability to engage learners made me reflect on my own teaching method. Thus, the study suggests that there is a need for the schools to invite two community members to assist the teachers and the learners in enacting the integration of IK in Science as aspired to by CAPS (2011). Furthermore, I recommend, based on the findings of this study, that the Natural Science teachers of Buyelembu Combined should invite Sir Mlo to share his knowledge of low and high tides in the strand Earth and Beyond. I also recommend that the school invite Sir Mba to assist with the Doppler Effect, as his indigenous knowledge could assist the learners to understand this tricky topic. The study recommends that there is a need for Science teachers to take seriously their learners' socio-cultural backgrounds during their Science lessons.

Also, I presented a lesson on practical activities on waves and sound prior to the intervention, wherein learners were actively involved. The social interactions (Vygotsky, 1978) during the practical activity, seemed to have a positive impact on the learners' conceptions, dispositions and sense-making. I recommend that Science teachers should include properly planned practical activities to help learners make sense of abstract science concepts. Maselwa and Ngcoza (2003) suggest that practical activities can promote learners' conceptual understanding through discussions and conceptual maps.

Then, then two Science teachers and I co-planned a lesson plan that included IK. I then taught the topic on waves and tried to integrate IK during my Science lesson and asked the two Science teachers from the participating school to be my critical friends. The lesson was video recorded.

During the lesson I asked the learners questions based on what was presented by the two community members; scholars such as Roschelle (1995), Kuhlane (2011) and Mavhunga and Rollnick (2013) refer to this as elicitation of prior knowledge. The level of participation by the learners was very high during the lesson. Thus, I recommend proper planning by the teachers and that they should integrate IK in their lessons to mediate border crossing. Furthermore, I recommend co-development of lesson plans by the Science teachers. In addition, I recommend that teachers, especially Physical Sciences teachers should consider learners' prior knowledge when planning their lessons. Ausubel (1968) asserts, that the most important single factor influencing learning is what the learner already knows, and teachers need to ascertain this and teach from that accordingly.

The study revealed that language plays a crucial role in teaching and learning, hence, I recommend that township schools reconsider their language of learning and teaching (LoLT), for example, instead of using English only as the LoLT, they use both English and Xhosa, to promote maximum participation of the learners.

6.4 Areas for Future Research

This study has opened up opportunities for possible further research on the integration of indigenous knowledge (IK) in Science lessons. I would thus recommend that further research could be done on the same topic addressed by the study. However, the focus could be on the teachers instead of the learners and questionnaires, document analysis and workshops could be used as tools for gathering data. A similar study could be conducted, where the focus could be on community members, and they could be interviewed on how they think indigenous knowledge can be included in education.

6.5 Limitations of the Study

This case study was designed to work *with* one grade 10 Physical Sciences class in one township school. The limitation of this study therefore is that it had a small sample size (18 learners as my co-researchers) and the findings of the qualitative case study cannot be generalised to represent all Physical Sciences learners in the Sarah Baartman District or the entire Eastern Cape. As a case

study, the findings were generated from one Grade 10 Physical Sciences class and two community members, therefore the findings cannot be generalised but could provide insights into the integration of IK in teaching Science.

It could be that some meanings of words translated from *IsiXhosa* to English were distorted during the translation, but Miss S helped double check the translations. Also, the delay in the ethics clearance process somewhat limited the time taken for the study.

If I were to do the study again, I would make sure that I get the ethical clearance in good time. Secondly, I would invite the two community members to come and listen to the presentations by the learners and by the teacher inside the classroom, and thereafter ask for their inputs on how to better my teaching strategy.

6.6 Personal Reflections

I first came to Rhodes University in 1992 to pursue a BSc degree. Unfortunately, the political climate in our country led me to politics, which I got too involved in, losing focus in my studies and failing my first year. The following year I worked, saved some money, then in 1994 I moved to Fort Hare University where I dedicated myself to my studies and completed my BSc degree in record time. In 1997, I completed my Higher Diploma in Education and started working as a Physical Sciences and Mathematics teacher in 1998.

I joined Rhodes University again in 2009 to do my ACE in school leadership and management, a qualification I needed as the principal of a school. In 2016, I came back to Rhodes to pursue my Honours Degree in Education on a part time basis, meaning I was doing my honours over two years, attending four times a year during block sessions (5 days per session). Towards the end of my Honours degree, Professor Ngcoza who was on sabbatical leave, sacrificed his time and came back and introduced us to the concept of “Indigenous Knowledge”. I found lessons on indigenous knowledge (IK) very interesting, partly because they were based more on our everyday experiences (which I could relate to) and partly due to the manner in which Professor Ngcoza introduced IK which I found most fascinating. This triggered my research interest as a pure sciences student, and I saw an opportunity to develop myself and improve my teaching strategy.

After the last contact session, I went back to school and shared my experiences with my colleagues (the two Science teachers who were my critical friends in this study). I told my colleagues that I was interested in furthering my studies and wanted to focus on IK, and that my desire was to improve my teaching. They encouraged me and promised that they would support me as we were a community of practice. My desire to improve my teaching strategies was based on what I have highlighted in Section 1.2 of Chapter One. My hope was, that if I tapped into indigenous knowledge, I could make my Science lessons interesting and hopefully contribute positively towards the academic performance of our learners in Physical Sciences.

In 2018 I registered for my Master's degree in Science education with Rhodes University. My research journey has been a challenging and rewarding experience. It was challenging because I battled to strike a healthy balance between my studies, work, family and church. Secondly, it was challenging because I found it difficult to navigate the tension between Rhodes research ethics policy and *ubuntu* principles embedded in IK. For instance, according to the ethics policy, when conducting a research you must tell the participants that they have the right to withdraw from the study should they choose to do so; this is in contrast to the way you talk to the *Xhosas*, according to the *Xhosa* values, this statement is viewed as being rude and insensitive especially to the elders. Also, the Rhodes ethics policy requires that we must have written consent, whereas in the *Xhosa* culture we use *ubuntu*, where your word of mouth is enough and the elders battled to understand why they needed to sign anything, as if I did not trust them and were disrespecting their culture. Nonetheless, as a *Xhosa* child myself, I managed to mediate those tensions, but it was not easy.

The journey was rewarding as it contributed positively to my professional development in so many ways. Firstly, I have developed knowledge on how to integrate IK in my Science lessons and my teaching. Secondly, my computer skills have improved and other skills that I need as a teacher. This study has taught me to value and appreciate the knowledge that the community members have. I was humbled by the presentations by the two community members and the skills they have, and I concur with Vygotsky (1978), that indeed they are more knowledgeable others. Thirdly, the study was rewarding as it afforded me an opportunity to work with the learners as my co-researchers; the quality of work they produced during the brainstorming, and their level of participation during the group presentations showed me that our learners are capable, they just

need to be given a chance. Fourthly, during the journey, I learnt the importance of using prior knowledge and I intend to use elicitation of prior knowledge in my teaching, which is one of the things that I has been lacking in my teaching practice.

Lastly, I believe that this study has opened my eyes in so many ways, and the experiences from this study have equipped me to be a better teacher.

6.7 Conclusion

The main goal of this study was to explore whether learners' conceptions, dispositions, and sense-making are influenced (or not) by integrating local or indigenous knowledge when teaching the topic on waves and sound in a Grade 10 Physical Sciences township class. To achieve this goal, I used the following data gathering techniques: a group activity, observations, stimulated recall interviews and journal reflections. The findings from this study revealed that there are indigenous practices and knowledge that can be integrated into the topic on waves and sound in Grade 10 Physical Sciences lessons. However, regarding relevance of those beliefs to science, the study revealed that the learners found no relevance at all.

Secondly, the study revealed that there was a positive interaction between the learners and the community members. The study also revealed that participation by the learners during the presentations was very high and that the learners were learning during the presentations. Additionally, the study revealed that language plays a crucial role in teaching and learning, and that it stimulated learners to interact, participate and learn during the presentations by the community members, and encouraged discussions among the learners.

Thirdly, regarding the third question, which was aimed at finding out how lessons on waves and sound that integrate IK shift (or not) Grade 10 Physical Sciences learners' conceptions, dispositions, and sense-making, the findings revealed that learners were actively involved during the discussions and their conceptions, dispositions and sense-making were positively influenced by integrating local or IK in the topic on waves. The study thus recommends that there is a need for Science teachers to take seriously their learners' socio-cultural backgrounds during their Science lessons.

