Connecting Culture and Science: Utilising *Oshikundu* and *Ombidi* in Biology Lessons on Diffusion and Osmosis

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By

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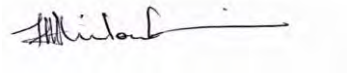
Declaration of Originality

I, Helena N. I Shilomboleni (19S9556) hereby declare that this thesis is my original work and has not been submitted for a degree or any form for assessment in any other university apart from Rhodes University. All ideas, quotations and other materials used in the study derived from other scholars have been acknowledged using referencing according to the Rhodes University Education Department Guidelines.

Signature



Date

20 June 2024

Dedication

This thesis is dedicated to my loving family (husband and children) who gave me space and moral support throughout this journey. Your patience and powerful prayers which kept me moving are highly appreciated. I further dedicate this thesis to my esteemed supervisor, Professor Ken Ngcoza whose constant support and encouragement fuelled my determination to see this thesis through.

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Abstract

Various science curricula including that of Namibia recommend that teaching and learning should start with the knowledge and experiences of learners from their homes and communities. These experiences are the learners' Indigenous Knowledge (IK) which should be integrated to make science accessible and relevant to learners from diverse sociocultural backgrounds. This suggests that science teachers are encouraged to integrate IK into their teaching to help learners grasp abstract concepts and construct their own understanding of phenomena. However, much literature has revealed that many teachers find it difficult to integrate IK into their science teaching. Some scholars further argue that teachers lack the pedagogical content knowledge to effectively integrate IK. I assume this could be because the science curriculum is not explicit on how IK should be integrated into science teaching. It is against this backdrop that in this study I mobilised the Indigenous technologies of making *oshikundu* and preserving *ombidi* to support Grade 10 Biology learners in talking and making sense of diffusion and osmosis.

This study was underpinned by the interpretivist and Indigenous research paradigms. Within the Indigenous research paradigm, I focused on Ubuntu as a perspective. A qualitative case study was employed and conducted at a certain school in the northern part of Namibia, in the Ohangwena region. I worked with a group of 35 Grade 10 learners, two Indigenous Knowledge Custodians (KCs) who are the custodians of cultural heritage and one Biology teacher (critical friend) as participants in this study. Qualitative data were collected using a focus group interview (sharing circle), group activity, participatory observation, and learners' journal reflections. Vygotsky's sociocultural theory together with Ogunniyi's Contiguity Argumentative Theory were used as lenses to analyse data. The findings of the study revealed that during the IKCs' practical demonstrations learners were able to identify science concepts embedded in the cultural practices of making *oshikundu* and preserving *ombidi*. The findings further revealed that the practical demonstrations enhanced active participation and interactions among learners. I thus recommend that teachers should tap into IKCs' cultural heritage by inviting them into their classrooms to make science relevant, accessible and meaningful to learners.

Keywords: Biology, diffusion; osmosis; Indigenous technology; *oshikundu*; *ombidi;* sense-making; sociocultural theory; contiguity argumentative theory

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List of Abbreviations and Acronyms

BEd:	Bachelor of Education
CAT:	Contiguity Argumentative Theory
CPD:	Continuous Professional Development
IK:	Indigenous Knowledge
IKCs:	Indigenous Knowledge Custodians
IKS:	Indigenous Knowledge System
MKO:	More Knowledgeable Other
MoEAC:	Ministry of Education, Arts and Culture
NCBE:	National Curriculum for Basic Education
NIEC:	National Institute for Educational Development
TMESD:	Transformative Model of Education for Sustainable Development
ZPD:	Zone of Proximal Development

CHAPTER ONE: SITUATING THE STUDY

1.1 Introduction

The study's purpose was to mobilise the Indigenous technologies of making *oshikundu* and preserving *ombidi* to support Grade 10 learners in making sense of diffusion and osmosis. What prompted me to conduct this study was my personal experience as a science teacher, which I will discuss later, and the vast evidence from the literature showing that school science content knowledge seems to be taught in decontextualised ways (Gwekwerere, 2016; Mavuru & Ramnarain, 2020). As a result, in most countries including Namibia, the knowledge that learners bring from home seems to be regarded as irrelevant in the classrooms (Taylor & Cameron, 2016). This creates a gap in knowledge reconstruction since learners cannot relate to what they are taught. The use of Indigenous technologies has the potential to bridge this gap, providing opportunities for contextualisation and making science relevant to learners' everyday lives (Gwekwerere, 2016).

In this chapter, I describe the study's background by providing an international context concerning the integration of Indigenous Knowledge (IK). I then focus on the local context based on Namibia's National Curriculum for Basic Education (NCBE) (Ministry of Education, Arts and Culture [MoEAC], 2016). Next, I discuss the problem statement including my personal experience, the purpose and significance of this study, the research goal, and the research questions. I further present a summary of the theoretical and analytical frameworks and data-gathering methods. Lastly, I provide the key concepts and the thesis outline. The chapter ends with a chapter summary to pull the threads together.

1.2 Background of the Study

Namibia's Vision 2030 strives for a knowledge-based society, producing learners who have creative skills and can think scientifically. In pursuit of this vision, the Namibian education system has undergone extensive restructuring, including addressing the challenge of a national curriculum based on Western notions of knowledge to the neglect of IK.

Several scholars have noted that the science taught in most African countries is Eurocentric with textbooks dominated by Western practical examples (Liveve, 2017; Nikodemus, 2017; Simasiku, 2017). Govender (2014) claims that Indigenous learners in South African science classrooms learn science in an abstract context with no reference to their everyday lived experiences (Gwekwerere, 2016). The consequence of Eurocentric science is evident in the struggle faced by teachers when mediating the learning of certain science concepts which results in learners' poor academic achievement.

For this reason, some scholars have advocated a review of the science curriculum to reflect the African ways of knowing and being (Aikenhead & Jegede, 1999; Kakambi, 2020; Mukwambo et al., 2014). Several scholars — such as Nyika (2017), Kibirige and Van Rooyen (2006) and Ogunniyi (2008) — advocate teaching pedagogies to accommodate Indigenous learners to make school science relevant to them. The use of IK to teach content in a contextualised way is among the pedagogical approaches suggested by these scholars. Similarly, studies in Namibia suggest that drawing on learners' cultural heritage makes the learning of science relevant and improves learners' understanding of science concepts (Nyamakuti, 2020; Shinana, 2019).

However, this pedagogical approach does not seem to be well implemented in the Namibian science classrooms. Consequently, learners do not comprehend content resulting in poor performance. In the same vein, Sewry et al. (2023) believe that South African learners' poor performance is exacerbated by how they learn science and their attitudes towards science. They learn abstractly because science is taught without reference to their local or Indigenous experiences. Hence, there is a call for the mobilisation of Indigenous technologies, the focus of my study, in science teaching so that learners can make sense of the content being taught (Klein, 2011; Rosales & Sulaiman, 2016).

In my teaching practice, for instance, I have observed with concern that learners perform poorly in Life Science and Biology due in part to a lack of conceptual understanding. This observation is evident in Life Science and Biology examiners' reports for 2016–2023 which highlight that learners fail to answer questions related to diffusion and osmosis because they seem to confuse these concepts. For example, the examiner's report for Biology 2020 pointed out that in the final examination of Biology Paper 2, there were still many responses showing confusion, lack of knowledge and understanding, sloppy terminology and poor explanations from the learners.

Based on these findings, examiners suggested that the poor performance observed in learners' examination scripts could be attributed partly to poor teaching of science and a lack of understanding of some science concepts. Examiners further suggested that scientific concepts should be well explained to learners and teachers should refer to their contexts (Mavuru & Ramnarain, 2020) to enable them to apply their knowledge and understand the topic.

Studies conducted in Namibia have also revealed that a lack of understanding of certain science concepts as noted earlier is caused by the limited use of hands-on practical activities when learning science (Asheela, 2017; Asheela et al., 2021; Nangolo, 2019; Shinana et al., 2021). For this reason, these scholars explored ways of using easily accessible resources to address this challenge. It is against this background that in this study, *oshikundu* and *ombidi*, locally accessible resources in the selected community, were used to mediate the learning of diffusion and osmosis.

1.3 My Personal Experience – Situating Myself in the Study

I was born and raised in an Oshiwambo cultural lifestyle in a rural area surrounded by Indigenous practices. Porridge, *ombidi*, *oshikundu*, beans, dry maize and *mahangu* were some of our staple foods in the village. Growing up with my parents was a blessing. For instance, my mother taught me Indigenous techniques such as collecting firewood, pounding millet (*mahangu*), harvesting and preserving wild spinach (*ombidi*) and making *oshikundu*.

My father also taught me masculine house chores such as looking after cattle, grazing, milking and ploughing. He had a slogan: "*Lumosho li longa manga lulyo ina teka*", which translates to "the left hand should be trained to do work while the right hand is in good health". This slogan implies that everybody, male or female, young or old, should learn and carry out all the above-mentioned Indigenous practices while elders are still alive. This was our humbling upbringing at home and today I am grateful for it.

After school, we played Indigenous games such as *ndota*, *ama-goos* and *owela*. At times, we (my fellow village mates and I) would play for a long time, forgetting even to carry out daily house chores. Consequently, my father would fetch me from the playground with a whip as a form of discipline.

Little did I know that these Indigenous practices were relevant to science education. Most scientific concepts are present in these Indigenous practices I learned from home, although there seemed to be no link between home and school education. For example, the preservation of *ombidi* at home is basically to deactivate the enzymes by cooking it and letting it dry, preventing it from getting rotten. This process is carried out by Indigenous people in rural areas with no refrigerators to sustain themselves during dry seasons. But none of these rich everyday home experiences featured in my schooling. All examples and diagrams used in textbooks were Western and strange. As a result, I learned science abstractly and developed a negative attitude towards it. I was demotivated and believed that science was only for naturally gifted learners. Sharing a similar experience, Sheehama (2024, p. 9) reflected:

> I learned science through memorisation without any conceptual understanding. Consequently, I developed a negative attitude towards science as it was difficult for me to relate to the knowledge imparted because my everyday knowledge was not considered valuable.

My experience of education was also not in any way related to my home experience, despite all the Indigenous knowledge (IK) I brought along to school. My teachers never linked my prior everyday knowledge (Kuhlane, 2011) to what was taught at school. However, I cannot blame them because that is how they themselves were taught. This is still the case in schools, hence this research study.

Notably, in my own experience of teaching science, I have also not acknowledged my learners' everyday home experiences as their prior knowledge. Instead, I have only taught what was prescribed in the syllabus and the textbooks. I could not see anything wrong with my teaching because I was never trained how to integrate learners' home experiences. After enrolling for my BEd Honours at Rhodes University, I realised that integrating IK into science teaching could potentially make science relevant and meaningful to my learners.

1.4 Statement of the Problem

Although the NCBE (MoEAC, 2016) emphasises the use of IK in science teaching, it remains unclear how teachers should use the approach and help learners comprehend scientific concepts. As a result, studies conducted in Namibia (Asheela, 2017; Kakambi, 2020; Simasiku, 2017) reveal that science teachers struggle to integrate learners' IK because they lack pedagogical insights into how to integrate IK into their teaching.

Although learners remain central to the learning process according to the Learner-Centred Education policy in Namibia, many studies conducted in Namibia on the integration of IK into science teaching (Asheela et al., 2021; Shinana et al., 2021) have focused on teachers rather than learners. I argue that the misunderstanding of science concepts makes science more complex and demotivating to learners who are the focus of this study. It is against this backdrop that in this study I mobilised the Indigenous technologies of making *oshikundu* and preserving *ombidi* to support Grade 10 learners to talk about and make sense of diffusion and osmosis.

1.5 My Positionality and Reflexivity

Skelton (2001, p. 89) describes positionality as the factors that "impact on the way we do our research and how the people we work with perceive us". These factors include culture, gender, race, ethnicity, marital status and power dynamics. This means that the issue of positionality and power plays a role in the research process; therefore, researchers have an undeniable position that can affect how observations and interpretations are carried out (Thomas, 2013). Holmes (2020) similarly explains that researchers cannot separate themselves from the social reality they live in and carry out studies objectively. That is, a researcher's positionality influences the way they see the world, the kind of research questions that they choose to investigate and the research outcomes (Holmes, 2020).

When I conducted this research, my interest was in developing my academic understanding of how best to integrate IK in my science classroom and broaden my knowledge of examples of IK in the surroundings that could be aligned with the teaching of Life Sciences and Biology. It is for these reasons that I agree with Thomas (2013) who argues that interpretative researchers (like me) have an absolute position in the research process; this position affects the nature of observations and interpretations they make. Because of these factors, I considered a reflexive approach appropriate – an approach which refers to the examination of one's own beliefs and position during the research process and how these may influence the study (Holmes, 2020).

I conducted this research in my classroom with my learners, my critical friend who was a colleague and two Indigenous Knowledge Custodians (IKCs). I was cognisant that our educational backgrounds were different and might affect power dynamics. For instance, since my critical friend and I were both teaching the subject (Biology) and the learners knew us as their teachers, they might perceive us as MKOs (Vygotsky,1978). To

counteract this, I ensured that all participants knew and understood that they were voluntarily participating in the study and could withdraw at any time. My male critical friend — less knowledgeable about the process of making *oshikundu* and preserving *ombidi* than I was and culturally not allowed to carry out these practices — and I positioned ourselves as co-learners in this study during the practical presentations by the IKCs. I also explained to my research participants that the intervention was aimed at creating new learning opportunities for all of us and that I was researching with them and not on them, as explained by Ngcoza and Southwood (2015).

Furthermore, because I was a female teacher from the Oshiwambo culture (where *oshikundu* and *ombidi* were staple foods), my informants might have perceived me as an MKO. The intervention was based on the presentations by the IKCs who the custodians of cultural heritage and MKOs (Vygotsky, 1978). This put me in the position of a co-learner and not an academic expert during the research process.

1.6 Rationale and Significance of My Study

There are numerous studies on integrating IK into science teaching in Namibia and elsewhere in South Africa in the Rhodes University research programme of which my study is a part. Studies conducted in South Africa (Vhurumuku & Molekeche, 2009) and Namibia (Asheela et al., 2021; Nandjedi, 2022) to mention a few, have pointed out that the integration of IK into science education is influenced by both the need to redress the legacy of Apartheid and the need to make science education accessible to all learners.

This study sought to mobilise the Indigenous technologies of making *oshikundu* and preserving *ombidi* to support Grade 10 learners in exploring and making sense of diffusion and osmosis. It was hoped that these Indigenous technologies would help to contextualise and make science relevant to learners' everyday lives (Gwekwerere, 2016). Shinana et al. (2021) posit that using Indigenous technology as a cultural tool for mediating classroom science allows for the visualisation of scientific concepts, presenting learners (the focus of my study) with an opportunity to make sense of the science concepts in new but familiar contexts. Additionally, this study might help fellow teachers (and myself) gain some insights into how IK can be used to contextualise science and ultimately enhance learners' performance in Biology.

1.7 Research Goal and Research Questions

The main goal of this study was to mobilise the Indigenous technologies of making *oshikundu* and preserving *ombidi* to support Grade 10 Biology learners in making sense of diffusion and osmosis. To achieve this goal, the following questions were addressed:

1. What enabled or constrained Grade 10 Biology learners from talking and making sense of diffusion and osmosis before the intervention?
2. What did Grade 10 Biology learners know about diffusion and osmosis from their homes and communities?
3. What learning opportunities were created for Grade 10 Biology learners during the IKCs' practical demonstrations on the Indigenous technologies of making *oshikundu* and preserving *ombidi*?
4. How did the Grade 10 Biology learners' talk and sense-making of diffusion and osmosis shift (or not) as a result of the practical demonstrations of the IKCs' Indigenous technologies of making *oshikundu* and preserving *ombidi*?

1.8 Theoretical and Analytical Frameworks

This study was informed by Vygotsky's (1978) sociocultural theory and Ogunniyi's (2007a) Contiguity Argumentative Theory (CAT) as theoretical and analytical frameworks respectively. To Vygotsky (1978), social constructivism emphasises the collaborative nature of learning through which reality is believed to be constructed through human activities. Like other theorists, such as Charlesworth and Lind (2007) and Kim (2006), Vygotsky believed that the environment contained many opportunities for learners to gain knowledge and thus posited that learners interacted with each other, shared ideas, and created new thoughts and expertise.

In the classroom environment, for instance, learners interact with cultural materials in their society and with MKOs. I focused on the following concepts within this theory: mediation of learning, culture and language, social interactions and zone of proximal development (ZPD). I augmented the sociocultural theory with Ogunniyi's (2007a) CAT to help me understand my learners' views and the contradictions when integrating IK into science lessons. According to Hewson and Ogunniyi (2011), CAT consists of five cognitive states: dominant, assimilation, suppressed, emergent and equipollent. These cognitive states or conceptions are in a constant

state of uncertainty about what should be done or what is right or wrong (Hewson & Ogunniyi, 2011).

1.9 Data-Gathering Methods

Four data-gathering methods were used to gather data for this study:

- Focus group interview (sharing circle);
- Group activity;
- Participatory observation; and
- Learners' reflective journals.

1.10 Definition of the Concepts

Below are some of the key concepts used in this thesis. These definitions provided a foundation and a broader conceptual understanding.

Indigenous knowledge: the inherited information and practices of Indigenous people on which they have survived for a long time (Mapara, 2009).

Indigenous technology: the community-based skills or way of doing things.

Local knowledge: the knowledge we learn from parents and society.

Prior knowledge: part of Indigenous technology which can be described as the experiences that learners acquire from their everyday lives and that they take from previous grades which help them to make meaningful connections to the new learning content.

Contiguity Argumentative Theory: a theory which asserts that one or two worldviews readily rely on each other to create an optimum cognitive state (Ogunniyi, 2007a).

Western science: in this study, the term refers to school science whose content and contexts are Western and foreign to Africans.

Oshikundu: a non-alcoholic traditional beverage made from the fermentation of *mahangu* (millet flour) and *ongudo* (malted sorghum). It is a staple drink, rich in nutrients, of the Ovawambo tribe.

***Ombidi**: ombidi* is both an Indigenous plant (a green leafy plant) and a dish in Namibia, often referred to as wild spinach.

Sociocultural theory: a social learning theory that focuses on acquired knowledge through social interactions (Vygotsky, 1978).

1.11 Thesis Outline

This thesis consists of six chapters which are outlined below:

Chapter One: Situating the Study

This is an introductory chapter aimed at situating the study. The chapter highlighted the international, regional and Namibian contexts regarding the integration of IK into the science curriculum. Thereafter, the chapter focused on the statement of the problem, the purpose of the study, the significance of the study, the research goals, the research questions and the theoretical and the analytical frameworks. The chapter ended with a definition of key concepts used in this study and a chapter summary.

Chapter Two: Literature Review and Theoretical Framework

This chapter presents a review of related literature on the integration of IK into science teaching and learning. The literature highlights the concepts of diffusion, osmosis, learners' prior knowledge, the role of language in science, hands-on practical activities and visualisation. The chapter ends with a discussion of the theoretical and analytical frameworks that underpinned this study.

Chapter Three: Research Methodology

In this chapter, I present an overview of the research methodology (that is paradigms and research design) employed in the study. The research questions, goal, site and participants are outlined in this chapter. Thereafter, the data-gathering methods, sampling, validity, trustworthiness, ethical considerations and positionality are presented. The chapter also explains how the data generated from various techniques were analysed.

Chapter Four: Data Analysis of Sharing Circle and Group Activity

This chapter presents the data analysis and discussion emerging from the focus group interview and group activity carried out by the learners.

Chapter Five: Data Analysis of Participatory Observation and Learners' Journal Reflections

In this chapter, the data presentation, analysis and discussion arising from the participatory observation and learners' reflections are outlined.

Chapter Six: Summary of Findings, Recommendations, and Conclusion

This is a reflective space where key findings, personal reflection, limitations and new knowledge emerging from the study are presented. Recommendations for further studies and conclusions are presented in this chapter.

1.12 Chapter Summary

In this chapter, I discussed the background of the study in the Namibian and international contexts regarding the integration of IK into science learning. I then presented my personal experience and my positionality in this study. I discussed the statement of the problem, the rationale and significance of the study, the research goal, the research questions, and the data-gathering techniques. Furthermore, I defined the key concepts used in this thesis and gave the thesis outline. In the next chapter, I discuss literature relevant to the study.

CHAPTER TWO: LITERATURE REVIEW AND THEORETICAL FRAMEWORKS

2.1 Introduction

A literature review is a very specific piece of argumentative writing, based largely on a critical review of relevant and accredited sources of information that creates a space for research (O'Leary, 2014, p. 98). Bertram and Christiansen (2020) describe a literature review as "a section that puts a research study into the context of previous research by showing how it fits into a particular field" (p. 13). In this chapter, I discuss the concepts of diffusion and osmosis, the importance of each concept and the differences between the two concepts. Furthermore, I discuss the notion of learners' prior knowledge in science classrooms and IK and the need for integrating IK into science teaching. I also discuss hands-on practical activities for learners and the role of language in the learning of science. The chapter ends with a discussion of the theoretical and analytical frameworks underpinning this study.

2.2 Definition of Diffusion and Osmosis

Life Sciences and Biology are subjects that require learners to identify and make the link between micro and macro relations between concepts. Cook et al. (2008) suggest that diffusion and osmosis are important concepts that help us understand cells and their environments. Moreover, diffusion and osmosis help us understand the exchange of matter between living organisms during equilibrium and water transport essential for the operations of life and certain biological events in living bodies. The subject of diffusion is of great practical and theoretical importance in the biological sciences. Every cell of every organism at every moment of its existence is dependent upon this process for supplying it with the necessary materials from its surroundings, for distributing these and other materials within its boundaries and for removing metabolic products to a safe distance.

The Namibian Senior Secondary Certificate Biology syllabus for grades 10-11 (MoEAC, 2020, p. 11) instructs that learners should be able to describe the diffusion process and understand it in terms of the movement of molecules. Diffusion can be roughly defined as molecules' movement from a high concentration to a low concentration area owing to their kinetic energies (Kurt et al., 2013). Furthermore, learners are required to define osmosis and describe the importance of osmosis in the uptake of water by plants.

Conceptually, osmosis is the movement/passage of water molecules from a region of high(er) water potential to a region of low(er) water potential through a partially permeable membrane down the water potential gradient (de Klerk, 2013). Nelson (2017) claims that osmosis is a fundamental process to the physiology of all living things although its physical basis remains a challenging topic. Figure 2.1 illustrates the difference between diffusion and osmosis.

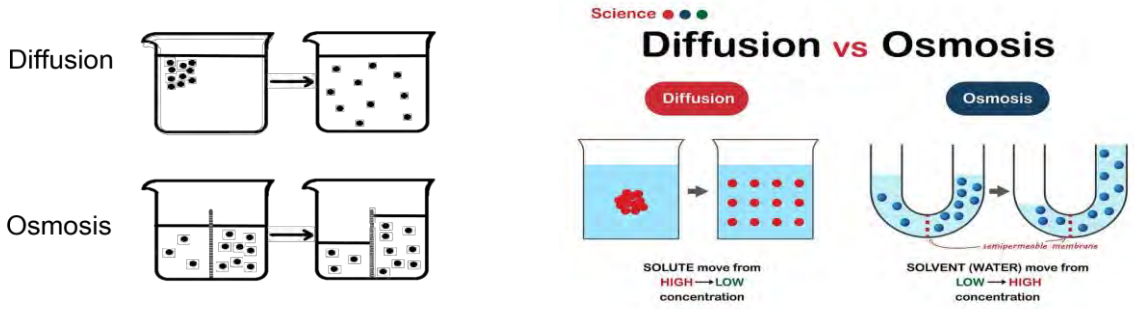

Figure 2.1: The difference between diffusion and osmosis (adapted from https://88guru.com>library>biology>difference between diffusion-and-osmosis)

Conceptual knowledge is not only to know a concept's definition but also for seeing the relations or connections between concepts. Kurt et al. (2013) aver that an accurate comprehension of diffusion and osmosis is essential for learning numerous biological processes such as digestion, gas exchange and excretion. The curriculum demands that learners understand the concepts of diffusion and osmosis from a broader perspective and apply them to real-life situations (Gwekwerere, 2016). Besides the curriculum demand, it is reported that learners perform poorly during external examinations in all osmosis and diffusion-related questions. For example, in various examination reports (MoEAC, 2016–2023), it is evident that learners struggle to answer simple questions on diffusion and osmosis, continuing to make mistakes that lead to the unnecessary loss of marks (MoEAC, 2008–2023). It is further noted that learners are unable to differentiate between the concepts of diffusion and osmosis (MoEAC, 2016).

Oztas (2014) believes that such misconceptions might be due to the formal nature of the two concepts where teachers need to select content materials that learners can actively manipulate, record, and analyse so that they can make the distinction. Furthermore, hands-on practical activities are believed to contribute to the effective learning of science through observing real objects and using the theoretical aspects to make meaning of the concepts being studied (Asheela et al., 2021; Shinana et al., 2021). For this reason, this study sought to mobilise the Indigenous technology of making *oshikundu* to learn diffusion and the preservation of *ombidi* to learn osmosis. These two Indigenous practices have the potential to serve as learners' prior everyday knowledge (Kuhlane, 2011).

2.3 Learners' Prior Knowledge

Prior knowledge can be described as the experiences that learners acquire from their everyday lives and that they take from the previous grades which help them make meaningful connections to new learning content (Kuhlane, 2011; Okanlawon, 2017). Kuhlane (2011) asserts that prior knowledge is a crucial element in the learning process claiming that it significantly shifts the perception of learning to conceptual transformation.

Kuhlane (2011) expands the concept of prior knowledge to 'prior everyday knowledge' which is deeply rooted in IK and reflects cultural experiences that learners bring to school from their homes or community. For example, the topic of diffusion in the Namibian science curriculum runs from Grade 8 up to Grade 12 in Life Science, Physical Science and Biology. This suggests that Grade 10 learners (participants in this study) are likely to have some foundational understanding of diffusion and osmosis in their everyday experiences. In my study, learners' prior knowledge refers to the traditional knowledge of making *oshikundu* and preserving *ombidi* which they bring from home or community. Furthermore, Kuhlane (2011) points out that learners cannot learn without a foundation of prior knowledge, explaining that what learners already know is paramount in shaping their educational journey. Sharing the same sentiments, Tshitshi (2024) argues that pre-existing knowledge influences how the learners assimilate new information presented in the classroom, allowing them to construct new knowledge based on what they already know.

However, using prior knowledge in educational settings is not without its critics. Roschelle (1995), for instance, maintains that prior knowledge is not always effective as it can provide an incorrect alternative to a theory. Taylor (1999) similarly points out that not all prior

knowledge is educative as it can have misconceptions embedded in it. He further asserts that if prior knowledge is not properly enacted, it might create misunderstandings rather than making learners' everyday knowledge relevant to newly learned knowledge. Hodson (2009) also cautions curriculum developers not to include anything and everything in the curriculum under the banner of science. It is acknowledged, however, that prior knowledge could be in the form of IK which I discuss below.

2.4 Indigenous Knowledge/Indigenous Technology

Kibirige and van Rooyen (2006) define IK, also known as indigenous knowledge technology, as a legacy of knowledge and skills unique to a particular Indigenous culture, involving wisdom developed and passed on over generations. To Ogunniyi (2007a) and Nyika (2017), IK refers to knowledge gained by people as they live and work in their communities. The elders in the community are the custodians of IK which can be in the form of beliefs, norms, songs, local language, imitations or stories which are usually passed from generation to generation orally (Nyika, 2017; Seehawer, 2018).

A large body of literature calls for the integration of IK into school curricula, in particular in science (e.g. Aikenhead & Jegede 1999; Baquete et al., 2016; Ogunniyi & Ogawa, 2008). These scholars suggest that integrating IK into curricula could be beneficial in many ways. For instance, Aikenhead and Jegede (1999) suggest that IK can enable border crossing between home and school science. Govender (2014) suggests that integrating IK into science classrooms can lead to learners' motivation to learn science. Furthermore, it increases learners' participation in classrooms (Naidoo, 2010; Sedlacek & Sedova, 2017).

Kibirige and Van Rooyen (2006) argue that science teaching is enriched when IK is used as Indigenous prior knowledge in the classroom and can thus be used as a starting point to explore concepts associated with Western science. These authors further argue that integrating IK promotes communication skills and learner talk.

Furthermore, integrating IK into classrooms helps to decolonise and Africanise science education (Mukwambo et al., 2014; Seehawer, 2018a; Seehawer & Breidlid, 2021). In this study, I integrated the Indigenous technologies of making *oshikundu* and the preservation of *ombidi* and these presentations were made by IKCs. It was hoped that this intervention would

help learners answer questions about diffusion and other related concepts such as osmosis and active transport.

However, some scholars seem to be against integrating IK into science teaching (Hodson, 2009; Horsthemke & Schafer, 2008; Snively & Corsiglia, 2001). In their arguments, these scholars note that not everything labelled IK is valuable and suitable for use in science teaching. For instance, Hodson (2009) acknowledges the benefits of IK while maintaining that IK works well in the contexts in which it was developed. Similarly, some proponents of IK integration such as Afonso-Nhelevilo (2013), Ogunniyi (2007a), Mukwambo et al. (2014), Keane et al. (2016) and Mhakure and Otulaja (2017) have also cautioned against romanticising IK. These scholars propose that any misconceptions embedded in IK should be identified and corrected. In my view, hands-on practical activities have the potential for learners to visualise and hence identify misconceptions. I now discuss this below.

2.5 Hands-on Practical Activities and Visualisation

Practical activities refer to any teaching and learning activity that requires learners to observe or manipulate objects and materials they are studying (Mavuru & Ramnarain, 2020; Millar, 2004). Asheela (2017) further explains that hands-on practical activities are learning experiences designed, through action, to forge a link between the observations and the theories and ideas of science. She believes that hands-on practical activities help to promote learners' conceptual understanding of science concepts as they are encouraged to predict, explore, observe and explain (Asheela et al., 2021). The Namibian Physical Sciences and Biology curricula recommend hands-on practical activities in each topic for learners to observe and develop their scientific skills (Nhase, 2019; Shinana et al., 2021). Extending on Shinana's (2019) study which revealed the usefulness of hands-on practical activities, this study focused on the involvement of learners in authentic practical investigations of making *oshikundu* and *ombidi* preservation as Indigenous technologies to mediate learning.

It should also be recognised that hands-on practical activities are a form of visual presentation vital in learning. Therefore, the purpose of presentations by IKCs in this study was to make room for visual representations. Notable also is that the IKCs made their presentations in Oshiwambo which is their home language and the learners, highlighting the importance and role of language in learning science.

2.6 The Role of Language in Learning Science

Vygotsky (1978) asserted that language is the most vital tool for constructing knowledge. Oyoo (2015) believes that learning science subjects requires learners to be proficient in both the language of science and the language of instruction. Although science at the school level is largely viewed as a practical subject, language is still necessary when doing hands-on practical activities because teachers must explain what they are doing and learners need to talk and ask questions. Mavuru and Ramnarain (2019) indicate that it is through language that learners can construct knowledge and make sense of science.

The rationale is that using learners' home language when teaching science tends to empower learners as they can express their thoughts fluently and eloquently (Nhase, 2019; Nieto, 2004). The Language Policy for Schools in Namibia (2003) promotes the use of the mother tongue as a medium of instruction in the formative years of schooling (Grade 1–3) and its continued use as a school subject in further education. Similarly, Ntsaone (2005) calls for the promotion and protection of Indigenous African languages. Therefore, it should be recognised that using Indigenous languages mediates the learning of science and makes it relevant to the learners.

Many teachers recognise that learners' poor proficiency in English, which is a medium of instruction in many Namibian schools, contributes to the high failure rate. For instance, during an interview conducted in Endjala's (2023) study, one teacher recounted: "What I've realised is that learners fail due to the language problem because they understand what is being asked but they can't express themselves in English".

Similarly, Jawahar and Dempster (2013) found that the poor English proficiency of many learners in rural schools and the demands of English as the language of learning and teaching have resulted in many teachers resorting to codeswitching. Sharing the same sentiments, Msimanga and Lelliot (2014) assert that some learners may not be confident using English during lesson presentations and should therefore be allowed to use their home language to engage with difficult concepts. In this intervention, the Oshiwambo language was used by both the IKCs and the learners but translated into English so that both languages could be learned (Ngcoza, 2019).

2.7 Learner Talk and Sense-Making

As stated earlier, conceptual understanding is not only knowing the definition of a concept but also being able to see the relationships or connections between concepts. Kurt et al. (2013) suggest that to achieve conceptual understanding, the learning activities should use a scientific approach and integrative learning which emphasise meaningful learning conditions. According to Wieck et al. (2005), sense-making is a way of making information understandable in clear language. Furthermore, Weick et al. (2005) argue that sense-making involves turning circumstances into a situation that is comprehended explicitly in words; this serves as a springboard to action. Nikodemus (2017) emphasises that sense-making is when meaning materialises, a crucial part of language, talk and communication. He further argues that sense-making is retrospective in nature and occurs during socialisation.

In this study, I developed the Grade 10 learners' talk and their sense-making of diffusion and osmosis using the Indigenous technologies of making *oshikundu* and preserving *ombidi*. I observed the learners' talk, conceptual understanding and sense-making of differentiating diffusion from osmosis during the presentations by the IKCs. These practical demonstrations were carried out in the local language (Oshiwambo) following Msimanga and Lelliot (2014) and Mavuru and Ramnarain (2017) who claim that reverting to the home language helps learners who lack confidence in English to talk and construct their understanding of scientific concepts.

2.8 Theoretical and Analytical Frameworks

The theoretical framework is the central component of any study and is the theory that explains why the research problem under study exists (Abend, 2008). This study was informed by two theories, namely Vygotsky's (1978) Sociocultural Theory and Ogunniyi's (2007a) CAT. I used sociocultural theory as a lens to determine how learners learn through social interactions among themselves and with IKCs and how learning takes place in a social-cultural context. Furthermore, I used CAT as my analytical framework to understand my learners' views on the integration of IK in science lessons.

2.8.1 Theoretical framework: Vygotsky's sociocultural theory

To Vygotsky (1978), social constructivism emphasises the collaborative nature of learning through which reality is believed to be constructed through human activities. Vygotsky

believed that knowledge was a human product that was socially and culturally constructed. This means that individuals create meaning through their interactions with others and the environment they live in. Learning is viewed as a social process that occurs when individuals are engaged in social activities. Like other theorists (Charlesworth & Lind, 2007; Kim, 2006), Vygotsky believed that the environment contained many opportunities for learners to gain knowledge and thus posited that learners need to interact with one another, share ideas, and create new thoughts and knowledge. In the classroom environment, for instance, this means that learners interact with cultural materials in their society and MKOs. In this theory, I used four concepts as lenses – mediation of learning, culture and language, social interactions and ZPD. I now discuss each of these below.

2.8.1.1 Mediation of learning

Vygotsky (1978) proposed that in the learning process, experts use tools to mediate learning. These mediatory tools can be materials, cultural artefacts or humans within a social environment (Vygotsky, 1978) that will transform abstract concepts to the concrete level.

Building on Vygotsky's seminal work, Kakambi (2020) and Kzulin (2004) found that mediation involved the interaction between the teacher, subject content and learners. In this study, the Indigenous technologies of making *oshikundu* and preserving *ombidi* were purposefully used as mediational cultural tools to promote learner talk and mediate learning of the scientific concepts of diffusion and osmosis. It was during these practical demonstrations that mediation of learning took place. In this context, the IKCs as MKOs demonstrated how to make *oshikundu* and preserve *ombidi* for the less knowledgeable teachers and learners. The role of the MKO is to give instructional support to the learners so that they can extend their understanding of what they already know to what they could potentially do with assistance. Lavallee (2009) and Klein (2011) postulate that elders who are the custodians of the cultural heritage have an important role to play in the education of learners by using culturally embedded knowledge in demonstrations and relating it to science concepts.