In conclusion, the main findings of this study revealed that the integration of indigenous practices and knowledge when teaching the topic on waves and sound to a township Grade 10 Physical sciences class enhanced social interactions amongst learners and afforded them an opportunity to discuss and argue. Additionally, involving community members who are custodians of these indigenous practices and knowledge about the sea created a conducive and relaxed environment for both teachers and learners. As a result, learners' conceptions, dispositions and sense-making of waves and sound were influenced positively.

References

- Abrahams, I., & Millar, R. (2008). Does practical work really work? A study of the effectiveness of practical work as a teaching and learning method in School science. *International Journal of Science Education*, 30(14), 1945-1969.
- Agunbiade, E., Ngcoza, K., Jawahar, K., & Sewry, J. (2017). An exploratory study of the relationship between learners' attitudes towards learning science and characteristics of an afterschool science club. *African Journal of Research in Mathematics, Science and Technology Education*. doi:10.1080/18117295.2017.1369274
- 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(3), 269-287.
- Asheela, E. N. (2017). *An intervention on how using easily accessible resources to carry out hands-on practical activities in science influences science teachers' conceptual development and dispositions*. Unpublished master's thesis. Rhodes University, Grahamstown.
- 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.
- Ausubel, D. (1968). *Educational psychology - A cognitive view*. New York: Rinehart and Winston.
- Banu, S. (2011). *The role of practical work in teaching and learning at secondary level in Bangladesh*. Unpublished master's thesis, University of Canterbury, New Zealand.

- Bertram, C., & Christiansen, I. (2015). *Understanding research: An introduction to reading research*. Pretoria: Van Schaik Publishers.
- Broster, P., Horn, W., James, H., & Paarman, S. (2011). *Oxford successful physical sciences: Teacher's guide. Grade 10*. Oxford University Press Southern Africa.
- Caper, S., & Leask, M. (1993). *Learning to teach in the secondary school*. London: Routledge.
- Chikamori, K., Tanimura, C., & Ueno, M. (2019). Transformational model of education for sustainable development as a learning process of socialization. *Journal of Critical Realism*, 18(4), 420-436.
- Cobern, W. W., & Loving, C. C. (2001). Defining “science” in a multicultural world: Implications for science education. *Science Education*, 85(1), 50-67.
- Cocks, M. L., Alexander, J., & Dold, T. (2012). Inkubeko Nendalo: A bio-cultural diversity schools education project in South Africa and its implications for inclusive indigenous knowledge systems (IKS) sustainability. *Journal of Education for Sustainable Development*, 6(2), 241-252.
- Cohen, L., Manion, L., & Morrison, K. (2011). *Research methods in education* (7th ed.) New York: Routledge.
- Cohen, L., Manion, L., & Morrison, K. (2018). *Research methods in education* (8th ed.) New York: Routledge.
- Creswell, J. W. (2008). *Educational research: Planning, conducting and evaluating quantitative and qualitative research* (3rd ed.). Canada: Pearson.
- Crick, D., & Yu, G. (2008). Assessing learning disposition: is the effective life-long learning inventory valid and reliable as a measurement tool? *Education Research*, 50(4), 387-402.

- 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.
- Diwu, C.T., & Ogunniyi, M. B. (2012). Dialogical argumentation instruction as a catalytic agent for the integration of school science with Indigenous Knowledge Systems. *African Journal of Research in Mathematics, Science and Technology*, 16(3), 333-347.
- Dziva, D., Mpofu, V., & Kusure, L. P. (2011). Teachers' conceptions of indigenous knowledge in science curriculum in the context of Mberengwa district, Zimbabwe. *African Journal of Educational and Technology*, 1(3), 88-102.
- Enghono, A. M. (2013). *Understanding how trainee teachers engage with prior everyday knowledge and experience associated with biological concepts during integrated Natural Science education 5-7: A case study*. Unpublished master's thesis, Rhodes University, Grahamstown.
- Gardner, P. L. (1975). Attitudes to science: A review. *Studies in Science Education*, 2, 1-41.
- Gass, S., & Mackey, A. (2017). *Stimulated recall methodology in applied linguistics and L2 research*. New York: Routledge. doi:10.4324/9781315813349
- Goos, M. (2004). Learning Mathematics in a classroom community of inquiry. *Journal for Research in Mathematics*, 35(4), 258-291.
- 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). Grahamstown: Rhodes University.

- Hamming, B. (2005). Epistemology from the African point of view. In B. Hamming (Ed.), *Knowledge cultures: Comparative western and African epistemology*, 57-84. Amsterdam: Rodopi.
- Harrison, G., & Muthivhi, A. (2013). Mediating self-regulation in kindergarten classrooms: An exploratory case study of early childhood education in South Africa. *Journal of Education*, 57, 79-102.
- Hashondili, S. (2019). *Exploring working with Grade 6 elementary Agricultural Science teachers on how to integrate local knowledge in food preservation*. Unpublished master's thesis. Rhodes University, Grahamstown.
- Hodson, D. (2009). *Teaching and learning about science language, theories, methods, history, traditions and values*. Rotterdam: Sense Publishers.
- Horsthemke, K., & Schafer, M. (2007). Does 'African mathematics' facilitate access to mathematics? Towards an ongoing critical analysis of ethnomathematics in a South African context. *Pythagoras*, 65, 2-9.
- Huberman, A. M., & Miles, M. B. (1994). Data management and analysis methods. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 428-444). Thousand Oaks, CA, US: Sage Publications, Inc.
- Jegede, O. J. (1999). Science education in non-western cultures: Towards a theory of collateral learning. In L. M. Semali & J. L. Kincheloe (Eds.) *What is indigenous knowledge? Voices from the Academy* (pp. 119-142). New York: Palmer Press.
- Kadis, J. (2015). *Acoustic: The study of sound waves*. Retrieved 21 December, 2019, from www.educ/192a/lecture1caustic.pdf

- Keane, M., Khupe, C., & Muza, B. (2016). It matters who you are: Indigenous knowledge research. *Education as Change*, 20(2), 163-183.
- Khupe, C. (2014). *Indigenous knowledge and school: Possibilities for integration*. Unpublished PhD thesis, University of Witwatersrand, Johannesburg.
- 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*. Braamfontein: Macmillan.
- Klein, J. (2011). Indigenous knowledge and education-the case of the Nama people in Namibia. *Education as Change*, 15(1), 81-94.
- Kozulin, A., Gindis, B., Ageyev, V. S., & Miller, S. M. (2003). Introduction: Sociocultural theory and education: Students, teachers, and knowledge. In A. Kozulin, B. Gindis, V. S. Ageyev & S. M. Miller (Eds.), *Vygotsky's educational theory in cultural context* (pp. 1-11). Cambridge: Cambridge University Press.
- Kuhlane, Z. (2011). *An investigation into benefits of integrating learners' prior everyday knowledge and experience during teaching and learning of acids and bases in grade 7: A case study*. Unpublished master's thesis, Rhodes University, Grahamstown.
- Le Grange, L. (2007). Integrating western and indigenous knowledge systems: The basis for effective science education in South Africa. *International Review of Education*, 53, 577-591.
- Lemke, J. L. (1990). *Talking science: Language, learning, and values*. Norwood, NJ: Ablex Publishing Corporation.
- Liveve, A. K. (2017). *Exploring the possibility of integrating traditional music and dance into the design and delivery of lessons on the concepts of echo and waves in the grade 10 Physical Science sound topic*. Unpublished master's thesis. Rhodes University, Grahamstown.