2.8.1.2 Culture and language

Vygotsky emphasised culture and believed that culture provided tools that mediated thinking. According to Vygotsky (1978), all high-order mental processes such as reasoning and problem-solving were mediated by psychological tools such as signs, symbols and language (Woolfolk

et al., 2008). Parents teach these tools to children in their day-to-day activities; children internalise them which helps them advance their development. In this study, the use of IK was a response to cultural tools that mediate thinking. Hence, as these IKCs, who were more experienced in their culture (MKO) (Vygotsky, 1978) carried out demonstrations on cultural ways of making *oshikundu* and preserving *ombidi*, this theory was used as a lens for understanding how integrating IK influenced learning and the impact it had on the understanding of learners. Also, since these demonstrations were carried out by community members in their local language (Oshiwambo), this helped learners understand concepts better and increased their level of participation (Naidoo, 2010; Sedlacek & Sedova, 2017). Active participation is a function of social interactions which I now discuss below.

2.8.1.3 Social interactions

To Vygotsky (1978), the world is a social space where individuals interact to negotiate the meaning of the world. Vygotsky believed that learning occurs through social interactions with peers or knowledgeable others (parents, teachers or other learners). In this study, when the IKCs explained and demonstrated the process of making *oshikundu* and preserving *ombidi* to the learners, they contributed to the learning experiences of the learners. Social interactions were captured during the practical demonstrations of making o*shikundu* and preserving *ombidi* by the IKCs. As they were interacting in the demonstrations they learned from each other. This theory, therefore, informed this study on how learning takes place in a sociocultural context (Mavuru & Ramnarain, 2020).

2.8.1.4 Zone of proximal development

According to Vygotsky (1978), the ZPD is the distance between the actual development level as determined through independent problem-solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers. He further posited that learning was mediated within the ZPD and could lead to cognitive development and the acquisition of higher levels of psychological functions. These higher levels of psychological functions are the ability to analyse, evaluate and synthesise information or situations (Zohar & Dori, 2003). In addition, Barak and Dori (2009) viewed these skills as skills that enabled people to pose complex questions, present solid opinions and demonstrate critical thinking. In the proposed study, the practical demonstrations of making

oshikundu and preserving *ombidi* were good platforms for exploring higher-order thinking skills that the participants could acquire.

2.8.2 Analytical framework: Ogunniyi's contiguity argumentative theory

According to Ogunniyi (2007a), the Contiguity Argumentative Theory (CAT) deals with the nature of interactions between distinctly different thought systems, for example, IK and Western science. Moreover, CAT is contextually based and asserts that science and IK tend to link to make meaningful understanding (Ogunniyi & Hewson, 2008). In this study, the CAT theory was used as the lens to scrutinise how knowledge was generated through the argumentation process. This theory was deemed relevant as it would enable me to pay attention to minute processes that gave rise to new knowledge as the Indigenous Knowledge Custodians (IKCs), the teacher, and the learners engaged and interacted. This resonates with Vygotsky's (1978) socio-cultural theory.

According to Ogunniyi (2007a), CAT consists of five cognitive states that explain how conceptions move within a learner's mind. These are the dominant, suppressed, assimilated, emergent, and the equipollent cognitive states. He explains that the dominant cognitive state exists when there is a powerful idea that explains and predicts facts and events effectively.

Also, a dominant conception may be adaptable in one context but suppressed or assimilated in another. In contrast, the suppressed cognitive state occurs when an idea is suppressed in the presence of a more dominant one. Similarly, an assimilated cognitive state is a less powerful idea in terms of the persuasiveness of the dominant idea in each context. On the other hand, an emergent cognitive state pertains to circumstances where no prior knowledge exists. For instance, science is not permanent knowledge, but changes as new experiments and theories develop (Govender, 2014). Likewise, an equipollent cognitive state occurs when two competing ideas have comparably equal intellectual power. Mashoko (2018) explains that CAT captures learners' experiences outside school environments. Indeed, this has resonance with my study which focused on mobilising the Indigenous technologies of making *oshikundu* and preserving *ombidi* to support the Grade 10 Biology learners to talk about and make sense of diffusion and osmosis.

In the context of this study, the concepts from CAT described above enabled me to analyse the shifts in the learners' understanding from one cognitive state to the other as they argued, debated, or discussed. In other words, CAT was used as the theoretical lens through which the meaning-making process that occurred during the argumentation process was observed. In this way, it enabled me to understand the cognitive-perceptual shifts that occurred during the integration of IK in the science lessons (Mashoko, 2018).

Essentially, in this study, learning is viewed as a shift in one's cognition and perception that results from argumentation. Furthermore, the CAT theory also helped me to observe the interaction of Western Science as the dominant knowledge system and IK which was suppressed for many years. Through CAT, therefore, I was able to analyse the learning opportunities that emerged in internal dialogues that involved conflicting ideas during the teaching and learning of the concepts of diffusion and osmosis. These two theories were useful theoretical and analytical frameworks, and they were deemed fit for this study as they complemented each other.

2.9 Chapter Summary

In this chapter, I synthesised literature relevant to this study. The literature presented a conceptual understanding of diffusion and osmosis. I also reviewed the literature on IK and the need to integrate it into the science curriculum. I further discussed the need for hands-on practical activities and visualisation in the teaching and learning of science. I unpacked the literature on the role of language in learning science, conceptual understanding and sense-making. The chapter ended with a synthesis of the sociocultural theory and CAT as the theoretical and analytical frameworks guiding the study, respectively. In the next chapter, I discuss the research methodology employed in this study.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

In the previous chapter, I discussed literature relevant to diffusion and osmosis and the integration of IK into the science curriculum. I also discussed the role of language in science classrooms and the theoretical and analytical frameworks. In this chapter, I thus outline the research methodology underpinning this study.

A research methodology is defined by Kivunja and Kuyini (2017, p. 28) as "a broad term used to refer to the research design, methods, approaches and procedures used in an investigation that is well planned to find out something". More specifically, it is about how a researcher systematically designs a study to ensure valid and reliable results that address the research aims and objectives. This section discusses the research paradigm, design, site, sampling methods and data-gathering techniques. I further discuss the study's validity and trustworthiness and issues pertaining to ethical considerations.

3.2 Research Paradigm

According to Chilisa (2012, p. 35), a research paradigm is a "way of describing a world that is informed by philosophical assumptions about the nature of social reality (ontology), ways of knowing (epistemology) and ethics and values (axiology)". In this study, a combination of the interpretivist and Indigenous research paradigms was used to study how learners talk and make sense of diffusion and osmosis during the presentations on the Indigenous technologies of making *oshikundu* and *ombidi* preservation. I now discuss these below.

3.2.1 Interpretivist paradigm

Bertram and Christiansen (2020) explained that an interpretive paradigm tries to understand the social world, including human agency, behaviour, attitudes, beliefs and conceptions. Thomas (2013) further indicated that interpretivists are interested in people and the way they interrelate, what they think, and how they form ideas about the world. This approach was thus suitable for this study as it allowed my learners and me to interact with community members

by interpreting the science within making *oshikundu* and preserving *ombidi* which integrate diffusion, osmosis and other associated concepts. However, the interpretivist paradigm is criticised for only focusing on providing descriptions of contexts without seeking to change or improve them (Creswell & Creswell, 2018). For this reason, I complemented the interpretivist paradigm with the Indigenous research paradigm (Chilisa, 2012), focusing on the Ubuntu perspective (Ogunniyi, 2018; Seehawer, 2023) to alleviate this limitation.

3.2.2 Indigenous paradigm

To Chilisa (2012), central to the Indigenous research paradigm is the belief system that considers peoples' lived experiences, values and historical contexts. The Indigenous research paradigm is viewed by many scholars as an emerging approach to research that foregrounds Indigenous peoples' ontologies, epistemologies and axiologies (e.g. Chilisa, 2012; Mbembe, 2021; Mutanho, 2021; Seehawer, 2021). For this reason, I drew on Ubuntu, a perspective embedded in the Indigenous paradigm as the lens that informed our conduct as we engaged in the co-construction of knowledge in this study (Chilisa, 2012). Ubuntu is an African philosophy characterised by putting the interests of others first; as summarised by Nusbaum (2003), ubuntu is characterised by the spirit of togetherness. Within ubuntu, people relate to each other and share in times of sorrow and times of happiness.

According to Seehawer (2018a), within an Ubuntu perspective, knowledge is validated through discussions with the concerned community members so that their views and opinions are equally valued and there is a validation of different knowledges emerging from the communal discussions. Furthermore, the Ubuntu perspective aligns well with Vygotsky's (1978) sociocultural theory which states that people's actions are influenced by the social, cultural and historical context of the activities they share with others. In the context of this study, learners made meaning out of the activities they were exposed to during their social interactions. Using an interpretivist paradigm complemented with an Indigenous paradigm focusing on the Ubuntu perspective allowed me to observe and understand learners' talk when making *oshikundu* and preserving *ombidi* was integrated into the study. During the process of data collection in this study, the spirit of ubuntu was demonstrated by all participants. The learners, myself, my critical friend and the IKCs collaborated well during the demonstrations. Furthermore, the IKCs' willingness to demonstrate the process of making *oshikundu* and *ombidi* preservation

was a true reflection of ubuntu. The research design used in this study is explored in the next section.

3.3 Research Design

According to Bertram and Christiansen (2015), a research design can be defined as a plan of how the researcher will systematically collect and analyse the data needed to answer the research question. Thus, a case study research design was employed.

3.3.1 Case study

A case study is an inquiry that focuses on a single phenomenon studied in its real-life context to understand the dynamics related to the case (Cohen et al., 2018). Concurring, Bertram and Christiansen (2020) proffered that a case study allows for deep exploration of participants' lived experiences. A case study was employed in this study to gain in-depth information about social concepts and promote understanding of how to integrate the knowledge gained into the science classroom to facilitate learners' understanding. It also helped me generate learners' explanations of Biology and community members' views and experiences of making *oshikundu* and preserving *ombidi* concerning diffusion and osmosis respectively. A case study uses various research instruments to capture data from different angles giving validity to the findings. For instance, I accessed information from participatory observations, group activity and the reflections provided by learners.

The case in this study was the Grade 10 Biology class from a certain rural secondary school in the northern part of Namibia. Thirty-five Grade 10 learners, two IKCs and my critical friend, a Biology teacher, were participants in this study. My unit of analysis was the social interactions, participation and learning experiences during the IKCs' presentations. I also focused on how the practical demonstrations of making *oshikundu* and preserving *ombidi* by the IKCs created learning opportunities (or not) for the Grade 10 Biology learners and their attitudes, motivation, talk and sense-making of diffusion and osmosis.

Similarly to Nyamakuti (2020) and Sheehama (2024), in this study, I used a participatory approach informed by Chikamori et al.'s (2019) Transformation Model of Education for Sustainable Development (TMESD) framework. This model was deemed appropriate for elaborating how IK could be integrated and enacted in science lessons. According to Chikamori et al. (2019), the TMESD framework composes three learning processes,

namely knowing the present, past-present relationship and future-present. To these scholars, the past-present relationships are known as *retroductive* learning and the future-present relationships as *retrodictive* learning (see Figure 3.1 below).

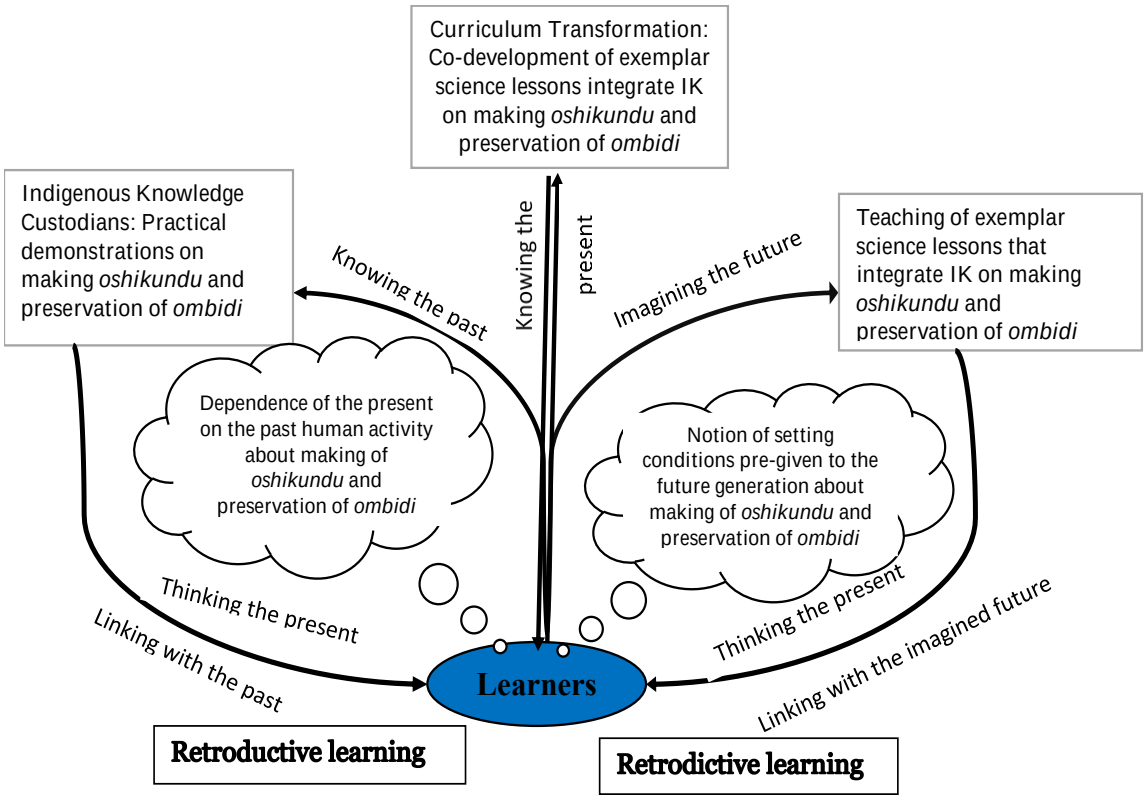

Figure 3.1: Shows the process of IK integration in science (adapted from Chikamori et al., 2019, p. 9)

This model explains the processes involved in how IK could be integrated into Biology lessons. Thus, this study was considered suitable for the TMESD framework because creating and executing IK-integrated lessons were at its core. The first process (knowing the present) was achieved using a sharing circle interview to find out the learners' prior knowledge on the process of making *oshikundu* and preserving *ombidi*, and how the two processes integrate IK or not. In the second sub-process (past-present relationship) the learners were engaged in participatory observations in which the IKCs presented and demonstrated their IK of the two processes. During the practical demonstrations, learners were able to link the scientific concepts embedded in the traditional ways of making *oshikundu* and preserving *ombidi* with the scientific concepts learned at school. The third sub-process (future-present) was achieved through learners' reflections stating how they imagined the future science lessons.

In this study, the TMESD model facilitated learning, providing opportunities for learners to grasp past, present and future situations as agents who could transform society sustainably. Essentially, the invitation of IKCs resonates with the TMESD model as it focuses on the transformation of society, whereby elders become cognisant of what is happening in the classroom and how their wisdom could benefit the learners. This resonated with the goal of this study which sought to mobilise the Indigenous technologies of making *oshikundu* and preserving *ombidi* to support learners' talk and make sense of the concepts of diffusion and osmosis.

The Chikamori et al. (2019) TMESD framework was deemed fit for this study as it outlines the process of integrating IK into science lessons. In my view, this model afforded the IKCs a platform to share their traditional knowledge of making oshikundu and preserving ombidi (*retroductive* learning) and enhance meaningful learning of diffusion and osmosis (retrodictive learning) for the learners.

3.3.2 Research goal and questions

The goal of any study outlines what the study aims to achieve. To achieve a study's goal there should be well-formulated questions directed at achieving that particular goal. I now present these below.

3.3.2.1 Research goal

The main goal of this study was to mobilise the Indigenous technologies of making *oshikundu* and preserving *ombidi* to support Grade 10 Biology learners' talk and sense-making of the concepts of diffusion and osmosis. To achieve this goal, the following research questions were addressed.

3.3.2.2 Research questions

2. What enabled or constrained Grade 10 Biology learners from talking and making sense of diffusion and osmosis before the intervention?
3. What did Grade 10 Biology learners know about diffusion and osmosis from their homes and communities?

4. What learning opportunities were created for Grade 10 Biology learners during the IKCs' practical demonstrations on the Indigenous technologies of making *oshikundu* and preserving *ombidi*?
5. How did the Grade 10 Biology learners' talk and sense-making of diffusion and osmosis shift (or not) as a result of the practical demonstrations of the IKCs' Indigenous technologies of making *oshikundu* and preserving *ombidi*?

3.3.3 Research site

The study was carried out in the Ohangwena region in the northern part of Namibia. The Ohangwena region is one of 14 regions of Namibia. Considering its size, it is one of the most densely populated areas, with approximately 250 000 residents. The region receives a good amount of rain annually; thus, residents take advantage by cultivating crops such as *mahangu*, sorghum, maize and a few vegetables. It is for this reason that I became interested in conducting a study to mobilise the Indigenous technology of making *oshikundu* since it is made from mahangu and sorghum which are readily available in the region.

The study was conducted at two sites; one at Oshiyandja Secondary School [pseudonym] where my critical friend and I were science teachers and the other at Oheeno Village [pseudonym] where the two IKCs resided. The 35 Grade 10 learners were also schooling at Oshiyandja Secondary School. At the time of this study, the school had about 910 learners from grades 10 to 12. The school had 32 teaching staff and 30 non-teaching staff. The school management consists of three heads of departments responsible for the departments of mathematics and natural sciences, languages and social science, and the headmaster.

Oshiyandja is a boarding school and many of the learners come from rural and semi-rural areas from different sociocultural backgrounds (Mavuru & Ramnarain, 2017). For instance, most learners were from high-poverty areas and depended only on social grants, while others came from middle-income groups. In terms of infrastructure and facilities, the school has enough classrooms, a computer laboratory and a library. The school also has a science laboratory which is not fully functional because there is no gas, water and working stations for the learners. Figure 3.2 shows the Namibian map showing the Ohangwena region as the research site of this study.

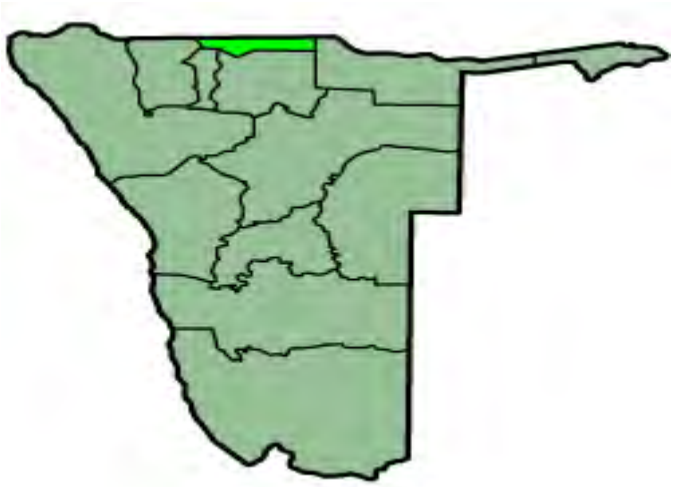

Figure 3.2: The Namibian map showing Ohangwena region where the study occurred (common.wikimedia.org/wiki/File:Namibia_Regions_Ohangwena-250px.png)

Interestingly, the school where this study was conducted is one of the top-performing schools in the region and nationally. However, the topics of diffusion and osmosis seem to be poorly performed.

3.3.4 Sampling

Sampling is selecting and identifying who will participate in a study (Maree, 2011). In this study, convenient and purposive sampling were used. Bertram and Christiansen (2015) affirm that purposive sampling means that the researcher makes specific choices about who to include in the study. Thus, the school where I teach, the learners I was teaching Biology at the time of this study and my critical friend, my colleague, were purposively selected and participated voluntarily. Furthermore, the two IKCs who demonstrated the processes of making *oshikundu* and preserving *ombidi* were purposively chosen because of their expertise and as the custodians of these traditional practices. Moreover, to cut costs and save time, I decided to do research at the school where I was teaching so I could gather data easily and conveniently.

3.3.5 Participants

As stated earlier, sampling is about selecting participants to be involved in the study. I now discuss the research individuals who took part in this study.

3.3.5.1 Learners and a teacher

My target population for this study was a group of 35 Grade 10 Biology learners as the goal was to support learners to talk and make sense of the concepts of diffusion and osmosis through the mobilisation of IK. Drawing on the work of Bertram and Christiansen (2020), a Grade 10 Biology class in the field of science was purposively selected in this study because the topics of diffusion and osmosis are part of the Grade 10 syllabus and are poorly performed during examination assessments. Although I needed to work with a smaller group of learners due to the COVID-19 pandemic at the time of this study, this was not practical because the class consisted of 35 learners, 15 boys and 20 girls, and I aimed to include them all in the study. It is for this reason that I divided the class into five groups of seven learners for effective interactions and to minimise large gatherings.

Moreover, the other participant was a female Biology teacher at the same school who was my critical friend in this study. The teacher was purposively chosen because she is a fellow Biology teacher for other class groups and has taught for over 10 years, so was well experienced with learners' learning difficulties. She was requested to videotape all activities during the study. My critical friend and I presented ourselves as co-learners during the study and reflected together on how the practical demonstrations went (see Appendix H).

3.3.5.2 Indigenous Knowledge Custodians

Similarly to Shinana's (2019) and Nandjedi's (2022) studies conducted in Namibia, I involved two IKCs, both women, who were more knowledgeable about the process of making *oshikundu* and preserving *ombidi* to share their knowledge with my learners using practical demonstrations. The IKCs were from the Ovawambo tribe and spoke Oshiwambo, in particular, the Oshikwanyama dialect.

They were sampled purposively as they had experience in the chosen Indigenous practices for the study. The aim was to maximise the use of Indigenous technologies (making *oshikundu* and preserving *ombidi)* to support and motivate the Grade 10 learners to talk and make sense of the concepts of diffusion and osmosis and understand the differences between these two concepts. In this study, the two IKCs were regarded as the custodians of cultural heritage who were more knowledgeable about the local knowledge (Vygotsky, 1978). I present their profiles in the table below.

Table 3.1: Profiles of the two Indigenous knowledge custodians

Biographical information	Category	Community member
Age	67 59	Johanna Hamutenya Ndeshiteelela Shipena
Gender	Female	Both
Cultural background	Oshiwambo	Both
Home language	Oshiwambo	Both
Highest standard passed	Standard 8 Standard 4	Johanna Hamutenya Ndeshiteelela Shipena

In the table above, I presented the profiles of the two IKCs who demonstrated the processes of making *oshikundu* and preserving *ombidi.* The practical demonstrations aimed at allowing the IKCs to share their cultural heritage and expertise on making *oshikundu* and preserving *ombidi,* something unusual at our schools.

These demonstrations took place at the village and homes of the IKCs making the experience an out-of-school one. A group of 35 learners, my critical friend and I had to travel to Oheeno Village about 1.2 kilometres from the school on two consecutive days for the practical demonstrations. Although time was sufficient for the demonstrations, we experienced a challenge with transport due to the large number of participants; therefore, we ended up making three round trips with one vehicle. All demonstrations were done in Oshiwambo and then translated into English by my critical friend so that both languages were used in the process.

3.3.6 Data-gathering methods

Data gathering methods are different approaches used by a researcher to gather data. Cohen et al. (2018) resonate with Mill (2011) who posited that using different data-gathering techniques allows the gathering of rich data and helps with data triangulation. In this study, I used multiple methods to answer my research questions: a focus group interview (sharing circle), group activity, observation (participatory) and learners' journal reflections. I now discuss each of these data-gathering techniques below.

3.3.6.1 Focus group interview (sharing circle)

Bertram and Christiansen (2020) defined interviewing as the conversation between the researcher and the respondent, whereby the researcher asks the respondent questions and obtains answers. In this study, the focus group interview was in the form of a sharing circle which is an Indigenous methodological approach. Sharing circles are commonly used in qualitative research to explore and construct knowledge about a phenomenon (Lavallee, 2009; Redman-MacLaren et al., 2014). Also, sharing circles provide an opportunity for each person to be heard whether they choose to speak or not.

In this study, I grouped learners in sevens giving a total of five groups of boys and girls ensuring a gender balance. From each group, a representative was chosen by the group members to join the interview session in the sharing circle. This meant that five representatives showed up for the interview and I designed an interview schedule which I used as a guiding tool (see Appendix F).

Creswell (2008) stated that in focus group interviews, participants who are hesitant to share information or shy are generally more relaxed in a group than in individual interviews which was certainly true with my learners. During the interview, two learners were hesitant and would hardly volunteer to answer questions posed to the group at the beginning, but started engaging as time went on. I also encouraged the participants to express themselves freely without fear of being judged on their English proficiency and to use their vernacular (Oshiwambo).

My critical friend assisted with videotaping our interview session which took place in the afternoon and lasted for about 50 minutes. The data from this focus group interview aimed at answering my research question 1 (see Appendix F: Focus Group Interview Questions and Answers).

3.3.6.2 Group activity

Similarly to Shetunyenga's (2019) study conducted in Namibia and Mayana's (2020) and Nuntsu's (2020) studies conducted in South Africa, I used a group activity as a data-gathering method to create a non-threatening classroom climate for the learners. Giving learners a group activity, which consisted of six questions that I formulated, at this stage helped me determine their individual prior knowledge and the data generated helped me answer my research question

two. Sedlacek and Sedova (2017) maintained that a group activity has the potential to maximise active participation among the participants.

To facilitate active participation in this study learners were divided into five groups of seven. Each group was required to search for answers to questions in the activity on diffusion and osmosis (see Appendix E). Their responses were recorded on flip charts and presented to the rest of the class. Some limitations in the study, such as language barriers, surfaced whereby some participants did not understand some questions. I then addressed them by clearly explaining each question.

3.3.6.3 Participatory observation

Bertram and Christiansen (2020) posit that observation means that a researcher goes to the study site, which may be a school, a classroom, a staffroom or a community meeting space, and observes what is actually taking place there. Observation gives a researcher an opportunity to grasp the whole scene and an opportunity to gain first-hand experience and data on a phenomenon (Bertram & Christiansen, 2020). To Maxwell (2012), observation provides a direct and powerful way of learning about people's behaviours and the context in which this occurs. In this study, I employed participatory observation as a co-learner. I took part in all the activities and discussions during the IKCs' presentations on making *oshikundu* and preserving *ombidi,* to see the effects of integrating IK into teaching. This resonates well with Gay et al. (2012) who described participatory observation as a setting where the observer becomes part of and a participant in the situation being observed.

During these participatory observations, a video camera and observation schedule (adapted from Nikodemus, 2017) were used to record all the processes. My critical friend assisted in video recording all the activities and interactions during the observation sessions. Then, my critical friend and I watched the recorded videos the following day at school, together with the learners. The video recordings helped me explore the learning opportunities created by the IKCs on the Indigenous technologies of making *oshikundu* and preserving *ombidi*. Videotaping also gave us an opportunity to revisit the recorded events and make some reflections on them.

Furthermore, the learners would consolidate the presentations by brainstorming concepts that emerged from the practical demonstrations through mind maps (see Figure 5.8) – to determine the learning opportunities created, or not, during the practical demonstrations of Indigenous

technologies. The data generated during this stage helped me to answer research questions three and four.

3.3.6.4 Learners' journal reflections

McMillan and Schumacher (2014) explained that journals are a personal account of the learning experience that helps to consolidate knowledge and skills learned. Writing reflections in this study was a way to allow the learners to express their feelings and views about the learning experience so that they could make suggestions. Like Mayana's (2020) study conducted in South Africa, at the beginning of 2022, I introduced my learners to writing reflections so that by the time I gathered my data they would be familiar with it. During my data generation process, I gave all participants notebooks where they could record their thoughts and actions during and after the research study (see Appendix K). I provided them with five guiding questions that I formulated to make reflections clear and straight to the point (see Appendix J).

The participants' reflections ascertained whether the mediation tool (IK) had brought about a better understanding of IK and whether its integration assisted learners in differentiating between the concepts (diffusion and osmosis). This was an attempt to answer my research question four, determining if there were shifts (or not) in their motivation to learn and making sense of the concepts of diffusion and osmosis after the intervention.

Table 3.2: A summary of the data-gathering techniques used in the study

Phases	**Method to be used to gather data**	**Purpose**	**Research question**
Phase 1	Focus group interview	To find out the learners' attitudes towards learning the concepts of diffusion and osmosis	1
Phase 2	Group activity	To determine learners' individual prior-knowledge	2
Phase 3	Participatory observation	To find out the influence of integrating IK in teaching Mediation of learning using model lessons on diffusion and osmosis that integrate IK	3 & 4

Phase 4	Learners' journal reflections	To find out the influence of model lessons that integrate IK in the teaching of science	4

3.3.7 Data analysis

Data analysis is a process that involves organising, accounting, explaining and reducing data for it to make sense (Cohen et al., 2018). This study used qualitative data analysis whereby data from the focus group interviews (sharing circle), group activity, observations (participatory observation) and learners' reflections were coded and contrasted.

In this study, data collected are presented and analysed in chapters four and five and organised following the research questions. Similar to Nyamakuti's (2020) study conducted in Namibia, I adopted a thematic approach to analyse data inductively. That is, sub-themes were allowed to emerge from the data and common sub-themes were grouped to form themes. The emerging themes were then discussed in relation to the literature and theory. Moreover, concepts from Vygotsky's (1978) SCT and Ogunniyi's (2007a) CAT were used as lenses to analyse data to establish whether the integration of IK influenced (or not) learners' talk and sense-making of the concepts of diffusion and osmosis.

In chapter four, I present data from the focus group interview and group activity and present and analyse learners' conceptions and dispositions using criteria adapted from Atallah et al. (2010). In chapter five, I present data from the videotaped learners' interactions during the demonstrations by IKCs from the participatory observation and learners' journal reflections.

3.4 Validity and Trustworthiness

Shenton (2004) stated that validity ensures that the researcher's findings of the study are actual findings rather than the impression of the researcher. According to Cohen et al. (2018), validity is an important key to effective research as it measures how accurate and credible the findings are. To ensure validity in this study, I used multiple data collection techniques such as a focus group interview (sharing circle), group activity, participatory observation, and learners' journal reflections. I also ensured that the data-gathering tools were systematic, credible and transparent (Bertram & Christiansen, 2020). For instance, I carried out the focus group interview in a sharing circle to afford participants equal chances to answer questions

voluntarily, which were audio-recorded. I also video recorded the participatory observations and then transcribed the videos verbatim to retain data. According to Cohen et al. (2018), using audio recording devices to record verbal interviews is more accurate, reliable and trustworthy than taking notes.

3.5 Ethical Considerations

The researcher must ensure that research is conducted ethically and responsibly, from planning to publication. Ethical considerations in research are a set of principles that guide research designs and practices. Bertram and Christiansen (2020) asserted that ethics in research is all about acceptable behaviour that is considered right when conducting research. I now discuss aspects of the ethical considerations in this study.

3.5.1 Respect and dignity

After identifying the IKCs for the practical demonstrations of making *oshikundu* and preserving *ombidi,* I started building personal relationships with them. I explained the aims, benefits and nature of the study to them. I allowed the IKCs to sign consent forms in which I explained that their participation was voluntary and that they had the right to withdraw from the study any time they wished. As for the learners, I obtained consent from their parents and guardians.

Moreover, I respected the human rights and dignity of the participants in this study. For instance, I was mindful and respectful of the schedule of the participants by ensuring that all the research activities took place at convenient times and places. For the learners, I made sure that our activities took place in the afternoons to avoid lesson disturbances. I also considered one of the IKC's convenient times, in the afternoon, as she was a local snack vendor at a neighbouring school. I informed my participants that all research activities would be audio or videotaped and not be shared with a third party without their permission.

3.5.1.1 Transparency and honesty

It is considered good ethical practice to share research openly and transparently. I clearly explained the study's aim, objectives and process to all participants before they consented to participate. I honestly explained their roles in the study, and that it was a remuneration-free exercise. Letters of consent for community members and learners' guardians were written in

Oshiwambo, to ensure that all participants understood the content (see Appendix H). Furthermore, permission to carry out this research was sought in writing and granted by the education regional director, the circuit inspector and the school principal.

3.5.1.2 Accountability and responsibility

I conducted this study following Rhodes University's educational research ethics, principles and guidelines. I was completely accountable for all data gathered which I kept safe on an external hard drive. It was during this time of data collection that my laptop screen broke. It was my responsibility to replace the screen immediately for my research progress, although it was not easy financially. Furthermore, I was constantly in communication with my supervisor for guidance throughout the research process.

3.5.1.3 Integrity and academic professionalism

I declare that this thesis is an original product, and I used my own ideas. Where I used ideas of other scholars, researchers, institutions, organisations and authors I correctly acknowledged and referenced them according to the APA referencing guidelines.

3.6 Chapter Summary

This chapter provided a comprehensive overview of the research methodology employed in the study. I discussed the research paradigms and design underpinning the study, viz. interpretivist and Indigenous research paradigms. Furthermore, I outlined the research goal and questions. Different data collection methods such as a focus group interview, observations (participatory observation), learners' group activity and journal reflections were used in the study and discussed in this chapter. In addition, research ethical issues were considered and explained. In the next chapter, I present, analyse and discuss the data generated from the sharing circle and group activity.

CHAPTER FOUR: SHARING CIRCLE AND GROUP ACTIVITY

4.1 Introduction

This study aimed to mobilise the Indigenous technologies of making *oshikundu* and preserving *ombidi* to support Grade 10 learners to talk and make sense of the concepts of diffusion and osmosis. In the previous chapter, I discussed the research methodology employed in this study. I explained how data were gathered to answer my research questions.

In this chapter, I present and analyse data from the sharing circle and group activity. A sharing circle is an Indigenous research methodology tool which gives all participants equal opportunities to share information and ensures that everyone's contribution is respected (Seehawer, 2018b). These two data-gathering methods aimed to address and find answers to my research questions one and two:

- *What enabled or constrained Grade 10 Biology learners from talking and making sense of diffusion and osmosis before the intervention?*
- *What did the Grade 10 Biology learners know about diffusion and osmosis from their homes and communities?*

I first present, analyse and discuss data from the sharing circle. Then, I discuss data generated from learners' group activity which took the form of group presentations to determine their individual prior knowledge.

4.2 Focus Group Interview (Sharing Circle)

The focus group interview, which took the form of a sharing circle (Lavallee, 2009; Seehawer, 2018b), consisted of six learners chosen by their peers to represent their groups. The interview was voice-recorded with the participants' permission. The code for the sharing circle is SC and participants were coded L1 to L6 representing learner one to learner six and M and F at the end indicating the gender. For instance, L1F represents female and L2M represents male (see Table 4.1 below). These codes are used throughout the thesis.

Table 4.1: The biographical information of learners

Biographical information	Category	Number of learners	Learners' codes
Ethnicity	Ovawambo	6	L1F, L2F, L3M, L4F, L5M, L6M
Age group	15 16 17	1 4 1	L6M L1F, L3M, L4F, L5M L2F
Gender	Females Males	3 3	L1F, L2F, L4F L3M, L5M, L6M

As explained earlier, this study was carried out at a rural secondary school in the Ohangwena region. Six learners, three males (L3M, L5M, L6M) and three females (L1F, L2F, L4F), participated in this interview. They all belonged to the same ethnic group, which is, Ovawambo. These participants were chosen by their fellow group members to be part of the sharing circle; this took place one afternoon in an isolated venue (classroom) in the last block of the school. The sharing circle was carried out successfully and was fun because participants expressed themselves freely and confidently. Although two participants were more vocal than others, I encouraged them to allow others to participate. The interview session was voice-recorded with the participants' permission and lasted about 50 minutes.