- Magoon, A. J. (1977). Constructivist approaches in educational research. *Review of Educational Research*, 47(4), 651-693.
- Manzini, S. (2000). Learners' attitude towards the teaching of indigenous african science as part of the school science curriculum. *Journal of the Southern African Association for Research in Mathematics, Science and Technology Education*, 4(1), 19-32.
- Maselwa, M. R., & Ngcoza, K. M. (2003). 'Hands-on', 'minds-on' and 'words-on' practical activities in electrostatics: Towards conceptual understanding. In D. Fisher & T. Marsh (Eds.), *Making Science, Mathematics and Technology Education accessible to all. Proceedings of The Third International Conference on Science, Mathematics and Technology Education*. Perth: Key Centre for School Science and Mathematics.
- Mathison, S. (1988). Why triangulate? *Educational Researcher*, 17, 13-17.
- Maxwell, J. A. (2012). *A realistic approach for qualitative research*. United Kingdom: Sage Publication.
- Mavhunga, E., & Rollnick, M. (2013). Improving PCK of chemical equilibrium in pre-service teachers. *African Journal of Research in Mathematics, Science and Technology Education*, 17(1-2), 113-125.
- 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), 176-1876.
- Mavuru, L., & Ramnarain, U. D. (2019). Language affordances and pedagogical challenges in multilingual grade 9 natural sciences classrooms in South Africa. *International Journal of Science Education*, 1-21.
- McMillan, J., & Schumacher, S. (2014). *Research in education: Evidence-based inquiry* (7th ed.). USA: Pearson.

- McRobbie, C., & Tobin, K. (1997). A social constructivist perspective on learning environments. *International Journal of Science Education*, 19(2), 193-208.
- Mhakure, D., & Otulaja, F. S. (2017). Culturally-responsive pedagogy in science education: narrowing the divide between indigenous knowledge and scientific knowledge. In F. S. Otulaja & M. B. Ogunniyi (Eds.), *The world of science education: a handbook of research in science education in Sub-Saharan Africa* (pp. 81-100). Rotterdam: Sense Publishers.
- Millar, R. (2004). *The role of practical work in the teaching and learning of science*. University of York: Department of Educational Studies.
- Millar, R. (2010). Practical work. In J. Dillon (ed.), *Good practices in science teaching: What research has to say* (2nd ed.) (pp. 108-134). England: Open University Press.
- Mothwa, M. M. (2011). *Teachers' experiences of incorporating indigenous knowledge in the life sciences classroom*. Unpublished master's thesis. University of Johannesburg, Johannesburg.
- Msimanga, A., & Lelliott, A. (2014). Talking science in multilingual contexts in South Africa: Possibilities and challenges for engagement in learners home languages in high school classrooms. *International Journal of Science Education*, 36(7), 1159-1183.
- 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.
- 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.
- Ngcoza, K., & Southwood, S. (2015). Professional development networks: From transmission to co-construction. *Perspectives in Education*, 33(1), 4-14.

- 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. Education Department, Rhodes University, Grahamstown.
- 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.
- Ogunniyi, M. B. (2006). Effects of a discursive course on two science teachers' perceptions of the nature of science. *African Journal of Research in Mathematics, Science and Technology Education*, 10(1), 93-102.
- Ogunniyi, M. B. (2007). Teachers' stances and practical arguments regarding a science-indigenous knowledge curriculum: Part 1. *International Journal of Science Education*, 29(8), 963-986.
- Ogunniyi, M. B., & Hewson, M. G. (2008). Effect of an argumentation-based course on teachers' disposition towards a science-indigenous knowledge curriculum. *International Journal of Environmental and Science Education*, 3(4), 159-177.
- Resnick, L. B. (1983). Mathematics and science learning: A new conception. *Science*, 220(4596), 477-478.
- Roschelle, J. (1995). *Learning in interactive environments prior knowledge and new experiences*. Retrieved 11 March, 2017, from <http://www.exploratorium.edu/ifi/resources/museumeducation/priorknowledge.html>
- Scanlon, E., Morris, E., Terry, D. P., & Cooper, M. (2002). Contemporary approaches to learning science. Technologically-mediated practical work. *Studies in Science Education*, 38(1), 73-114.

- Sedlacek, M., & Sedova, K. (2017). How many are talking? The role of collectivity in dialogic teaching. *International Journal of Educational Research*, 85, 99-108.
- 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. (2013). Reclaiming our indigenous voices: The problem with postcolonial sub-saharan African school curriculum. *Journal of Indigenous Social Development*, 2(1), 1-18.
- South African Council for Educators. (2013). The CPTD Management System Handbook. *Towards Excellence in Education*, 1, 4-6.
- South Africa. Department of Education. (2003). *National Curriculum Statement Grades 10 -12: Physical Sciences*. Pretoria: Government Printer.
- South Africa. Department of Education. (2011). *National Curriculum Statement Grades R -12: Curriculum and Assessment Policy Statement (CAPS), Physical Sciences FET*. Pretoria: Government Printer.
- Southerland, S. A. (2000). Epistemic universalism and the shortcomings of curricular multicultural science education. *Science Education*, 9, 289-307.
- Stears, M., Malcolm, C., & Kowlas, L. (2003). Making use of everyday knowledge in the science classroom. *African Journal of Research in SMT Education*, 7, 107-118.
- Stott, D. (2016). Making sense of the ZPD: An organizing framework for Mathematics education research. *African Journal of Research in Mathematics, Science and Technology Education*, 20(1), 25-34.
- 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.

- Thaman, K. H. (2009). Towards cultural democracy in teaching and learning with specific reference to Pacific Islands. *International Journal of Scholarship of Teaching and Learning*, 3(2), 1-11.
- Thomas, G. (2013). *How to do your research project: A guide to students in education and applied social sciences*. London: Sage Publications.
- 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). New York, NY, England: Macmillan Publishing Co, Inc.
- Towndrow, P. A., Ling, T. A., & Venthan, A. M. (2008). Promoting inquiry through science reflective journal writing. *Eurasia Journal of Mathematics, Science & Technology Education*, 4(3), 279-283.
- Tsai, C-C. & Kuo, P-C. (2008). Cram school students' conceptions of learning science in Taiwan. *International Journal of Science Education*, 30(3), 353-375.
- Tsoukas, H., & Chia. R. (2002). Organizational becoming: Rethinking organizational change. *Organization Science*, 13(5), 567-582.
- UNESCO. 1999. *Cultural challenges of the International Decade of the World's Indigenous People*, 18-20 October. Paris: UNESCO.
- Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Webb, P. (2013). Xhosa indigenous knowledge: Stakeholder awareness, value and choice. *International Journal of Science and Mathematics Education*, 11(1), 89-110.
- Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. (2005). Organizing and the process of sensemaking. *Organization Science*, 16(4), 409-421.

Wells, G. (1999). *Dialogic inquiry: Towards a sociocultural practice and theory of education*.
New York: Cambridge University Press.

Woodley, E. (2009). Practical work in school science – Why is it important? *School Science Review*, 91(335).

Appendices

Appendix A: Ethical clearance



RHODES UNIVERSITY
Where leaders learn

Human Ethics subcommittee
Rhodes University Ethical Standards Committee
PO Box 94, Grahamstown, 6140, South Africa
t: +27 (0) 46 603 8055
f: +27 (0) 46 603 8822
e: ethics-committee@ru.ac.za
www.ru.ac.za/research/research/ethics
NHREC Registration no. REC-241114-045

19 July 2019

Xolani Mayana

Review Reference: 2019-0247-721

Email: g92M2833@campus.ru.ac.za

Dear Xolani Mayana

Re: Integrating indigenous knowledge in science lessons ,

Principal Investigator: Prof Kenneth Mlungisi Ngcoza

Collaborators: Mr Xolani Justice Mayana ,

This letter confirms that the above research proposal has been reviewed and **APPROVED** by the Rhodes University Ethical Standards Committee (RUESC) – Human Ethics (HE) sub-committee.

Approval has been granted for 1 year. An annual progress report will be required in order to renew approval for an additional period. You will receive an email notifying when the annual report is due.

Please ensure that the ethical standards committee is notified should any substantive change(s) be made, for whatever reason, during the research process. This includes changes in investigators. Please also ensure that a brief report is submitted to the ethics committee on completion of the research. The purpose of this report is to indicate whether the research was conducted successfully, if any aspects could not be completed, or if any problems arose that the ethical standards committee should be aware of. If a thesis or dissertation arising from this research is submitted to the library's electronic theses and dissertations (ETD) repository, please notify the committee of the date of submission and/or any reference or cataloguing number allocated.