4.2.1 The development of themes

The learners were interviewed in the sharing circle as explained earlier, and the interview session was audio-recorded with the participants' permission. Thereafter, I transcribed the interview verbatim so that no information was lost (Bertram & Christiansen, 2020). The qualitative data gathered from this sharing circle were classified based on the questions the learners answered and their responses were colour-coded based on similarities (see Appendix F). This is where the sub-themes were generated and later developed into themes to answer my research question one (see Table 4.2).

What enabled or constrained Grade 10 Biology learners from talking and making sense of diffusion and osmosis before the intervention?

Table 4.2: The main themes that emerged from the sharing circle and group activity

Research question 1: What enabled or constrained Grade 10 Biology learners from talking and making sense of diffusion and osmosis before the intervention?		
Themes	**Sub-themes**	**Literature/Theory**
Learners' attitudes and motivations for learning science	• Science field career possibilities • Interest in Biology • Learners' views on the integration of IK • Learners' aspirations for learning science	Atallah et al. (2010); Hambaze (2020); Mavuru and Ramnarain (2020); Mhakure and Otulaja (2017); Nandjedi (2022); Mukwambo et al. (2014)
Learners' conceptions on the integration of IK	• Indigenous knowledge (IK) • Prior knowledge • Misconceptions and perceptions about IK • Collaborative learning	Mosimege and Onwu (2004); Kibirige and Van Rooyen (2006); Roschelle (1995); Tylor (1999); Kuhlane (2011) Dziva et al. (2011); Higgs (2010); Mukwambo et al. (2014); Matemba and Lilemba (2015); Tylor and Cameron (2016); Mavuru and Ramnarian (2017) Jegede (1999); Ogunniyi and Hewson (2008); Mushanyika and Ogunniyi (2011); Govender (2014); Asheela (2017); Nikodemus (2017); Shinana (2019); Chikamori et al. (2019); Hashondili (2020); Magwetshu (2020); Nyamakuti (2020)
The role of language in learning science	• Language usage • Collaborative learning • Codeswitching • Translanguaging	Chikamori et al. (2019); Hashondili (2020); Magwetshu (2020); Nyamakuti (2020) Vygotsky (1978); Oyoo (2015); Nhase (2019); Jawahar and Dempster (2013)

4.2.2 Discussion of themes from the sharing circle

Data generated from the sharing circle were classified according to the questions they answered, and three themes were developed as noted earlier. As shown in Table 4.2, the themes

are learners' attitudes and motivations for learning science, learners' conceptions of the integration of IK and the role of language in learning science. I now discuss each theme about theory and the relevant literature.

4.2.2.1 Learners' attitudes and motivations for learning science

In the sharing circle, learners were asked to share the reasons why they chose to study Biology. It emerged that most learners' responses were positive about learning science, Biology in particular. Five learners answered as follows:

> *I want to be a doctor, and for me to become a doctor I have to study Biology (L1F).*
>
> *I chose Biology because I want to become a surgeon, and the career requires Biology which is the study of the human body (L2F)*
>
> *I want to be a biologist in future (L3M)*
>
> *I grew the curiosity to learn science when I was in Grade 8, and also because my preferred career is related to Biology (L4F).*
>
> *I performed well in Life Science in the previous grade and developed the interest in Biology (L5M).*

In the above excerpts, it was noted that the learners' conceptions and dispositions towards learning science seemed to be positive. For example, L1Fand L2F posited that they chose to study Biology because their career choices are science-related, that is, to become a doctor and a surgeon, respectively. This correlates with Juan et al. (2016) who stated that a positive attitude towards science studies is an antecedent to interest in pursuing science-related careers.

Furthermore, L4F stated that she developed the curiosity of learning science back when she was in the junior secondary phase. She narrated that she developed an interest in science because she discovered that science is useful and could see the link between science concepts and her surroundings. She added that it is through studying Biology that she would be able to achieve her goal of becoming a cardiologist. It could be surmised that this learner recognises the importance of science in their everyday lives (Gwekwerere, 2016). However, L6M seemed to differ from the rest, and he had this to say: "*Biology is compulsory in the class group I was placed, I did not opt for it".*

From this learner's reflection, it could be concluded that he had no alternative but to do Biology. In essence, both negative and positive attitudes towards the subject could be deduced from his response. It is for this reason that L6M became a targeted participant, to understand and review his attitude after the study's intervention.

Learners were also probed to relate the concepts of diffusion and osmosis to their everyday lives and to share their views on how best they could learn these concepts. All six learners could give good examples with the correct conceptual understanding of the concepts. The learners indicated that they applied some of the things learned from school at home. For instance, L5M commented:

> *The knowledge we gain at school helps us to educate our parents more. For example, I always tell my grandmother not to dry her ombidi (wild spinach) on a metal surface or corrugated iron as this will speed up the process of osmosis which might destroy all the nutrients. Consequently, the spinach will become tasteless and turns white.*

This excerpt shows that this learner appreciates the knowledge he learnt from school and relates these concepts to real-life situations (Gwekwerere, 2016). Sharing the same sentiments, L2F and L3M acknowledged the relevance of these concepts in their daily lives – learning them at school helps them to understand things better at home.

Furthermore, when asked how best the topic of diffusion and osmosis should be taught, the learners stressed the need for the lesson presentations to relate to local examples for better understanding. For example, L2F, L4F and L5M stated that the topics of diffusion and osmosis should be taught with more practical examples and real-life experiences. These views cohere with Cetin-Dindar and Geban (2017) who avowed that science taught in class should include familiar situations. In addition to local practices, L4F stated: "*Diffusion and osmosis can only be taught and learned better by doing experiments and by relating these concepts to everyday life*".

This finding contradicts Horsthemke and Schafer's (2007) thoughts that learners perceived everyday knowledge as outdated. Instead, it could be concluded that this learner sees the need for experiments and hands-on practical activities in science classrooms as espoused by Asheela et al. (2021), Nandjedi (2022) and Shinana et al. (2021). These findings align with Bybee and McCrae's (2011) view that a positive attitude towards science ultimately influences learners' continuing engagement in science activities and uptake of science vocations. In addition, Juan

et al. (2016) averred that a lack of positive feelings, enthusiasm and motivation towards science may lead to decreased engagement and participation in the subject.

4.2.2.2 Learners' conceptions on the integration of IK

Learners' conceptions and views on the integration of IK were vital points of discussion in this study. For instance, the learners involved in this study were requested to state their understanding of IK and its relevance at school. The learners' responses revealed that they had some understanding of what IK is and embraced its integration into school science. For instance, L2F referred to IK as *"local practices that we do in everyday life".* She added that IK is useful because it helps learners apply the things they learn from school at home. In agreement were L3M and L4F, who referred to IK as the things practised at home, such as milking, preserving *ombidi*, ploughing, making traditional beer and *oshikundu.* L5M and L6M also believed that IK is the wisdom they get from their parents and cultural backgrounds.

These explanations and definitions of IK given by the learners resonate with definitions of many other scholars such as Kibirige and Van Rooyen (2006), Nyika (2017) and Seehawer (2018). These scholars defined IK, also known as Indigenous technology, as a legacy of knowledge and skills unique to a particular Indigenous culture, involving wisdom developed and passed on over generations. Concurring, Ogunniyi (2007a) added that IK refers to knowledge gained by people as they live and work in their communities. These findings are in line with Mosimenge and Onwu (2004), who defined IK as all-inclusive knowledge that covers the technologies and practices that Indigenous people use for their existence, survival and environmental adaptation. Extending from these findings, I believe learners portrayed a good understanding of IK and viewed it as cultural knowledge that is unique to their culture.

4.2.2.3 The role of language in learning science

Some participants, for example, L6M, believe that the English language barrier limits their conceptual understanding in science lessons and therefore calls on teachers to translate concepts into their vernacular so they can construct knowledge (Nhase, 2019). This coheres with Msimanga and Lelliot (2014) who highlighted the double challenge experienced by English second language speakers of simultaneously learning the language of teaching and learning and developing a register for science language.

Some IK scholars (see Msimanga & Lelliot, 2014) propose Indigenous languages as a legitimate resource for science teachers to mediate difficult concepts as it also enhances learners' conceptual understanding as proposed by L6M. Teachers may opt for codeswitching or translanguaging (Denuga, 2015). Codeswitching according to Msimanga and Lelliot (2014) is the change by a speaker from one language to another, or the use of more than one language to contextualise communication. In support, Mavuru and Ramnarain (2020) posited that home language can be instrumental in the integration of scientific concepts as it has the potential to allow learners to think and express their opinions explicitly.

4.3 Group Activity

Like Nuntsu's (2020) and Nandjedi's (2022) studies, learners were given questions to go and research the IK on *oshikundu* and *ombidi* from their homes or communities. The participants were given an opportunity to engage in group discussions in the classroom, document their findings on flip charts and present them to the class.

Thirty-five learners participated in the group activity and were placed in five groups of seven, each group dominated by girls because the class had few boys. Groups were asked to give themselves names using taxonomic ranks of classification. For example, group 1 named their group Kingdom, group 2 Phyla, group 3 Class, group 4 Order and group 5 Family. This was done as a warm-up exercise for learners to recall what they had learned in Life Sciences in the previous grade. The learners were given guiding questions to direct their findings and group discussions (see Appendix H).

Group members were assigned codes such as L1K–L7K (learners from the Kingdom group), L1P–L7P (learners from the Phyla group), L1C–L7C (learners from the Class group), L1O–L7O (learners from the Order group) and L1F–L7F (learners from the Family group). The gender of each participant is indicated as M for male or F for female, for instance, L1KF represents learner one from the Kingdom group who is a female and L7FM represents learner seven male from the Family group. All groups were given 10 minutes each to present to the class and another 10-minute session after the presentations for questions and comments. The discussions were fascinating and fun and all learners were actively engaged throughout the presentations.

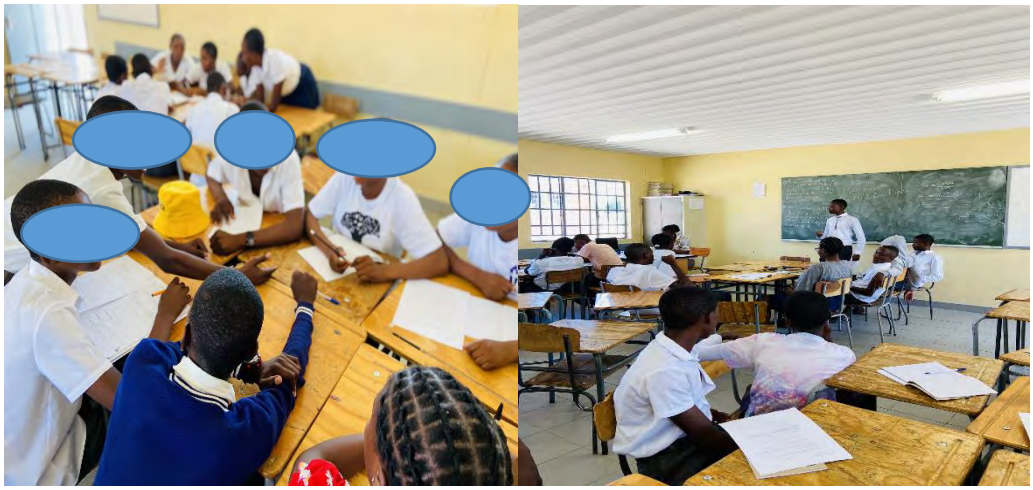

Figure 4.1: Shows learners discussing in their groups Figure 4.2: Shows L3CM presenting their findings

The main aim of the group activity was to determine learners' individual prior knowledge of traditional practices in their local communities related to diffusion and osmosis. The data generated here helped me to answer my research two:

> *What did Grade 10 Biology learners know about diffusion and osmosis from their homes and communities?*

To answer this research question, a summary of the presentation of all five groups is provided in Table 4.3 below.

Table 4.3: A summary of learners' responses from the group activity

Guiding questions	**Groups**				
	Kingdom (K)	**Phyla (P)**	**Class (C)**	**Order (O)**	**Family (F)**
Traditional practices related to diffusion	Oshide in water to dye traditional attires Opening of bottle of oshikundu and carbon dioxide diffuse in the air	Dissolving salt in water and use the water to gargle to cure sore throat Efumika (traditional dye) Smell of delicious food from the kitchen	Smoke in the air when burning mahangu remains to clear the field in preparation for next season Oshide in water to dye traditional attires	Burning of bitter bush to smell the smoke to treat flu Adding flour to water when preparing traditional beer	Steaming for flu with elephant dung Carbon dioxide diffusing out from the container of oshikundu when opened
Traditional practices related to osmosis	Food preservation such as meat and ombidi Water collected underground in the earth dam	To salt the meat and dry it Soaking eembe(wild berries) in water and eembe becomes puffed in preparation of ombike(traditional whisky)	Absorption of water through plant roots	Meat preserving(eedingu) Ombidi preserving	Osmotic dehydration in food processing Digging a borehole
Difference between diffusion and osmosis	Osmosis requires liquid medium while diffusion requires solid, gas and liquid	Osmosis requires semi-permeable membrane, while diffusion does not	For osmosis, the particles flow in one direction, whereas in diffusion flows in different directions	Osmosis needs liquid medium while diffusion needs all (liquid, solid, gas)	Diffusion can occur in all three mediums(solid, gas, liquid), whereas osmosis takes place in liquid only
How is diffusion related or not to osmosis	They are all active transport	Both are active transport	They are all active transport	Both do not require energy	Both are passive transport processes

4.3.1 Themes emerging from the group activity

From the learners' presentations, I extracted some episodes and combined common sub-themes to form themes about theory or the literature as shown in Table 4.4 below.

Table 4.4: Themes from the group activity

Themes	Literature/Theory
The role of learners' prior knowledge, culture and IK in learning the concepts of diffusion and osmosis	Kibirige and van Rooyen (2006); Ogunniyi (2007); Nyika (2017); Vygotsky (1978)
Learners' interactions and participation	Roschelle (1995); Mavhunga and Rollnick (2013); Khuhlane (2011); Vygotsky (1978); Scott (2016); Cohen et al. (2018)

4.3.1.1 The role of learners' prior knowledge, culture, and IK in learning the concepts of diffusion and osmosis

After all the groups had presented, the first theme emerged – the role of learners' prior knowledge, culture and IK. Group members were asked to mention traditional practices that they knew from their homes related to diffusion and osmosis. Members from the Kingdom group were the first to list interesting and relevant examples. For example, L2KF stood up and presented their findings. Among their examples of diffusion, she listed: dying traditional attires with a red traditional dye called *Oshide* and burning bitter bush plant leaves to prevent mosquitoes at night. The presenter also highlighted one example of food preservation, which was *ombidi* as a traditional practice related to osmosis. Notably, L1CM who was the presenter from one of the groups (Class) responded:

> *Opening a container of fermented oshikundu makes a popping sound of a certain gas coming out, but I'm not quite sure of which gas is it. And also after drinking oshikundu, one has to burp.*

Another member (L6CF) stood up and commented:

> *My grandmother once told me to stop drinking oshikundu as it contains too much gas (carbon dioxide) because I am a gastric patient. I can still recall that she said is carbon dioxide.*

Adding to the list of traditional practices related to osmosis was L4FF who gave an example of soaking meat in salt to preserve it (*eedingu*); the water from the meat comes out and salt goes into the meat, referring to osmotic dehydration.

In the above excerpts, the learners showed their prior knowledge of the IK in making *oshikundu* and relating it to diffusion. Understanding the pre-existing knowledge that learners bring into the classroom allows teachers to create a bridge to new learning experiences. This view aligns well with Vygotsky's theory of the ZPD, which suggests that learning occurs most effectively when it builds and extends on what a learner already knows. Freire (2018) posited that the starting point of teaching and learning is what the learners bring to school from the family and community through interactions.

All these examples were relevant to the study which aimed at mobilising the learners' cultural insights of making *oshikundu* and preserving *ombidi* to mediate the learning of the concepts of diffusion and osmosis. The findings cohere with Kuhlane's (2011) view that prior knowledge is part of Indigenous technology which can be described as the experiences that learners acquire from their everyday lives. In addition, these learners seemed to possess knowledge about diffusion and osmosis from the previous grades which helped them make meaningful connections to the new learning content (Kuhlane, 2011; Okanlawon, 2017).

Although most learners revealed a good prior knowledge of diffusion and osmosis, some could not establish the link between the two concepts which was also part of the group activity questions. Most of the learners admitted that they knew nothing about the differences or the relationship between diffusion and osmosis but rather copied down the answers from the textbooks. For instance, Phylum group members honestly stated that they accessed one of the teacher's computers and obtained answers from the internet without concrete understanding (see answers in Table 4.1 above).

However, some groups figured out that diffusion can occur in all mediums (solid, gas and liquid), whereas osmosis requires a liquid medium only. For instance, L3OM listed two examples of traditional practices related to each concept. He mentioned dissolving salt in water and using the water to gargle to cure a sore throat as an example of osmosis and smelling delicious food from the kitchen as an example of diffusion.

This study acknowledges the rich traditional knowledge the learners bring from their local communities. Therefore, recognising the learners' prior knowledge will always positively influence their participation in the subject (Ogunniyi & Ogawa, 2008). Sharing the same sentiments is Agubiade et al. (2017) who emphasised that when learners see their own experiences and knowledge reflected in the curriculum, their interest and engagement in the subject matter increase significantly. Although there seems to be a wide range of benefits of integrating prior knowledge into science learning, Cobern and Loving (2001) caution educators to clearly integrate and interpret IK in a way that respects its origins and maintains its authenticity.