Sincerely



Prof Joanna Dames
Chair: Human Ethics sub-committee, RUESC- HE

Appendix B: Department of education consent letter



CURRICULUM SECTION : Curriculum Management
Sarah Baartman Education District, c/o Murray & Paul Kruger Street, Private Bag X726, GRAAFF-REINET, 6280
REPUBLIC OF SOUTH AFRICA, Website: www.ecdoe.gov.za

E-mail: pierdev20@gmail.com / Pierre.deVilliers@ecdoe.gov.za

Ref. No. Enquiries: Pierre de Villiers Tel.: 0498073006 Fax: 0866663882 Cell: 0832911505 / 0605233094 <http://hartsourr.weebly.com>

TO : *The Principal*
[REDACTED]
Grahamstown CMC
Sarah Baartman Education District

FROM : *Pierre de Villiers*
CES Curriculum

SUBJECT : *Mr. Xolani Mayana*

DATE : *14 February 2019*

CES CURRICULUM

Dear Principal

Mr. Xolani Mayana is a M Ed student in Science Education at the Rhodes University. His research topic is "*Exploring the effect of integrating indigenous knowledge (IK) when teaching the topic on waves and sound in a township school*"

Herewith we are granting permission to Mr. Mayana to enter schools in the [REDACTED] to continue his research and request principals and relevant teachers to support Mr. Mayana in his efforts.

Yours in Education

[REDACTED]
CES Curriculum

building blocks for growth



Republiek van Suid-Afrika

Appendix C: Deputy Principal's consent letter



P.O. Box [REDACTED]
PORT ALFRED
2839 JOE SLOVO
6170
OFFICE: 046 624 8234
E/MAIL: kuyasacs@gmail.com
DEPUTY PRINCIPAL: S.A Yankwa
CELL: 0609466106
EMAIL: yankwadjamouo@gmail.com

18/02/2019

FROM : [REDACTED]
SUBJECT : Deputy Principal
DATE : MEd Research permission granted
DATE : 18 February 2019

To whom it may concern

Mr. Xolani Mayana is a M Ed student in science Education at Rhodes University. His research topic is "Exploring the effect of integrating indigenous knowledge (IK) when teaching the topic on waves and sound in a township school"

Herewith we are granting permission to Mr. Mayana to do his research in our school. The two physical sciences teachers and the grade 10 physical sciences learners are encouraged to assist Mr. Mayana in this regard.

Yours in education

[REDACTED]
Deputy Principal and Head of Sciences

Appendix D (a): Letter to the community members

Enquiries: Mr XJ Mayana

Cell number: 0605093028

Dear Mr xxxxxxxxxxxxxxx

RE: PERMISSION LETTER: PRESENTATION AT xxxxxx COMBINED SCHOOL

I am Xolani Justice Mayana, a part-time student doing master's in science education at Rhodes University, South Africa. I am also the principal and Mathematics and Physical Sciences teacher at xxxxx Combined School. I hereby humbly request your permission to be a research participant in my research project that I will be conducting with my Grade 10 Physical Sciences learners at xxxxx Combined. The focus of the study is to explore how the integration of local or indigenous knowledge during the lessons on the topic on waves influences (or not) Grade 10 Physical Sciences learners' conceptions, dispositions and sense-making. I plan to conduct the study for about two weeks in July/August 2019.

Since we will be concentrating on the study on waves, your main role will be to present to the Grade 10 Physical Sciences learners your local knowledge or indigenous knowledge about the sea and related cultural practices. With your permission I will videotape your presentation and myself and the learners will interview you.

Your participation in this research study is completely voluntary and you can withdraw at any time you wish. I will ensure that your identity will not be revealed and that I will maintain anonymity.

I henceforth request you to indicate your choice by making a tick (✓) in an appropriate box below.

Agree

Not agree

Signature:.....

Your cooperation will be highly appreciated

Yours Sincerely

XJ Mayana

I can be reached at 0605093028 or email (xj.mayana@gmail.com)

Note: My supervisor is Prof K.M Ngcoza at Rhodes University, email address (k.ngcoza@ru.ac.za)

My co-supervisor is Mrs Joyce Sewry at Rhodes University, email address (j.sewry@ru.ac.za)

The Rhodes University Ethic coordinator is Mr Siyabonga Manqele, email address (s.manqele@ru.ac.za)

Appendix D (b): Translated letter

Mnumzana obekekileyo,

Igama lam ngu Xolani Justice Mayana umfundisintsapho kweZezibalo neNzululwazi exxxx CS. Ndicela ukuba ube yinxalenye kuphando ulunxulumene nezifundo zam zakwi Dyunivesithi yase Rhodes. Uphando lwam ndizakulenza exxxx CS, lunxulumene nokuphanda ukuba umndla wabafundi ungakhula akanye udodobale xa kufundiswa iNzululazwi kwibanga lesibhozo kudityaniswa ulwazi nenkcubeko efumaneka eluntwini nasekuhlaleni ngokubanzi xa kufundiswa ngolwandle namaza kwakunye neenkolo zoluntu ezidibandakanya ulwandle.

Oluphando luzakuthatha izigaba ezine. Isigaba sesibini sinxulumene nokufundisa nokucacisela abafundi nootitshala beNzululwazi ukuba luthini ulwazi lwemveli ngolwandle kwakunye neenkolo zakwantu. Injongo ephambili yoluphando kukuqwalasela ukuba kungakwazi ukuhlanganiswa ulwazi lwemveli neNzululwazi, ukuzama ukukhulisa umdla wabafundi kwezeNzululwazi. Ndiyazithoba ndikucela kanaanjalo ukuba uzokusifundisa, ngolwazi lwemveli ngolwandle kwakunye neenkolo zoluntu ezidibene nolwandle namaza.

Ndakuvuyiswa yinxaxheba yakho koluphando. Imithetho yeDyunivesithi ke ayibabopheleli abathathi nxaxheba into ethetha ukuba banakho ukurhoxa nanini na xa befuna. Ndiyakuqinisekisa nakanjalo ukuba ulwazi olufumaneka kulophando aliyikunikwa nabanina ngaphandle kwemvume yakho. Ukanti, igama lakho aliyikuchazwa esidlangaleleni ngaphandle kwemvume yakho. Siye ke safumanisa ukuba masenze uphando lokuba sazi ukuba yintoni eyenza umdla nendlela abacinga ngayo abantwana xa beyinxalenye kusenziwa uphando nzulu kwizifundo zeNzululwazi ingakumbi kwizinto zaselunxwemeni.

Ukuba unombuzo malunga noluphando, nceda uqhagamishelane nam kolu cingo 0605093028, xj.mayana@gmail.com) okanye ingqonyela nengqonyelakazi endiphantsi kwazo uProf. Ken Ngcoza (k.ngcoza@ru.ac.za) (046-6037269) okwiSebe lwezeMfundo eRhodes Dyunivesithi, kwakunye noNkosikazi uJoyce Sewry (J.Sewry@ru.ac.za) okwiSebe lezeNzululwazi eRhodes Dyunivesithi.

Maz'enethole!

Ndiyakucela kanaanjalo ukuba uncede uzalise esi siqendu silandelayo.

Mna mnumzana (Igama lakho)

Ndiyavuma OKANYE Andivumi (Khetha ngokufaka ✓) ukuthabatha inxaxheba koluphando.

Tyikitya.....

Inombolo yomxeba.....

Appendix E (a): Letter to the parents/guardians

Enquiries: Mr Mayana XJ

Cell number: 0605093028

Dear Mrs/Mr xxxxxxxxx

Re: Participation in research on the integration of local or indigenous knowledge when teaching the topic on waves in the Grade 10 Physical Sciences class

I am Xolani Justice Mayana, a part-time student doing master's in science education with Rhodes University, South Africa. I am a Mathematics and Science teacher at xxxx Combined School. I hereby humbly request your permission for me to conduct a research study with your child/ward who is studying at xxxxx Combined. I plan to conduct the study for about two weeks in July 2019. The learners will be required to (a) complete pre and post questionnaires, (b) collect data from community members, (c) present in class and (d) interact with two community members who will be presenting about indigenous knowledge and related cultural practices about the sea, and these activities will be observed and I will videotape and interview the learners and the community members, with your permission.

The focus of the study is to explore the learners' conceptions, dispositions, and sense-making when integrating local or indigenous knowledge when teaching the topic on waves and sound to the Grade 10 Physical Sciences Class. Kindly be informed that participation in this study is voluntary. It is therefore the right of the parent to decide whether his/her child should participate or not. Also, participants are free to withdraw any time as they wish to do so. The identity and views of the participants will not be revealed, and I will maintain anonymity, and data that will be collected will not be used for other purposes apart from this study.