4.3.1.2 Learners' interactions and participation

The second theme emerging from the group presentations was the role of learners' interactions and participation. The integration of IK in this study facilitated social interactions (Vygotsky, 1978) and active participation (Sedlacek & Sedova, 2017). During the practical demonstrations of making *oshikundu* and preserving *ombidi*, I observed how learners freely interacted with each other and with the IKCs (MKOs) by asking questions and making comments on the presentations. This finding resonates well with Vygotsky's (1978) assertion that learners learn better from each other as they feel comfortable.

Moreover, the learners emphasised the need for more hands-on practical activities, citing that they enhance active involvement in the learning process. For instance, when asked how science lessons could be improved, L2F stated: "*Lessons should be practical, involving experiments and everyday home experiences".*

This excerpt underscores the importance of hands-on practical activities as reiterated by Asheela et al. (2021). This aligns with the concept of experiential learning whereby individuals learn through concrete experiences, observation, abstract conceptualisation and active experimentation (Morris, 2020). The findings revealed that learners strongly prefer hands-on practical activities as they allow them to engage directly with the subject matter, making learning more accessible and meaningful.

4.4 Chapter Summary

In this chapter, I presented, analysed, interpreted and discussed data generated from the focus group interview and group activity. This was aimed at answering my research questions one

and two, respectively. The findings revealed that learners have positive attitudes towards learning science. They demonstrated a good understanding of what IK is all about and the benefits of its integration into science classrooms. Although some learners could not precisely establish the differences and the links between osmosis and diffusion, they showed good prior knowledge about community traditional practices related to these concepts. In the next chapter, I present, analyse and discuss data generated from the participatory observation and learners' reflections.

CHAPTER FIVE: PARTICIPATORY OBSERVATIONS AND LEARNERS'JOURNAL REFLECTIONS

5.1 Introduction

The main goal of this study was to mobilise the Indigenous technologies of making *oshikundu* and preserving *ombidi* to mediate the learning of diffusion and osmosis. In this chapter, I thus present, analyse and discuss data gathered from the participatory observation and learners' journal reflections. These two data-gathering methods aimed to address my research questions three and four which are:

- *What learning opportunities were created for Grade 10 Biology learners during the IKCs' practical demonstrations on the Indigenous technologies of making oshikundu and preserving ombidi?*
- *How did the Grade 10 Biology learners' talk and sense-making of diffusion and osmosis shift (or not) as a result of the IKCs' practical demonstrations of the Indigenous technologies of making oshikundu and the preservation of ombidi?*

5.2 Participatory Observation

The participatory observation intended to get a holistic picture of learners' social interactions, talk and sense-making during the IKCs' presentation on the Indigenous practice of making *oshikundu* and preserving *ombidi*. As part of the intervention, I requested the IKCs to share their traditional skills and wisdom of making *oshikundu* and preserving *ombidi* with the learners. These IKCs had more knowledge of cultural practices, and such practices can be used for teaching science (Endjala, 2023; Mandikonza, 2008). In this regard, Vygotsky (1978) echoed that community members are the custodians of cultural heritage who are more knowledgeable about local knowledge.

My critical friend, a group of 35 learners and I travelled to the IKCs' village and home where both presentations took place. This was done to show respect and allow the IKCs the comfort of their homes. In addition, the presentations involved some procedures that required

Indigenous materials, tools and utensils which were hard to transport to class. The presentations were video recorded by my critical friend with the participants' permission. Like Neporo (2022), I transcribed the videos into a narration.

Throughout the presentations, the IKCs used their Indigenous language, namely Oshiwambo, and that enabled them to express themselves freely. The use of Oshiwambo was also considered a learning mediating cultural tool that promoted social interactions and active participation among learners and community members (Sedlacek & Sedova, 2017). In this thesis, however, the excerpts from the IKCs were translated into English. The IKCs were assigned codes that were used throughout the thesis. For instance, IKC1 presented the preparation of *oshikundu* and IKC2 presented the preservation of *ombidi*. However, the IKCs preferred to be called by their clan names, Meekulu Mkwanambwa and Mee Mkwanekamba, respectively, as a way of respecting female elders in the Ovawambo tribe. Learners were also given codes such as L1 – L35 referring to their position in the group and F/M to refer to their genders. I now present the summary of the two Indigenous technologies.

5.2.1 The making of *oshikundu*

IKC1 was a retired teacher who carried out a practical demonstration of how *oshikundu* is made. She was so excited to see many learners accompanied by their two teachers (my critical friend and I), seeking education from home for the first time in her entire life. As per cultural norms, the learners kneeled for greetings and welcoming remarks from their elder (IKC1). She welcomed us as follows:

> *Let me welcome you and thank you all for finding time to engage with community members as far as your education is concerned. Allow me also to thank you for choosing and granting me the opportunity to showcase my cultural expertise. It is my hope that you will find my presentations interesting, fun and educative.*

Before her presentations, IKC1 prepared all the traditional utensils and tools required in the preparation of *oshikundu*. She then began with a few questions to elicit learners' prior knowledge: *"What is oshikundu? Who knows how to prepare oshikundu? What are the names of these utensils? Who does not drink oshikundu?"*

Figure 5.1: Shows the arrival of participants at IKC1's home village

Figure 5.2: IKC1 shows the utensils and flours for preparing *oshikundu*

All learners actively participated by giving answers to these questions. The IKC was satisfied with the learners' prior knowledge and proceeded with the presentation. She started by displaying all the materials and tools needed, naming them one by one: "*Eshi ohatu shi ifana, olwiyo, oluko, oufila womahangu, ongudo, ehete nosho yoo elilo omo muna ongudo"* (We call this a clay pot, stirring stick, mahangu flour, fermented *oshikundu* and malted sorghum flour and the traditional basket plate). She also sent one learner to bring a kettle with boiled water from the open fire. She then measured three handfuls of mahangu flour and one handful of malted sorghum, put together in the container (clay pot). Before she poured the boiled water, she added a bit of cold water to the kettle and then poured it into the clay pot. She then started stirring immediately until evenly mixed.

IKC1 further explained: "*Efimbo limwe ohandi tulamo onghundu moshikundu opo shikale sha pama, shiyandje eenghono shoo shifufume nawa, ashike nena itandi tulamo shaashii inandi ilongekida"* (Sometimes I add *onghundu* [the first flour obtained from threshing millet grains] to the paste, which is rich in carbohydrates to give more energy and more taste, but not today because I don't have it).

Figure 5.3: Show IKC1 demonstrating how to make *oshikundu*

Interestingly, L1M posed a question as to why IKC1 added cold water to the boiling water. IKC1 responded and said that this intended to keep the water at an optimum temperature, not too hot and not too cold, otherwise, the mixture would be overcooked; if the water was too hot, it would produce a tasteless *oshikundu* or the *oshikundu* would become *etepi* (a whitish spoilt mixture of *oshikundu* which did not mix well) if the water used is just lukewarm. Although the IKC1 could not provide a clear reason why people do not use very hot water, scientifically it is because hot water will denature the enzymes responsible for breaking down the carbohydrates in the flours, hence the tasteless *oshikundu*. As a result, this suggests that lack of enzyme activities might hamper the fermentation process.

This was new knowledge to the participants, and it provided the opportunity to link the IK of making *oshikundu* and the scientific concepts such as enzymes, mixture, temperature and reaction. However, the Ovawambo have different ways of making *oshikundu*. Some add cold water and some do not; some people mix the two flours (mahangu and sorghum) before adding water, while some add the sorghum flour later. This suggests that some procedures when preparing *oshikundu* such as adding cold water and adding *onghundu* are just individual

preferences. The mixture of mahangu flour, malted sorghum flour and boiling water is called *embobo*. IKC1 continued to stir the *embobo* for some time before she let it cool down. She recounted:

> *Pamufyuululwakalo, oshikundu ohashi dungwa konguloshi pefimbo louvalelo, koomeme, shoo tashi pewa nee ounona vakale tava pilula fiyo shapola. Ohashi dungwa nee konguloshi opo shi mone efimbo lawana lokupya shaashi osho hashi nuwa ongula shiyandje eenghono dokuya moilonga. Ovashamane ohava pewa oumbao voikundu efimbo longula, eshi tavake eengubu davo, voo tavanu nee. Oshikundu ihashi haulwa shipyu nande nande, otashi kala shininge okayombo* (Culturally, *oshikundu* is prepared at night, mainly by women at the time of preparing dinner. It is then handed over to young girls to keep on stirring until it cools down and becomes watery ready for dilution. *Oshikundu* is usually prepared at night to give it enough time to ferment in the morning because it is used for breakfast. *Oshikundu* is usually given to men in the morning before they go for hunting, harvesting or debushing their fields. We do not dilute a hot mixture of *oshikundu* because it will become slimy and spoilt).

One learner, L14M, surprisingly commented: "*Shahala okutya mboli oshikundu shaninga okayombo eshi hakutiwa ohashi xunu eenghali, mboli ohash etifwa koku haula shipyu? Paife ndashiiva nee nawa"* (The spoilt (slimy) *oshikundu* we were told that it symbolises bad news (death) in the family is basically caused by diluting it while hot? Now I know).

In the above excerpt, it is evident that IKC1 was knowledgeable about what she was doing, and she explained every step she took. Learners listened attentively while taking notes and picked up many scientific concepts embedded in the practice of making *oshikundu* (see Appendix H). This resonates with Shizha's (2007) assertion that learners' participation takes place on a special dimension when IK is made visible in science education. The scientific explanation of diluting *oshikundu* that has cooled down resonates with Shinana's (2019) assertion that if *oshikundu* is diluted while warm, the enzyme activities are activated faster due to the temperature. This suggests that fermentation would start earlier and by the time one wanted to drink the *oshikundu*, it would have become sour (Nikodemus, 2017).

IKC1 continued with her explanations – besides using *oshikundu* as a breakfast for housemates, it is also used for feeding infants, especially those without mothers, to prevent them from malnutrition, because it is nutritious. L4F asked: "*Ondi shishi kutya moshikundu ohamu tulwa ongudo, ashike ondahala oku shiiva elalakano lo ngudo moshikundu"* (I know that people add *ongudo* in *oshikundu*, but what is the purpose of *ongudo*?). IKC1 responded and explained:

> *Ongudo oyo hai pifa oshikundu molwa ounyenye winya ulimo shaashii oyatekelwa, ngeenge inashiya ongudo itashi pi. Shoo osho uwete moshikundu hamu dulu oku wedwa osuuka yokofitola mopaife ngeenge wahala shipye diva. Mefimbo letu kamwali nee eesuuka* (*Ongudo* ferments *oshikundu* because of the sweetness in it when it was malted. If you do not add *ongudo, oshikundu* will not ferment. That is also the reason why some people nowadays add sugar to *oshikundu* if they want it to ferment faster, there were no sugars in our olden days).

Scientifically, the fermentation process is likely to occur in *oshikundu* in the presence of sugar. *Ongudo* (malted sorghum) contains natural sugar which is used to produce alcohol (ethanol CH_3CH_2OH) and carbon dioxide (CO_2). Adhikari and Acharya (2015) explained that the enzyme amylase produced during the malting leads to the hydrolysis of the starch and proteins, which then releases sugar and amino acids. My critical friend, also a Biology teacher, intervened and explained that due to the presence of sugar in *ongudo*, *ongudo* acts as a catalyst and a sweetener which speeds up the process of fermentation. He further stated that if you put too much *ongudo* in *oshikundu,* it will ferment too fast, and over-fermenting will result in the formation of alcohol as affirmed by Shinana (2019).

Another interesting new knowledge emerged when L7F amazingly shouted: *"No wonder one day my mom added sugar in oshikundu immediately after diluting and she said she wants it to ferment faster so that the children will find it ready when they return from school".* Another participant, L11M, commented *"She was actually speeding up the process of fermentation with sugar".* Participants could not hide their excitement about linking the science in *ongudo* to the science they learn at school.

At this point, IKC1 stopped and asked: "*Ngeenge wahala oshikundu shipye diva ito longifa oshipifo, oho dulu okushi tula pomutenya. Olyelye tadulu oku lombwelange kutya omolwashike"* (If you want *oshikundu* to ferment faster apart from adding *oshipifo*, you can place it in the sun, who can tell me why)? L11F responded: *"Omolwaashi pomutenya opapyu, woo oupyu otau pifa diva* oshikundu" (Due to the hot temperature in the sun maybe). IKC1 replied with a smiling face:

> *Ouli mondjila kaadona kange, ngeenge wahala oshikundu ile omalodu Oshiwambo apye diva oho wedele oupyu, kutya nee owatula pomutenya ile owatula omakala omundilo koshi yolwiyo ngeenge kapena etango. Shoo oshoyo hatu longifa oiyuma okupungula oshikundu shaashi ohai kwatelepo oupyu* (You are right my girl, if you want to speed up the process of fermentation either for *oshikundu* or traditionally brewed beer, you have to increase the temperature, either by putting the container in

> the sun or using hot charcoals or ashes and put them under the container. That's why we use clay pots to store *oshikundu* because they are good insulators).

IKC1 also made a final remark that *oshikundu* does not ferment fast during the winter season due to the cold conditions (temperature), hence the use *of oshipifo* is necessary. The IKC1 continued stirring the mixture and remarked: *"Remember, the more you stir, the sweeter the oshikundu will be, giving it a good taste".* This links to Endjala's (2022) study that stated that stirring helps to break down the flour particles. After the continuous stirring of the *oshikundu*, the *embobo* which was in a solid state turned into a liquid state. This was the most interesting part as most learners were eager to know what caused that. The explanation is that there are enzymes in *ongudo*, as noted earlier, that break down the carbohydrates making the mixture turn liquid. IKC1 gave a similar scenario:

> *Ngeenge ongudo oya xutukile moufila woku teleka oifima, ndee tau telekifwa, oshifima osho iha shi pame tuu nande*. *Oshelifa naana* (If one mixes *mahangu* flour with *ongudo* mistakenly, and go on to cook *mahangu* porridge, the porridge will never get thick, it will remain watery, it's the same example).

Towards the end of the practical demonstration, IKC1 informed the participants that she was going to dilute the *oshikundu* because it had cooled down. She poured almost five litres of water, without measuring, into the clay pot until it was full. As she stirred, the IKC1 informed the participants to be careful when diluting oshikundu. She said: "*Oshikundu ina shi pumbwa oku haulwa unene, shoo inashi pumbwa oku kala sha pama unene. Osha pumbumbwa oku tulwa ashike omeva ahenena opo shikale shili nawa, shoo opo shi kwate pedimo"* (*Oshikundu* should not be too diluted or too concentrated (thick), it should just be moderate, so that if you drink it, you will not feel hungry). She further explained that too diluted oshikundu is not good, and culturally, women who prepare bad oshikundu are not marriage material because they are unable to take good care of their husbands. This speaks to my personal reflections in chapter one, that my upbringing included drinking *oshikundu* daily for breakfast and that my mother taught me how to prepare good *oshikundu* for family members.

She continuously stirred for some time and finally added a cup of ready-made *oshikundu* (*oshipifo*) which acted as a catalyst for the fermentation process. At this point, another participant, L4F, shouted in her vernacular: "*Ndee oshipifo otashi nyika nawa, tashi halifange nee oshikundu*, *ndeshi efa nale shili"* (*Oshipifo* smells good, I feel like drinking *oshikundu* already, I missed it). All participants were amazed by this remark and agreed that the smell of

oshipifo (ready-made *oshikundu*) was all over. I then interrupted to explain the concept of diffusion which was shown in the demonstration:

> *Handiya manga meekulu ndiyemo kashona, etomelo lokuuda edimba ngaho it is because ee particles odo tadi linyange dayuka mewangadjo omu dili lowerly concentrated, tadi di mokakopi omu dilimo o higher concentration. Eshi osho nee edidiliko lo diffusion ei hatu lilongo moshinyangadalwa omu* (You could smell *oshikundu* because of the movement of air particles from the area of higher concentration (from the cup) to the area of lower concentration (into the space) and that is pure diffusion, the focus of this study).

During my explanation, I had to code-switch between Oshiwambo and English for IKC1 to grasp what I was explaining; also, some terms (such as catalyst, diffusion, particles, concentration, and catalyst) were not available in Oshiwambo. This coheres with Mavuru and Ramnarain (2020) who averred that home languages can be instrumental in the integration of scientific concepts as it has the potential to allow learners to think critically. These scholars advocate using the home language in education to allow learners to access science.

After diluting the *oshikundu*, IKC1 informed the participants that she would cover the clay pot with *elilo* (a traditional basket plate) and keep it in her storeroom (a traditional hut) to allow the fermentation process to take place. She later informed the participants to return the following day to observe and enjoy the results.

The presentation on making *oshikundu* was concluded the following day when the IKC1 invited the participants to pass by her home on their way to IKC2's home where the practical demonstration of *ombidi* would take place. Participants passed by as IKC1 had requested, to observe the *oshikundu* after the fermentation process and record what they had learned. IKC1 instructed the learners to observe the bubbles formed and listen to the fizzy sound produced in the *oshikundu*. She asked: *"Omu wete eembwibwi odo dili moshikundu, newi leembwibwi omu li udite, oshike mbela osho?"* (Can you see the bubbles and hear the fizzy sound produced in *oshikundu*? What do you think what that is)? All the learners responded and confirmed that the bubbles formed indicated the gas produced during the fermentation of the *oshikundu*. This observation was evidence that carbon dioxide (CO_2) molecules moved from a high concentration area to a low concentration area due to kinetic energy (Kurt et al., 2013).

Similar to Endjala's (2023) study, the observation gave the learners a good chance to visualise the concept of diffusion helping them gain conceptual understanding. These views are

congruent with Wiebe et al. (2001) who assert that using Indigenous technology as a cultural tool for mediating school science allows the visualisation of scientific concepts and making sense of science concepts in new but familiar contexts. To this, I can affirm that the visualisation of concepts in the form of illustrations, demonstrations, experiments or simulations has the potential to support meaningful science teaching as reiterated by Mavhunga et al. (2016).