If you have any question about the research, please feel free to contact me at 0605093028, xj.mayana@gmail.com or my supervisors Prof Ken Ngcoza at k.ngcoza@ru.ac.za and Mrs Joyce Sewry, J.Sewry@ru.ac.za.

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 content 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

XJ Mayana

Appendix E (b): Translated letter

Mzali obekekileyo,

Igama lam ngu Xolani Justice Mayana umfundisintsapho kweZezibalo neNzululwazi exxxx Combined. Ndicela ukuba umntwana wakho abeyinxalenye kuphando ulunxulumene nezifundo zam zakwi Dyunivesithi yase Rhodes. Uphando lwam ndizakulenza exxxx Combined, lunxulumene nokuphanda ukuba umndla wabafundi ungakhula akanye udodobale xa kufundiswa iNzululazwi kwibanga lesibhozo kudityaniswa ulwazi nenkcubeko efumaneka eluntwini nasekuhlaleni ngokubanzi xa kufundiswa ngolwandle namaza kwakunye neenkolo zoluntu ezidibandakanya ulwandle.

Oluphando luzakuthatha izigaba ezine. Isigaba sokuqala sinxulumene nokuba umntwana wakho ayokwenza uphando eluntwini malunga nolwazi lwemveli ngolwandle kwakunye neenkolo zakwantu. Injongo ephambili yoluphando kukuqwalasela ukuba kungakwazi ukuhlanganiswa ulwazi lwemveli nenzululwazi, ukuzama ukukhulisa umdla wabafundi kwezeNzululwazi. Ndiyazithoba ndikucela kananjalo ukuba umvumele umntwana wakho abe yinxalenye yoluphando.

Ndakuvuyiswa kakhulu yimvume yakho. Imithetho yeDyunivesithi ke ayibabopheleli abathathi nxaxheba into ethetha ukuba banakho ukurhoxa nanini na xa befuna. Ndiyakuqinisekisa nakanjalo ukuba ulwazi olufumaneka kulophando aliyikunikwa nabanina ngaphandle kwemvume yakho. Ukanti, igama lamntwana aliyikuchazwa esidlangaleleni ngaphandle kwemvume yakho kwakunye neyakhe. Siye ke safumanisa ukuba masenze uphando lokuba sazi ukuba yintoni eyenza umdla nendlela abacinga ngayo abantwana xa beyinxalenye kusenziwa uphando nzulu kwizifundo zeNzululwazi ingakumbi kwizinto zaselunxwemeni.

Ukuba unombuzo malunga noluphando, nceda uqhagamishelane nam kolu cingo 0605093028, xj.mayana@gmail.com) okanye ingqonyela nengqonyelakazi endiphantsi kwazo uProf. Ken Ngcoza (k.ngcoza@ru.ac.za) (046-6037269) okwiSebe lwezeMfundo eRhodes Dyunivesithi,

kwakunye noNkosikazi u Joyce Sewry (J.Sewry@ru.ac.za) okwisebe lezeNzululwazi eRhodes Dyunivesithi.

Maz' enethole!

Ndiyakucela kanaanjalo ukuba uncede uzalise esi siqendu silandelayo.

Mna mzali okanye mmeli mzali (Igama lakho), ka
.....(Igama lomntwana wakho)

Ndiyavuma OKANYE Andivumi (Khetha ngokufaka X) ukuba athathe inxaxheba koluphando.

Tyikitya.....

Inombolo yomxeba.....

Appendix F (a): Letter to the learner

Enquiries: Mr Mayana XJ

Cell number: 0605093028

Dear.....(Learner Name)

Re: Participation in research on the integration of local or indigenous knowledge when teaching the topic on waves in the Grade 10 Physical Sciences class

I am Xolani Justice Mayana, a part-time student doing Masters in Science Education at Rhodes University, South Africa. I am a Mathematics and Science teacher at xxxx Combined School. I hereby humbly request your permission for me to conduct a research study with you as my co-researcher, during teaching and learning of the topic on waves and sound at xxxx Combined. I plan to conduct the study for about two weeks in July/August 2019. The learners who will be participating will be required to (a) complete pre- and post-questionnaires, (b) collect data from community members, (c) present in class and (d) interact with two community members who will be presenting about indigenous knowledge and related cultural practices about the sea, and these activities will be observed. I will videotape and interview the learners and the community members with your permission.

The focus of the study is to explore the learners' conceptions, dispositions, and sense-making when integrating local or indigenous knowledge when teaching the topic on waves and sound to the Grade 10 Physical Sciences Class. Kindly be informed that participation in this study is voluntary. It is therefore your right to decide whether you wish to participate or not. Also, participants are free to withdraw any time as they wish to do so. The identity and views of the participants will not be revealed, and I will maintain anonymity, and data that will be collected will not be used for other purposes apart from this study. Please note: Extra support and activities such as worksheets, video lessons and other relevant teaching materials will be made available for all those learners who do not wish to be part of this research and they will not be disadvantaged in any way.

If you have any question about the research, please feel free to contact me at 0605093028, xj.mayana@gmail.com or my supervisors Prof Ken Ngcoza at k.ngcoza@ru.ac.za and Mrs Joyce Sewry, J.Sewry@ru.ac.za.

Lastly, if you agree or do not agree to participate in this research, please complete the consent form below.

I.....(full name of the learner), hereby confirm that I understand the content of this document and the nature of the research. I henceforth request you to indicate your choice by making a tick (✓) in an appropriate box below.

Agree to participate in the study

Do not wish to participate in the study

Signature:..... Date:.....

Yours Sincerely

XJ Mayana

Appendix F (b): Translated letter

Mfundi obekekileyo.....

Igama lam ngu Xolani Justice Mayana umfundisintsapho kweZezibalo neNzululwazi eKuyasa Combined. Ndicela ukuba ubeyinxalenye kuphando ulunxulumene nezifundo zam zakwi Dyunivesithi yase Rhodes. Oluphando sizakulenza exxxx Combined, lunxulumene nokuphanda ukuba umndla wabafundi ungakhula akanye udodobale xa kufundiswa iNzululazwi kwibanga lesibhozo kudityaniswa ulwazi nenkcubeko efumaneka eluntwini nasekuhlaleni ngokubanzi xa kufundiswa ngolwandle namaza kwakunye neenkolo zoluntu ezidibandakanya ulwandle.

Oluphando luzakuthatha izigaba ezine. Isigaba sokuqala sinxulumene nokuba umntwana wakho ayokwenza uphando eluntwini malunga nolwazi lwemveli ngolwandle kwakunye neenkolo zakwantu. Injongo ephambili yoluphando kukuqwalasela ukuba kungakwazi ukuhlenganiswa ulwazi lwemveli nenzululwazi, ukuzama ukukhulisa umdla wabafundi kwezeNzululwazi. Ndiyazithoba ndikucela kananjalo ukuba umvumele umntwana wakho abe yinxalenye yoluphando. Qwalasela, umntwana ongafuniyo ukuthabatha inxacheba akazokucinezelwa okanye ahlukunyezwe koko uncedo lomsebenzi uzakulinikwa kangangoko.

Ndakuvuyiswa kakhulu yimvume yakho. Imithetho yeDyunivesithi ke ayibabopheleli abathathi nxaxheba into ethetha ukuba banakho ukurhoxa nanini na xa befuna. Ndiyakuqinisekisa nakanjalo ukuba ulwazi olufumaneka kulophando aliyikunikwa nabanina ngaphandle kwemvume yakho. Ukanti, igama lakho aliyikuchazwa esidlangaleleni ngaphandle kwemvume yakho kwakunye neyomzali wakho. Ukuba uyavuma eyakho indima iyakuquka, (a) ukufilisha imibuzo yophando, (b) uyokufuna ulwazi kubantu abadala ekulhaleni olungqamene noluphando, (c) wabelane nabanye abafundi eklasini ngophando lwakho, kwa (d) ubeyinxalenye yabafundi abazakufundiswa ziingcali zasekuhlaleni ngolwazi lwemveli olunxulumene noluphando, uzibuzele imibuzo kubo.