In my view, the art of making *oshikundu* needs patience and all the stages involved are important because of the reaction that needs to take place. Notably, the catalyst (*oshipifo*) that is added to *oshikundu* speeds up the rate of reaction; this is why I believe the paste is left overnight to cool down. Therefore, water temperature is one factor that plays a vital role in the reaction taking place in the *oshikundu.*

At the end of the session, the informants were allowed to taste and enjoy the *oshikundu* before they proceeded to the next presentation (preservation of *ombidi*). IKC1 then thanked the participants for their time and for being actively involved during her presentation. Finally, L18F was given a chance to thank the IKC and she appreciated her efforts and kindness.

5.2.2 The preservation of *ombidi*

Ombidi is one of the favourite vegetables among the Ovawambo tribe in Namibia and it grows naturally in the mahangu fields. It is often harvested while fresh with traditional baskets, cooked and allowed to dry (osmosis) for later use. The preservation of *ombidi* is a cultural practice carried out during the rainy season, mainly by women.

Figure 5.4: Fresh *ombidi* in the traditional basket

Before her presentation, IKC2, who was a more knowledgeable other (Vygotsky, 1978), welcomed the participants to her home and showed her appreciation and honour granted to her in this study to share her knowledge on preserving *ombidi*. She further highlighted that she was a former learner of the same school as the participants. She proudly stated:

> *Ame name okwali omulongwa kofikola yeni oko, konima shiimba yeedula omilongo nhatu paife. Fyee okwali nee hatulongwa moshimbulu, noshilongwa osho tamuningi omapekaapeko musho ondeshi longwa, ashike omoshimbulu nee hatushi ifana hatuti "Biologie". Oshiingilisa opo sheya eshi oshilongo sha manguluka, kakele nasho ohandishi popi ngaho, nonande ha nawa* (I am a proud former learner of your school, and I left school about 30 years ago. Our lessons were conducted in Afrikaans, and I did the same subject you are researching in which was called Biologie by then. Although English language was introduced after independence, I learned it and I can communicate, but not fluently).

IKC2 was delighted to learn that permission was granted for her to conduct her presentations in Oshiwambo but invited the participants to ask questions in any language of their choice (English and Oshiwambo), translanguaging (Denuga, 2015; Msimanga & Lelliot, 2014). IKC2 set up the materials and utensils she had already prepared before our arrival and asked the learners to identify them. She then started:

> *Omwa tumbula metetekelo kutya ei oiyuma ndishi? iyaloo…ee, ioyuma ashike oina omalalakano ayoolokafana. Eshi ombiya, shikwawo olwiyo loku pungula omaufila, eedingu nombidi* (You have mentioned already that these are containers made from clay right? Yes, you are right, but each has a specific name and purpose. Lifting them up, this is a clay pot, and this is a storage container used to store preserved food such as mahangu flour, malted sorghum flour, dried meat and dried fruits).

Notably, IKC2 used a constructive and learner-centred approach during her introduction. For instance, she tested the learners' prior knowledge concerning the materials she used, arousing learners' interest and active participation. IKC2 further said*: "Otuna omikalo dili mbali doku pungula ombidi, okuima omavanda nokui nyaneka omuya wila, doo odo nee handi kemu uli kila nena apa"* (There are two ways of preserving *ombidi,* namely, cooking, pounding and moulding it as well as cooking and drying it loose. These are the two ways I am going to demonstrate now). She then explained the first way: *"Omukalo wotete, ohatu ke ombidi mepya noimbale ndee hatui yaula momeva mahapu lela opo edu noimbodi ishaale koshi yomeva"* (We harvest *ombidi* in our traditional baskets, wash it in a large container full of water to allow sand and unwanted weed or pests to sink the water).

Konima yoku iyaula, ohai tulwa mombiya yetu yopamufyuululwakalo, yedu, oyo haipifa nawa yoo ohaiteleke oikulya ina omulyo ndee totula pediko, *ngeno nee pomutenya nokuli* (After rinsing the *ombidi*, put it in the traditional clay pot I showed you in the beginning, which is culturally believed to be a faster cooker and cooks delicious food. Place the pot in the open fire, preferably in the sun and allow to cook for one or two hours).


(a)


(b)

Figure 5.5 (a): Shows a traditional clay pot and (b) modern three-legged stainless-steel pot

As she was explaining, participants were attentively listening and taking notes. All learners were amazed by IKC2's explanations and were eager to know more. One of the participants, L15M, raised his hand and commented: "*My grandmother prefers to cook ombidi in a three-legged pot instead, but she has a clay pot which she uses to cook her important meals such as evanda, odjove and traditional chicken for visitors*". Another learner, L4M added; *"I think I know the reason why women prefer to cook ombidi in clay pots, simply because clay pots cook fast and require less firewood*". IKC2 asked a follow-up question to L4M: "*Ömolwashike mbela ombiya yedu hai endelele okupifa, olye tetu yelifile nawa* (But why do they cook fast, who can tell us?). A moment of silence was observed as no one had an answer to the IKC2's question. With a smiling face, the IKC2 remarked:

Ombiya yedu oina okanya kashona, onghee oshimuke ihashi pitimo diva mombiya, shoo osho nee hashi kwafele oku pifa nawa oitelekomwa, naluhapu ino pumbwa oku tulamo omeva mahapu noikuni ino pumbwa oku longifa ihapu shaashi ohaipifa koshimuke. Ombiya yedu ihai polo diva, osho hashi vatele oku pungulamo oikulya oule fimbo inai talala (A clay pot has a narrow opening which prevents too much steam to leave the pot making the food from cooking fast. Mostly, we don't put in too much water and we use less firewood. A clay pot takes time to cool down, making it suitable for keeping food warm for a prolonged time).

L15M being too vocal this time around shouted:

I can link that explanation to what I learned in Physical Sciences. I think a clay pot is good insulator and it cooks with pressure because of the narrow opening which reduces

the amount of steam/evaporation into the air, meaning it is a traditional pressure cooker.

The whole group laughed at the concept of a 'traditional pressure cooker' and clapped hands for L15M who enlightened them scientifically. Participants were so fascinated to relate the IKC's IK to Western science. This enlightenment resonates with Oluruntegbe and Ikpe (2011) who posited that home knowledge is vital because it helps learners to relate to and understand Western science.

Figure 5.6: Cooked *ombidi* in a clay pot

Figure 5.7: Moulded *ombidi* ready for drying

It was now time to preserve the *ombidi.* IKC2 explained that after cooking the *ombidi* and allowing it to cool, it is entirely up to the individual how they want to preserve it. As noted earlier, there are two ways to preserve *ombidi.* She carried the pot with *ombidi* to her *oshini* (a pounding area) and invited the participants to follow her. She then demonstrated the process of pounding the *ombidi.* After pounding, IKC2 took a handful of pounded *ombidi* and moulded it into a circle shape using her bare hands. She remarked:

> Omu weteko amushe, ngaha onda mana okuma ombidi na ohatushi ifana paife kutya evanda. Ohandi keli nyaneka nee kombada yonduda yeehoni, oko lapumwa okukalako tali kukuta oule wefiku limwe ile avali. Mokambiya onda fiyamo ombidi inai tuwa yoo itai mewa, o handi kei nyaneka ashike ngahenya ininge ombidi yomuyawila, ngaashi nda popya metetekelo (Can you see all of you? I have finished with the process of moulding *ombidi* in the desired shape, and now it is called *evanda.* I will place it on top of a thatch-roofed hut to dry for about two days. There is still *ombidi* remaining in the pot which can be dried and preserved as loose as it is).

A very interesting point of discussion occurred when IKC2 stated that she placed her *evanda* on top of her thatched-roof hut. The IKC2 explained that evanda dried on a thatch roof dries better than if it is dried on a corrugated iron roof. She further highlighted that evanda dried on corrugated iron sheets or any metal surface dries faster but spoils due to the higher temperature on the metal surface. She recounted:

> *evanda la nyanekwa peehoni naali la nyanekwa poshipeleki oha eli monikila. Eli la kashela poshipeleki ohali toka, loo tali kanifa ounyenye* (There is a difference between *evanda* that is dried on a thatch roof and the one dried on a metal surface, the one that dried on a metal surface is usually pale in colour and does not taste good).

To me, this was quite interesting because the IKC2 tried to scientifically explain that a high temperature to dry *evanda* makes it tasteless as it destroys nutrients.

Figure 5.8: *Evanda* drying on top of a thatched roof

Figure 5.9: Shows a difference between *evanda* dried on a thatched roof (darker) and *evanda* dried on corrugated iron (pale)

At the end of the demonstration, everyone was impressed. IKC2 was excited too and volunteered to tell the participants a short poem about *evanda*. All the participants were excited and could not wait for the poem. As she gave a vote of thanks, IKC2 remarked:

> *Nandi mupandule eshi mwali mwa pwilikina nokukufa ombinga meuliko loshinyangadalwa eshi. Ondeli neekela omweli longamo sha. Pexulilo apa onda hala nee ndi mu ningilepo okatevo kevanda* (I want to thank you all for listening to me during the practical demonstration. I hope you have learned a lot. Lastly, I want to tell you a short poem).

She then started the poem:

> *Evanda tali popi* (Evanda speaking)
>
> *Aame kanhu nda dalwa kekwakwa* (I was born by wild spinach)
>
> *Nda dalwa kombidi yomungu* (born by *ombidi*)
>
> *Nda dalwa ndina oshilimbo* (born with a symbol)
>
> *Ndina oinyala itano* (a symbol of a 5-fingered hand)
>
> *Omulumhenhu alundukila melondo* (a stubborn boy)
>
> *Metunda lOvakwayama* (well known by Ovakwanyama)
>
> *Mongadjela nomOndonga yaNangolo* (in Ongadjela and Ondonga)
>
> *Aame Shime shaHailonga* (I'm the master)

From the above excerpt, it is worth noting that IK includes singing traditional songs, dancing, poems, storytelling and rituals carried out at various events (Magwentshu, 2020; Nyika, 2017; Seehawer, 2018). This was proven by the IKC2 when she volunteered to narrate an Indigenous poem about *evanda* as shown above. This finding resonates well with Magwentshu (2020), Nyika (2017) and Seehawer (2018), who averred that IK is revealed by community elders through cultural songs (including poems), the local language, games, cultural beliefs, rituals and ceremonies. Concurring, Liveve (2022) describes how stories and songs in the native language (Oshiwambo in the context of this study) play a vital role in teaching young people about values and discipline.

As a norm, one of the participants was granted a chance to give a vote of thanks to IKC2. She thanked her for her precious time and the wonderful demonstration carried out. The learner also applauded IKC2 for going the extra mile to showcase her traditional expertise on different ways of preserving *ombidi*. *"We are truly a blessed generation to have elders who care about our education. We will make sure that the knowledge we gained here today is passed on to the next generation".* The presentation concluded with participants brainstorming some cultural beliefs about *oshikundu* and *ombidi/evanda* as shown in Table 5.1 below.

Table 5.1: The cultural beliefs about *oshikundu* and *ombidi*

Cultural practice	**Cultural beliefs**
Oshikundu	*Oshikundu* is ideal for breakfast *Oshikundu* is used to feed breastfeeding mothers and infants Slimy oshikundu signifies death in the family Oshikundu failing to ferment – something bad in the family will happen *Oshikundu* cannot be prepared by a male, he will be regarded as a coward
Ombidi/Evanda	*Ombidi* is harvested and preserved by females only, a male who preserves *ombidi* is perceived to be a coward As a married woman, there should always be evanda/ombidi in your home

	Evanda is considered to be lucky Evandu is usually prepared for important events or cultural festivals, and it should be served first (starter) *Evanda/ombidi* is prepared for people embarking on a journey, travelling or seeking job opportunities

Based on the cultural beliefs stated above, the IKC2 highlighted that the cultural practices (such as demonstrated in this study) are ancestral norms and should be respected by the whole community. Some learners disagreed and opted to challenge some of these cultural beliefs. For instance, L6M reflected:

> *At our house, only females prepare oshikundu and preserve ombidi. It is believed that this work is for women and if you do it as a male, you will be laughed at and regarded as a coward. I am not happy about this.*

From this excerpt, this learner is aware of the stereotypes related to gender issues embedded in the two traditional practices. He felt this cultural belief was discriminatory. This finding is congruent with Govender (2014), who asserts that dominant views can suppress less dominant views, for example, the cultural belief of gender regarding the preparation of *oshikundu* and *ombidi*. Moreover, to Ogunniyi (2007a), this gender-based cultural belief is a result of a dominant cognitive state that explains the ideas behind some acceptable cultural norms. In this context, the dominant culture states that males are not allowed to prepare *oshikundu* and preserve *ombidi* which discourages them; this might compromise the benefits of gender equality in a social-cultural setup.

In my view, this is just a perception and a cultural norm practised long ago by married women (doing it for their husbands to show respect) as part of daily house chores. Preparing *oshikundu* and *ombidi* has nothing to do with gender; it is not documented anywhere that it should only be done by females. Therefore, cultural practices should be carried out by both genders for cultural knowledge gain. This resonates with Nyamakuti (2019), who asserts that certain cultural practices and skills are reserved for a certain gender because of known cultural symbolic meanings which cannot be scientifically proven. Concurring, Horsthemke and Schafer (2007) regarded some of these cultural beliefs as myths since there is no scientific evidence. I strongly recommend that culture should accommodate both genders and we must be careful not to consider some Indigenous knowledge (which turn out to be myths) as the only valid knowledge and ignore other forms of knowledge (Cobern & Loving, (2011).

Another interesting cultural belief is if the oshikundu fails to ferment or becomes slimy it symbolises bad news or death in the family. Notably, *oshikundu* will normally fail to ferment if the water used is not at the right temperature (boiled water that has cooled down a bit) because it will turn into *etepi*, as noted earlier. However, if *oshipifo* is added, it will ferment but the taste will not be good. Also, *oshikundu* usually becomes slimy when diluted while warm or due to unhygienic handling of the utensils, but this does not necessarily symbolise bad news. In agreement, Nikodemus (2017) and Shinana (2019) also explained that when *oshikundu* is prepared with too hot water the enzyme activities are denatured and in lukewarm water the *embobo* will turn into *etepi*.

Drawing on Nikodemus (2017) and Shinana (2019), some of the cultural beliefs could conflict with the scientific view. This might suggest that learners with such beliefs might lack scientific knowledge about catalysts (*oshipifo* in this context) and their function in a chemical reaction such as fermentation. However, beliefs should be considered important as they create opportunities for learning as highlighted by Shinana (2019).

5.3 Learners' Journal Reflections

Learners' reflections were done as the last part of the intervention and were aimed at addressing research question four. The main aim was to find out if there was a shift (or not) in learners' attitudes and motivation and how they made sense of diffusion and osmosis after the IKCs' practical demonstrations. Notably, all the learners who participated in the focus group interview and group activity before the intervention were the same learners who were requested to write down their personal reflections. However, only the five learners' written journal reflections who participated in the sharing circle were selected and analysed in this thesis.

In addition, after the IKCs' presentations, the learners in their initial groups were requested to write down scientific concepts that emerged from the practical demonstrations. This was an interesting part of the project as participants listed many concepts shown in Table 5.2 below, which they developed into mind maps (see Figure 5.10).

Table 5.2: Concepts that emerged from the practical demonstrations

Learners' groups	**Cultural practices**	
	Making *oshikundu*	**Preserving *ombidi***
Kingdom	Dilute Smell Steam Gas Temperature Process Shapes Sour Diffusion	Colour Evaporation Mixture Liquid Solid Change in shape Smell
Phyla	Water Temperature Steam insulator Smell Solid Liquid Gas	Water Evaporation Smell Shape Osmosis Heat
Class	Diffusion Colour Mixture Temperature Change in state Filtration Carbon dioxide	Preserve Osmosis Temperature Water speed
Order	Change	Shape

	Temperature Diffusion Float Sink State of matter Catalyst	Evaporation Steam Water
Family	Water Floating Sinking Density 3 states of matter Colour Diffusion Bubbles	Nutrients Cool Boil Taste Osmosis

5.4 Data from Participatory Observations and Learners' Journal Reflections

Data gathered from these two data collection tools were analysed inductively to formulate themes. Thereafter, formulated themes were interpreted and discussed integrating the literature and theory as shown in Table 5.5 below.

Table 5.3: The themes that emerged from the practical demonstrations

Themes	**Literature/Theory**
Learners' understanding of IK	Kibirige and Van Rooyen (2006); Iseke (2013); Nyika (2017)
The importance and benefits of integrating IK into Science teaching	Kibirige and Van Rooyen (2006); Aikenhead and Jegede (1999); Kuhlane (2011); Le Grange (2017); Chikamori et al. (2019); Horsthemke and Schafer (2007)

The role of practical demonstrations in learners' attitudes, motivations and sense-making of science concepts	Asheela (2017); Mawere (2015); Ogunniyi (2007a)
Shift in learning	Mavuru and Ramnarain (2020); Asheela et al. (2021); Vygotsky (1978); Ogunniyi and Hewson (2008)

5.4.1 Learners' understanding of IK

The learners had a good understanding of what IK was soon after the presentations by the two IKCs. For instance, L2F and L4F reflected:

> *This is the traditional knowledge that is passed on from one generation to the next by our elders, through storytelling (L2F)*

> *Indigenous knowledge is the cultural knowledge practised at home (L4F)*

From these excerpts, it could be surmised that learners had a better understanding of IK and related it to knowledge passed on from one generation to the next orally. These findings resonate with the definition of IK given by various scholars such as Kibirige and Van Rooyen (2006), Mosimege and Onwu (2004) and Nyika (2017). Iseke (2013) and Nyika (2017) posited that cultural teachings from elders are passed on to new generations in the form of beliefs, songs and storytelling.

5.4.2 The importance and benefits of integrating IK into science teaching

The learners in this study were asked about their current views on IK and the importance of IK integration into science lessons. Three learners reflected:

> *IK helps the young generation to retain their cultural norms and practices (L6M).*

> *It helps us to link what we know from home and what we hear in class (L5M).*

> *IK is important because it teaches us our moral values, in the past and of the future (L2F).*

From the excerpts above, L6M's quote resonates with Msimanga and Shizha (2014) who assert that IK helps learners connect to their cultures and traditions. Moreover, L5M pointed out the link between home science and school science. These findings cohere with Aikenhead and Jegede (1999) who assert that integrating IK into school science helps smooth cultural border crossing from home to school science reducing intellectual dissonance (Le Grange, 2017).