Ukuba unombuzo malunga noluphando, nceda uqhagamishelane nam kolu cingo 0605093028, xj.mayana@gmail.com) okanye ingqonyela nengqonyelakazi endiphantsi kwazo uProf. Ken Ngozoza (k.ngcoza@ru.ac.za) (046-6037269) okwiSebe lwezeMfundo eRhodes Dyunivesithi,

kwakunye noNkosikazi u Joyce Sewry (J.Sewry@ru.ac.za) okwisebe lezeNzululwazi eRhodes Dyunivesithi.

Maz' enethole!

Ndiyakucela kanaanjalo ukuba uncede uzalise esi siqendu silandelayo.

Mna mfundi (Igama lakho).

Ndiyavuma OKANYE Andivumi (Khetha ngokufaka X) ukuba athathe inxaxheba koluphando.

Tyikitya..... Inombolo yomxeba.....

Ozithobileyo, Xolani Mayana

Appendix G (a): Interviews questions

The researcher is interested to find out the effect of integrating indigenous knowledge (IK) when teaching the topic of waves and sound in a Grade 10 Physical Sciences class in one of the Eastern Cape township schools.

There are my basic questions as I will probe for more information.

Researcher: Tell me about your experiences of attending a Physics lesson

Group:

Researcher: What do you think are the reasons for the experiences that you have just mentioned?

Group:

Researcher: How did you find the inclusion of indigenous knowledge during the teaching of the topic on waves and sound?

Group:

Researcher: Do you think the school should invite the community members to assist in teaching?

Group:

Researcher: Does the topic on waves and sound make sense to you? Please explain your answer.

Group

Appendix G (b): Collated and colour coded responses from Focus Group Stimulated Recall Interviews

Question	Transcription	Similar statements	Sub-themes
1	<p>Responses from PRSRI</p> <p>I enjoy sometimes, but sometimes it's hard.</p> <p>I don't always understand Physics.</p> <p>Its ok but the concepts are difficult</p> <p>Responses from SNSRI</p> <p>The experience is good but the calculations are difficult.</p> <p>Physics is hard.</p> <p>I don't know sometimes I enjoy sometimes I don't.</p> <p>Physics is not easy but I think I get it now.</p> <p>Responses from ESRI</p> <p>I enjoy the lessons.</p> <p>Ngamanye amaxesha andiyazi nokuba kuthiwani, kodwa ngoku</p>	<p>Green: Dispositions</p> <p>Grey: On involving community members</p> <p>Yellow: Sense-making</p> <p>Purple: Level of understanding</p>	<p>Positive dispositions</p> <p>Level of understanding</p> <p>Positive attitude towards the involvement of community members</p>

	<p>ndiyayilandela (Translation: sometimes I don't really understand, but now I understand).</p> <p>Iyo iPhysics ayidlali, andiyiva nalento isencwadini, kubhetere noko ngoku (Translation: With a sigh, Physics its hard, I don't even understand what is in the textbook)</p> <p>The lessons are fun</p>		
2	<p>Responses from PRSRI</p> <p>I like the presentations by the community member.</p> <p>The practical are nice and they make me understand.</p> <p>Ilanguage yinngxaki, nemibuzo ndingayiva (Translation: language is the problem, even the questions I don't understand).</p> <p>IPhysics icomplecated hayke iconcepts ziyandiconfuza zona (Translation: Physics is complicated, the concepts are confusing me).</p>		

	<p>Responses from SNSRI</p> <p>I think I need to work on the calculations and maybe the teacher must help me with those calculations.</p> <p>Sometimes I don't follow in class and the textbook does not help me.</p> <p>Kuyaxhomekeka kwenziwa ntoni, like ngokuya bekukho abatata bekumnandi elwandle (Translation: It depends on what we are doing, like the time when the community members were presenting, it was nice at the sea)</p> <p>Maybe it's my attitude okanye yilandlela etitshwa ngayo, andiyazi (Translation: Maybe it's my attitude or it's the way it's being taught, I don't know).</p> <p>Responses from ESRI</p> <p>Ndiyayithanda lento kubizwa abatata basicacisele nepracticals (Translation: I like it when we invite the community members, to</p>		
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	<p>explain things and the practical activities).</p> <p>Lendlela kutitshwa nyayo ngoku ndiyayithanda (Translation: I like the way it is taught to us now)</p> <p>IPhysics iyandibhida ndikhetha iChem (Translation: Physics confuses me I prefer Chemistry)</p> <p>I don't have a problem with Physics, I understand what is being taught.</p>		
3	<p>Responses from PRSRI</p> <p>It was interesting I liked it.</p> <p>Abatata bacacisa kakuhle kwaye banika umdla (Translation: The community members explain well and they make it exciting)</p> <p>Ezinye izinto zenza isense kodwa ezinye andikaziqondi (Translation: some things make sense but I still don't understand other things)</p>		

	<p>Ininzi into esingayifunda kubantu abadala ngolwazi lwemveli (Translation: there is a lot that we could learn from the community members about indigenous knowledge.</p> <p>Responses from SNSRI</p> <p>I enjoy talking about local knowledge.</p> <p>Ezinye izinto abazithethileyo asiqali ukuziva, njengalanto yamawele (Translation: Some of the things they mentioned we have heard them before, like the belief about the twins).</p> <p>Ndiyithandile lento yokuloba bekumnandi (Translation: I enjoyed fishing, it was nice).</p> <p>I liked it when they were explaining about low and high tides it was interesting.</p> <p>Responses from ESRI</p> <p>I find it interesting.</p> <p>It was fun.</p>		
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	<p>I have learnt a lot from it.</p> <p>Some things don't make sense.</p>		
4	<p>Responses from PRSRI</p> <p>Yes</p> <p>Responses from SNSRI</p> <p>Yes</p> <p>Responses from ESRI</p> <p>Yes</p>		
5	<p>Responses from PRSRI</p> <p>Yes</p> <p>Responses from SNSRI</p> <p>Yes</p> <p>Responses from ESRI</p> <p>Yes</p>		

Appendix H: Letter to the physical sciences teacher

Enquiries: Mr Mayana XJ

Cell number: 0605093028

Dear.....(Teacher Name)

Re: Participation in research on the integration of local or indigenous knowledge when teaching the topic on waves in the Grade 10 Physical Sciences class

I am Xolani Justice Mayana, a part-time student doing Masters in Science Education at Rhodes University, South Africa. I am a Mathematics and Science teacher at xxxx Combined School. I hereby humbly request your permission for me to conduct a research study with you as my critical friend, during teaching and learning of the topic on waves and sound at xxxx Combined. I plan to conduct the study for about two weeks in July/August 2019. The grade 10 Physical Sciences learners who will be participating will be required to (a) complete pre- and post-questionnaires, (b) collect data from community members, (c) present in class and (d) interact with two community members who will be presenting about indigenous knowledge and related cultural practices about the sea, and these activities will be observed. Your role will be to assist videotape the lessons, assist in co-planning of lessons that include indigenous knowledge and help observe my lessons since I cannot observe my own lessons. In addition, you will be required to check and verify the findings of the study, this will help in validating the findings.

The focus of the study is to explore the learners' conceptions, dispositions, and sense-making when integrating local or indigenous knowledge when teaching the topic on waves and sound to the Grade 10 Physical Sciences Class. Kindly be informed that participation in this study is voluntary. It is therefore your right to decide whether you wish to participate or not. Also, participants are free to withdraw any time as they wish to do so. The identity and views of the participants will not be revealed, and I will maintain anonymity, and data that will be collected will not be used for other purposes apart from this study. Should you agree to participate in the study, you are reminded that all information and data collected during the study must be kept confidential.

If you have any question about the research, please feel free to contact me at 0605093028, xj.mayana@gmail.com or my supervisors Prof Ken Ngcoza at k.ngcoza@ru.ac.za and Mrs Joyce Sewry, J.Sewry@ru.ac.za.

Lastly, if you agree or do not agree to participate in this research, please complete the consent form below.

I.....(full name of the learner), hereby confirm that I understand the content of this document and the nature of the research. I henceforth request you to indicate your choice by making a tick (✓) in an appropriate box below.

Agree to participate in the study , Secondly, I am aware that information about the study must be kept confidential and high level of professionalism is expected from myself.

Do not wish to participate in the study

Signature:..... Date:.....

Yours Sincerely

XJ Mayana

Appendix I: Presentation by two community members, A Story from the videos.

Video 1

A story based on the two community members on the integration of IK when teaching the topic on waves and sound to the Grade 10 physical Sciences township class.

The topic for the two community (Sir Mba and Sir Mlo) members was on waves and sound and cultural practices and beliefs related to the sea. The two community members co-presented a lesson on cultural belief and practices associated with waves and sound at the sea to the physical sciences Grade 10 class of Buyelembo Combined (Pseudonym), the class consist of 18 learners (14 girls and 4 boys).

From my observation, I could see that the learners looked relaxed and were looking forward to the presentation (they had smiles on their faces). Sir Mba started the lesson by explaining the wave motion, that is how waves are formed. He asked learners questions to the learners tring to find out their understanding of how waves are formed and how waves moved from the deep end of the sea to the seashore. One of the learners explained that waves were moving because they were pushing each other from behind because they had energy.

Sir Mlo added by showing with his hands how the waves move and, explained that “Athechwaka xa ekude” meaning they are quiet when far away, but as they get closer, they make a loud sound, why he asked? The how does the water get here? “Niyawabona lamanzi avelaphi”? Avelaphi? Enziwa yintoni? (can you sea were the water came from? Where do they come from? What causes this wave motion? He continued to probe questions.

One learner responded that the waves are pushed by the waves behind them because they have energy, the learner explained “ Aqhutywa ngalamanzi eza emva kwawo” Sir Mba then explained that the sound made by sea indicates that the sea is breathing “ Yindlela ulwandle eliphfumla .ngalo” He added that the sea is also removing the dirty things that is why it is making the sound.

During the presentation I was a participatory observer, I kept on asking /probing questions from the two community members to get a better understanding of what they were presenting, in relation to the purpose of the study. For example, I asked them to explain any cultural beliefs and practices associated with the sea. Sir Mba responded by asking if there were twins in the group. Ngubani iwele apha? Maweze ngaphambili (let the twins come forward). Before Sir Mba could explain, one learner commented “azaku tshona” meaning the twins were going to drown in the sea, this suggested to me that the learner had prior knowledge about the twins and the sea. Sir Mba quickly responded by providing an explanation that the twins had to throw a coin in the sea before going in to swim, Sir Mlo added even if their twin is no more, he also explained that if the twin does not throw the coin they must pull hair from their head and throw it in the sea, this he said is a sign of respect to for ancestor who leaved in the sea, if you do that you will not drown “awuzotshona”.

The twins looked releaved at Sir Mba’s explanation as the other learners listened attentively. Sir Mbo demonstrated how this act was done, he removed his hat as a sign of respect (he told us), he stepped into the water, the learners including the twins followed. The water waves came towards us, Sir Mba told the learners that the calmness of the sea was a sign that the ancestors were happy.

Sir Mlo explained that the twins must take silver coins and throw them in the sea, as brown coins were not accepted. The twins boldly moved to the sea to throw the coin, but the sea became boisterous, they stepped back, Sir Mba encouraged them not to fear as nothing was going to happened to them, he offered to go with them. The twins took comfort in his support and they stepped in and threw in the coins, the class applauded, Sir Mlo explained that the fact that the sea has calmed down is an indication that the twins were welcome and all of us were now safe to go to the sea. Sir Mlo emphasizesd that the Xhosa’s believed that only silver coins were used, the learners agreed with him and said that was what they have taught by their parents at home.

One learner asked a question, “what would happen to you if the sea tooked you in?” , Sir Mlo explained that sometimes “ Uyathwetyulwa” meaning you are taken by the ancestors, he explained that the Xhosa’s believe that your family must not cry, but wait for you to come back, if they cry you will come back dead. He told a story of people who were taken in by the sea, the learners asked, where do those people stay in the sea? And how do they stay there. He explained that there

were unseen places inside the sea where they leaved, the learners laughed at his explanation showing unbelief (Respectful disagreed with his explanation), the learners seemed not convinced by his explanation, as one learners asked “how do you breath inside the sea?, but Sir Mlo insisted that there were people leaving inside the sea.

Sir Mba explained that there two different processes “ Ukuthwetyulwa” to be taken in “ Ukumka namanzi” to drown, Sir Mbo explained that the difference was that when you are taken in by the ancestors they pick you from the crowd and take you in, he explained that when this happen you , you walk into the sea, people watching you going in until you disappear from their sight. One learner asked if the water won’t come into your nose “Awutsarwa”? He said no, if you are called in by the ancestors. I observed that the learners battled to understand how this was possible, but they did not argue further with the old man, showing him some respect.

Another learner changed the subject and asked about the gravitation pulls things and wanted to know about its role when people were drowning or called in by the ancestors, Sir Mlo, explained in terms of the water waves going back and forth into the sea and the movement of the sea sand. He explained that when “amagqirha” the witch doctors perform their rituals in the sea they offered some gifts to the ancestors, such as “umqombothi” traditional beer in a metal container and other things but those things do not sink, they flout until they get to a certain point in the sea and then, they sink into the sea. He explained that those containers will come back later empty or with beads and roots as a sign that the gift has been accepted. At this point he caught the attention of the learners. Onother learner asked about the amplitude of the wave, Sir Mba explained that the stronger the wind the bigger the amplitude of a wave, Sir Mlo concurred with this explanation. They did not explain in terms of superposition but they believed that strong winds caused bigger waves (larger amplitudes). I observed that there was an interaction between the learners and the two community expects, but I also observed that the two community members were complementing each other during the presentations. In addition, I noticed that the learners’ interest during presentations was positive and they seemed to want to know more as they were trying to make sense of the given explanation. I also observed that the learners did not agree with the two community members on everything that was presented, without being rude or insensitive they

asked more questions to get a better understanding, and this is something that they lack in a normal science class when I present the lesson.

2.

VIDEO 2

After the first co-presentation by the two community members, Sir Mlo took us to his fishing spot. At the fishing spot Sir Mlo demonstrated how he used his fishing rod to catch some fish. He showed them how to put in the bait and explain the function of the bait, and asked the learners not to stand behind the rod as he was about to throw it in, he explained the dangers of standing behind him. For me this demonstrated that he cared about the learners and secondly, this also talks to the precautions that one must consider when doing a practical activity. The learners experimented with his fishing rod and had fun trying to catch fish. One of learners (Learner 17) knew how to fish using a fishing rod (prior) knowledge and willingly showed others how it was done (learning through social interaction). The learners marveled at his skills; this had a positive impact on learner 17 (who is repeating grade 10) and boosted his confidence, I saw a smile on his face.

I asked at what time or whether conditions do those boat/ship that fish go into the sea ‘ kengoku aba baloba nge bowuthi bangena xa kutheni? Trying to solicit more information from Sir Mlo. He responded that they go into the sea when the sea is calm, “Xa ulwandle lizolile kungekho moya, naxa liphumayo”

Sir Mlo explain about the low and high tide in terms of the size of the moon. According to him when it’s a quarter moon, that is an indication that there will be wind or it will be windy, secondly, he explained further that if in the morning during sun rise you see the moon behind the sun, surely it will be windy, thirdly Mr Mlobi explained that if there is full moon at night there will be low tide, but if the moon is up before sunrise there will be high tide. This is not too far from the scientific explanation, because according to science tides are caused by the moon. Wherein the moon’s gravitational pull generates something called the tidal force. The tidal force causes Earth

and its water to bulge out on the side closest to the moon and the side farthest from the moon. When you are not in one of the bulges, you experience a low tide. In my view

About fishing times, Sir Mlobi explained that it is best to fish during the night because there is more fish to catch, he explained further that this is because it is warm inside the water at night, and there were few disturbances such as boats and surfers, he added that it is the time where fish eat more at the shore, he added during the day the sea water is cold, but during the night it is warm.

From the story and the videos, episodes and themes were developed as shown in Tables (4.3.2 & 4.3.2(a)) below.

Table 4.3.2: Showing episodes and themes developed from the story

Episode	Description of activities	Emerging themes
1. Introduction	<p>Greeting</p> <p>Reactions of the learners</p> <p>Smiles on the faces</p> <p>How the presentation was introduced</p> <p>Asking questions</p> <p>Learners listening attentively</p> <p>Learners responding to questions</p> <p>Learners talk</p>	Nature of interactions
2. Co-presentations by two community members	<p>Explaining</p> <p>Asking more questions</p> <p>Asking questions that require prior knowledge</p> <p>Learners responding</p>	Level of participation

	<p>Learner participation in discussions</p> <p>Learners asking clarity seeking questions</p> <p>Cultural beliefs and practices associated with the sea and waves</p>	
<p>3. Teaching learners how to fish and explaining using waves and sound</p>	<p>Explaining where to fish, in terms of waves, for example, calm sea, less noise, few disturbances, availability of food, temperature in the water</p> <p>Engaging learners</p> <p>Giving learners an opportunity to try fishing</p> <p>Learners helping each other</p> <p>Discussions, arguments, learners talk</p> <p>Concepts related to waves that came up</p>	<p>Nature of learning opportunities</p>

Table 4.3.2(a): Shows themes emerged from the data and supporting theory or literature

Themes	Sub-themes	THEORY	
		Literature review	Frameworks
Theme1: Nature of interactions	Learner talk Asking questions Listening attentively	Lemke (1990)	Vygotsky (1978)
Theme2: Level of participation	Explaining Elicitation of prior knowledge Promoted arguments and dialogue	Sedlacek and Sedova (2017) Roschelle, 1995; Kuhlane, 2011; Mavhunga and Rollnick (2013)	Vygotsky (1978) CAT

Theme3: Nature of learning opportunities	Promotion of border crossing	Aikenhead and Jegede (1999)	CAT Vygotsky (1978) Vygotsky (1978)
	Promoted arguments and dialogue	Ogunniyi (2007); Govender (2014)	
	Using language as a resource	Mavuru & Ramnarain, 2019, Msimanga & Lelliot, 2014	
	Showing understanding		

Appendix J: Lesson plan

1. Lesson Plan – Intervention lesson that integrate IK in science		
(a) Lesson 1	Date:	Term:
- Background information	<ul style="list-style-type: none"> • Duration of lesson 	55 minutes
-	<ul style="list-style-type: none"> • Grade 	10
	<ul style="list-style-type: none"> • Subject Area 	Physics
	<ul style="list-style-type: none"> • Unit lesson 	Waves and sound
	<ul style="list-style-type: none"> • Lesson title 	Waves and sound
(b) Instructional goals and objectives	<ul style="list-style-type: none"> • Goals 	Learners to be able to define various concepts in this topic
	<ul style="list-style-type: none"> • Objectives 	<p>(1) To teach the related scientific concepts to the out-of-school lesson at the sea</p> <p>(2) To integrate IK tapping in on learners' prior knowledge and the presentations by the two community members</p> <p>(3) To promote learner talk and participation</p> <p>(3) To assist learners to have a clear understanding of waves and sound</p>
		Yes = 1 and No = 2
(c) Activities	<ul style="list-style-type: none"> • Classwork 	2
	<ul style="list-style-type: none"> • Homework 	1
	<ul style="list-style-type: none"> • Pre-prepared notes 	1

Appendix K: Homework, revision exercise taken from the learners' book (p. 105)

Module 2
Revision and extension

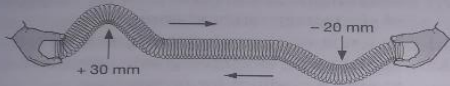
Transverse pulses and waves

1 Give ONE word/term for each of the following descriptions. (Note that a term can consist of more than one word.)

- 1.1 A substance through which something is transmitted.
- 1.2 The maximum displacement of a particle from the rest position.
- 1.3 The phenomenon that happens when two waves interact with each other.

2 Answer the following multiple choice questions. Write only the letter (A–D) of the answer.

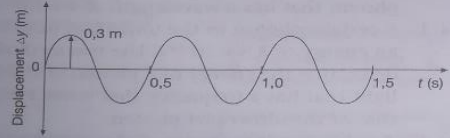
2.1 Consider the diagram of two pulses below.



When the two pulses in the diagram cross, the type of interference and amplitude of the disturbance are...

- A destructive; amplitude 10 mm
- B destructive; amplitude 50 mm
- C constructive; amplitude 10 mm
- D constructive; amplitude 50 mm

2.2 Study the wave below.



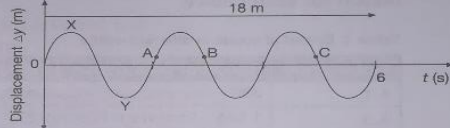
The period of the above wave is...

- A 2,0 s
- B 0,6 s
- C 0,5 s
- D 0,3 s

3 You produce a transverse pulse in a rope by moving one end of the rope quickly to one side and back again. The pulse has a pulse length of 30 mm and amplitude of 25 mm.

- 3.1 Draw a labelled diagram of the pulse that shows the above information.
- 3.2 Describe the motion of a point on the rope as the pulse moves past it.
- 3.3 At the same time as you produce the pulse, someone at the other end of the rope produces another pulse that moves towards you. The disturbances of the pulses are in the same direction. Describe what happens:
 - 3.3.1 when the two pulses meet
 - 3.3.2 after the two pulses have met.
- 3.4 Draw diagrams to illustrate your answer to Questions 3.3.1 and 3.3.2.

4 Study the wave below and then answer the questions that follow.



- 4.1 Write labels for points X and Y on the graph of a transverse wave.
- 4.2 Use the data on the diagram of the wave to calculate its frequency.
- 4.3 Use a method of your choice to calculate the speed of the wave.
- 4.4 Check your answer to Question 4.3 by using another calculation method.
- 4.5 Which of points A, B and C are in phase? Give a reason for your answer.

Longitudinal waves and sound

1 Give ONE word/term for each of the following descriptions:

- 1.1 How high or how low a sound is.
- 1.2 The parts of a sound wave where the pressure is less than elsewhere.
- 1.3 The distinctive sound of a trumpet compared with that of a guitar playing the same note.

2 Answer the following multiple choice question. Write only the letter (A–D) of the answer.

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Appendix L: Journal reflection

Instruction: Answer all the following questions

1. What have you learned from this lesson?

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2. What have you enjoyed in this lesson?

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3. What have you not enjoyed in this lesson?

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4. How can the lesson be improved?

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Appendix M: The various stages of data gathering process

Table 1: Shows the stages, methods, purpose, and research question addressed.

Stage	Method to be used to gather data	Purpose	Research Questions
Stage 1	Group Activity	<p>Learners to find information from the community</p> <p>Learners brainstorming cultural beliefs and practices on waves and the sea.</p>	1
Stage 2	Observation	<p>Sharing of knowledge on waves and the sea by community members.</p> <p>To find out how learners interact, participate and learn (or not) during the presentations by community members.</p> <p>Lesson on practical activities, learners to use hands-on activities to make sense of abstract science concepts</p>	2

		Co-developing of lessons plans that integrate IK in the topic on waves and sound	
Stage 3	Intervention	<p>Mediation of learning using model lessons on waves and sound that integrate IK.</p> <p>To find out how do lessons on waves and sound that integrate IK influence (or not) Grade 10 Physical Sciences learners' conceptions, dispositions, and sense-making.</p>	3
Stage 4	Focus group stimulated recall interviews	The main aim of the stimulated recall interviews was that I wanted to have a deep engagement with the learners, and I wanted to use the opportunity to get better understanding of the learners' conceptions, dispositions and sense-making of the topic on waves and sound.	3
Stage 5	Journals Reflections	To find out the influence of the presentations by two community members and model lessons that integrating IK on learners' conceptions, dispositions, and sense-making.	3

Appendix N: Proposed timeframes for this study

Table 2 : Showing proposed timeframe for this study

Date	Goals
January-October 2018	Writing of research proposal
November 2018	Submission of research proposal to the Education High Degree Committee (EHDC). Designing data gathering tools
February – June 2019	Piloting data gathering tools; Writing of Literature review and Methodology chapters
July - August 2019	Data gathering and Analysis
August - September 2019	Data analysis and discussion of findings
October - November 2019	Writing up and prepare for submission of first draft
November - December 2019	Corrections, editing and submission of second draft.
January 2020	Editing and submitting of final thesis