Like Nyamakuti's (2020) study, it is worth noting that L2F highlighted the importance of considering the moral values of the past (retroduction), the present and future (retrodiction) as espoused by Chikamori et al. (2019). These scholars acknowledged that past experiences pave the way for present and future learning. In addition, the learners' views resonate with Kuhlane (2011), who asserts that prior knowledge could be in the form of learners' home experiences which they bring to school. This means when learners' prior knowledge is considered their sociocultural backgrounds are acknowledged resulting in new knowledge construction (Mavuru & Ramnarain, 2020; Vygotsky, 1978).

Some learners seemed to appreciate the importance of cultural knowledge, both at home and at school. This is evidenced by these reflections:

> *In my view, I feel local knowledge should be included in the textbooks of Biology so that learners would understand it easily (L1F)*

> *I suggest that local knowledge should be documented and added into our textbooks because it is more self-explanatory (L3M).*

It is evident from these learners' reflections that they appreciated the teaching that comes from their everyday home experiences and appealed to include these experiences in textbooks for better learning. However, these findings contradict Horsthemke and Schafer's (2007) notion that IK integration does not solve the main problem of making science relevant because it is difficult to locate scientific skills embedded in cultural practices. Fortunately, this was not the case in my study because learners could see scientific concepts in the Indigenous practices of making *oshikundu* and preserving *ombidi*.

5.4.3 The role of practical demonstrations in learners' talk and sense-making of science concepts

Learners were probed to share their experiences during the practical demonstrations of making *oshikundu* and preserving *ombidi* by the IKCs. Three learners commented:

> *My experience with IKC was awesome because I witnessed the traditional practice of making oshikundu face-to-face, something I never paid attention to at home (L1F).*
>
> *I enjoyed the practical activities by the two IKCs because it was real show. I could see, I could touch and I could ask questions, wonderful indeed (L2F).*
>
> *Storytelling about cultural beliefs around oshikundu and ombidi preservation was the most interesting part to me. It is now clear that the two traditional practices are not only supposed to be carried out by females but rather a cultural belief (L5M)*

It is clear from these learners' reflections that the practical demonstrations by the IKCs aroused their interest and curiosity in the subject. Local knowledge through demonstrations is rich with science embraced by the learners to transition from home to classroom science. These findings are shared by Mawere (2015), that using IK makes Western science more accessible. In addition, these demonstrations were practical and live and are referred to as hands-on practical activities designed to forge a link between the observations and theories of science (Asheela, 2017). This was evidenced by the learners' reflections as they stressed that using IK as a cultural tool for mediating science allowed them to visualise scientific concepts, giving them the opportunity to make sense of new science concepts (such as enzymes) but in a familiar context. Furthermore, the learners also demonstrated that they were at an emergent stage (Ogunniyi, 2007a) because they were able to relate what was being taught in the classroom to real-life situations and learn something new.

5.4.4 Shift in learning

After the presentations by the IKCs, learners had a paradigm shift in their views about science. The presentations allowed learners to relate the Indigenous practice of making *oshikundu* and preserving *ombidi* to what they were learning in science classrooms. For instance, learners took notes in their reflective journals of what they had learned during the demonstrations. L1F and L4F reflected:

I knew from home that the water for preparing oshikundu should not be too hot or cold but not necessarily the reason behind it. Now I have learned that oshikundu should be prepared with lukewarm water (optimum temperature) where enzymes function best (L1F).

I have learned that preserving ombidi should not be placed on corrugated sheets for drying due to high temperature on the surface, but instead it should be dried on a thatch roof hut. Hot temperature destroys nutrients (L4F).

These reflections indicate that learners were able to extract scientific concepts that emerged from the two practical demonstrations by the IKCs as alluded to earlier. Thereafter, learners were asked to use mind maps to identify science concepts related to the process of making *oshikundu* and preserving *ombidi*. The learners used the identified concepts to come up with mind maps (as shown in Figure 5.10 below) and tried to link them to specific explanations or topics.

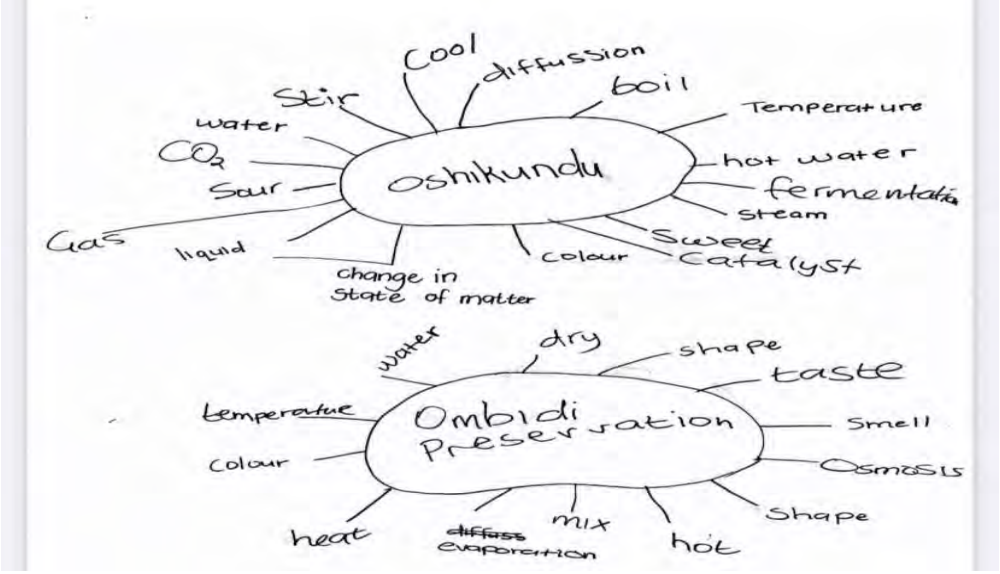

Figure 5.10: Shows learners' mind maps

The learners were able to identify a wide range of science concepts that emerged from these processes using accessible cultural tools (Asheela et al., 2021). For example, L1F identified the concept of enzymes present in the *oshikundu* and realised that they were deactivated by using cold water and denatured by using too hot water during the preparation of *oshikundu*.

Simply put, L1F and L4F seemed to have learned and acknowledged the use of knowledge systems learners bring to school (Mavuru, 2020). In my view, the above reflections affirm that learners can link home science to classroom science enabling border crossing, as advocated by Aikenhead and Jegede (1999). Moreover, throughout the practical demonstrations learners were actively engaged, discussing their observations and asking probing questions which indicated that learning was indeed taking place.

5.5 Chapter Summary

In this chapter, I presented the data from the participatory observations and the learners' reflections. This was aimed at addressing the study's third and fourth research questions. Findings revealed that learners understood what IK was. They also found the Indigenous technologies of making oshikundu and preserving ombidi useful to mediate the conceptual understanding of diffusion and osmosis. The learners' participation was very high, and they were eager to learn more during the practical demonstrations. In the next chapter, I present and discuss the findings, the recommendations and the conclusion.

CHAPTER SIX: SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

6.1 Introduction

In this chapter, I present a summary of the findings and recommendations for this study. I also suggest areas of future research, the limitations of the study and personal reflections. The chapter ends with the overall conclusion of the study.

6.2 Overview of the Study

The main goal of this study was to mobilise the Indigenous technologies of making *oshikundu* and preserving *ombidi* to mediate the learning of diffusion and osmosis. To generate data, I employed four data-gathering techniques: a sharing circle, group activity, participatory observation, and learners' journal reflections. The data generated were analysed inductively and discussed in relation to the literature and theories. Vygotsky's (1978) sociocultural theory and Ogunniyi's (2007a) CAT theory were employed as theoretical and analytical frameworks, respectively.

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

1. What enabled or constrained Grade 10 Biology learners from talking and making sense of diffusion and osmosis before the intervention?
2. What did the Grade 10 Biology learners know about diffusion and osmosis from their homes and communities?
3. What learning opportunities were created for Grade 10 Biology learners during the IKCs' practical demonstrations on the Indigenous technologies of making *oshikundu* and preserving *ombidi*?
4. How did the Grade 10 Biology learners' talk and sense-making of diffusion and osmosis shift (or not) as a result of the IKCs' practical demonstrations of the Indigenous technologies of making *oshikundu* and preserving *ombidi*?

6.3 Summary of the Findings

Here, I present my findings in relation to my research questions.

6.3.1 Research question 1

> *What enabled or constrained Grade 10 Biology learners from talking and making sense of diffusion and osmosis before the intervention?*

During the sharing circle interview learners were prompted to share traditional practices related to diffusion and osmosis from their homes or communities. The discussions and interactions during this stage provided insights into learners' motivations towards learning science. The findings revealed that learners are optimistic about learning science. Also, it was evident that learners seemed to know about traditional practices related to diffusion and osmosis. Notably, learners' performance in science has been relatively poor as evidenced in the examiners' reports (2011–2023) for external examinations in Namibia. The finding was that these poor results are attributed to learners' negative attitudes and lack of motivation. Therefore, there is a need to relate science to learners' daily life experiences to enhance better understanding and subsequently improve results. These findings resonate with Mavuru and Ramnarain (2020) who assert that integrating daily life experiences helps learners link outside science with classroom science and motivates them to learn science. Furthermore, the learners indicated daily life experiences should be included in the textbooks to make science more relevant.

6.3.2 Research question 2

> *What do Grade 10 Biology learners know about diffusion and osmosis from their homes and communities?*

The findings revealed that the participating learners had a good understanding of what prior knowledge is. For instance, L2F referred to prior knowledge as the pre-existing knowledge brought to school from home including IK. Similarly, the NCBE (MEAC, 2016) calls for teaching to build on learners' existing knowledge – their experiences from home including IK. This finding is congruent with Hashondili's (2020) and Kuhlane's (2011) studies conducted in Namibia and South Africa, respectively.

Moreover, during the practical demonstrations, both IKCs began by asking learners to identify the tools and utensils that had been prepared for the presentations. The learners managed to name all the tools in their home language and the IKCs were impressed by their responses. From these interactions, it could be surmised that the ICKs were eliciting the learners' prior knowledge (Kuhlane, 2011; Roschelle, 1995) which is crucial in the learning process. To me, this was critical, as it increased the participants' active participation (Sedlacek & Sedova, 2017).

In addition, towards the end of the first practical demonstration on how to make *oshikundu*, IKC1 asked a male participant to help her carry the 10-litre container with diluted *oshikundu* and place it on top of her locally made shack (hut) in the sun to ferment. In my view, IKC1 deliberately invited a male participant to assist her because the container was heavy; in my culture, heavy loads are mostly carried by men who are more powerful than women. It seemed the IKC employed the cultural gender-responsive approach espoused by Haimene (2023).

6.3.3 Research question 3

> *What learning opportunities were created for Grade 10 Biology learners during the IKCs' practical demonstrations on the Indigenous technologies of making oshikundu and preserving ombidi?*

The findings in this study revealed that the practical demonstrations by the IKCs enhanced active participation and interactions among learners (Sedlacek & Sedova, 2019). Notably, the learners' interactions and active participation were stimulated by using their home language (Oshiwambo in the context of this study) as a cultural tool. This means, the learners could use Oshiwambo to freely express themselves and ask questions. To my surprise, even the learners who were usually shy to talk in class freely expressed their views in this non-threatening environment. These findings are congruent with the findings of Kudumo (2020) and Nandjedi (2022). In this regard, Mavuru and Ramnarain (2020) aver that using the home language allows learners to express their thoughts freely and explicitly.

Moreover, the research findings revealed increased collaborative social interactions between the learners and IKCs. This was evident during the presentations when one of the IKCs asked a female participant to assist her in stirring the *oshikundu*. To me, this was an attempt to engage

learners in the presentation and ensure that learning took place through social interactions with peers or MKOs (Vygotsky, 1978).

Also noteworthy, the study revealed that learners could identify more science concepts embedded in the cultural practices of making *oshikundu* and preserving *ombidi* presented by the IKCs. To this, L3M reflected:

> *I was impressed to learn that there is a lot of science in the process of preserving ombidi. I have learnt that ombidi needs to be cooked and dried before storing. This corresponds with what we learn in Agricultural science under Nutrition (food preservation).*

This excerpt shows that learners could learn other science concepts than diffusion and osmosis, and they could link them to various science topics. The learners were also able to come up with various mind maps (as shown in Figure 5.8). The excerpt further demonstrates that the IKCs' presentations enabled learners to learn by relating them to their home experiences and allowed them to improve their conceptual understanding in this study – hence a shift in learning.

6.3.4 Research question 4

> *How did the Grade 10 Biology learners' talk and sense-making of diffusion and osmosis shift (or not) as a result of the IKCs' practical demonstrations of the Indigenous technologies of making oshikundu and preserving ombidi?*

The findings from this study revealed that the IKCs' presentations enhanced learners' understanding, thereby increasing their level of motivation towards science. For example, when the learners were asked to state the reasons why they chose to do science in their group activity, L6M commented: *"In the class I was placed, Biology was compulsory. I did not opt for it"*.

This excerpt shows that not all learners were motivated to do science and had no choice but to take the subject. The above excerpt also revealed that L6M's attitude towards learning science was somehow negative. However, after the presentations and the mobilisation of IK by the IKCs, the learners' participation increased (L6M in particular) and they started to value IK, citing that there was science in their local homes and communities. In my view, the practical demonstrations motivated learners to engage and learn science through integrating IK. The Indigenous practices of making *oshikundu* and preserving *ombidi* also assisted learners in bridging the gap between home science and school science.

It also emerged that the mobilisation of IK enabled learners to make sense of diffusion and osmosis through the lens of cultural heritage. These findings are congruent with the existing literature highlights the importance of community members passing on IK to the new generations. For example, Tyeda's (2024) study revealed that integrating local knowledge and involving community members who are the custodians of cultural heritage in science teaching positively impacts learners' interest and active participation.

6.4 Recommendations and Areas for Future Research

Based on the findings above, the study recommends that the Indigenous technologies of making *oshikundu* and preserving *ombidi* be integrated into teaching school science. This would make science relevant, accessible and meaningful to learners (Shinana et al., 2021). As such, the study recommends that teachers should tap into the cultural wisdom of Indigenous elders who are the custodians of cultural heritage (Klein, 2011) by inviting them into classrooms to share their expertise with the learners. More so, learners could be taken out of the classrooms into the community where traditional practices occur. This approach will strengthen the connection between schools and the local community enhancing a knowledge-sharing environment.

Furthermore, I recommend science teachers adopt a culture of using easily accessible materials (Asheela et al., 2021) when teaching science concepts that integrate IK. Teachers should always elicit their learners' prior knowledge (Kibirige & Van Rooyen, 2006) considering their sociocultural backgrounds (Mavuru & Ramnarain, 2020).

This study acknowledges the challenges in amending the curriculum and textbooks; however, the curriculum developers need to explicitly explain how IK should be integrated through lesson objectives stipulated in the syllabi. Furthermore, textbook writers should try to publish textbooks that reflect relevant IK applicable to the learners' cultural diversities.

I further recommend that teachers, through continuous professional development and workshops at both cluster and regional levels, should come together to learn how to integrate IK into science.

This research has opened opportunities for possible further research. This research could be extended, where teachers could co-develop exemplar lessons that integrate IK in their classrooms while others observe and reflect on these lessons. Further research could be done

on diffusion and osmosis where IKCs could demonstrate to teachers how preserving *ombidi* enables sense-making of the two concepts.

6.5 Limitations of the Study

The focus of the study was to explore how the mobilisation of the Indigenous technologies of making *oshikundu* and preserving *ombidi* mediate learning and sense-making of diffusion and osmosis. The sample size of 35 participants was relatively small and cannot be generalised to represent all the learners in the Ohangwena region where the study was conducted. Nonetheless, the findings provide sufficient insights to inform other Biology teachers on integrating IK into their lessons.

Although the use of the home language (Oshiwambo in the context of the study) fostered social interactions and active participation (Sedlacek & Sedova, 2017; Vygotsky, 1978), I was quite aware that some information might have been distorted or lost during the translation process. To counteract this, my critical friend ensured the data quality and validity were maintained.

Another aspect was that the IKCs' practical demonstrations were conducted in an out-of-school learning setting. For instance, we had to travel to the IKCs' home village and the learners were extremely excited. However, some learners did not pay much attention and instead, they seemed to have mini discussions due to excitement. I tried to take care of the situation and drew their attention to the presentations.

A potential limitation of the study worth noting is that I planned to develop an exemplar lesson after the IKCs' practical demonstrations. My critical friend and I had initially planned to co-develop an exemplar lesson that integrated IK that could be used in other interventions and professional development workshops (Ngcoza & Southwood, 2019). Unfortunately, this could not happen due to limited time.

6.6 Personal Reflections

My journey started way back in 2013 when I started applying for admission at Rhodes University but only secured a place in 2018. I was resilient and did not give up. As a result, in 2019 I was accepted to enrol for the BEd Honours degree. During my final year of the BEd Honours, I was introduced to the concept of IK, which was one of the key components of the

science education elective by Professor Ken Ngcoza (my lecturer and now my supervisor) with the assistance of Dr Chrispen Mutanho. At that time, I had no idea what IK was all about.

One day in class, we carried out an activity on cultural beliefs and practices about lightning. The level of engagement and social interactions were interesting as almost the whole class (which was culturally diverse) had similar responses or beliefs. For instance, it was shared that *"one may not be next to a fence or under a tree during lightning".* This was a common belief which was shared by everyone. I was so fascinated to see that there was science embedded in these cultural beliefs and started to develop a passion for IK integration into science. I thus realised that integrating traditional knowledge and cultural beliefs in teaching abstract concepts has the potential to make science interesting for learners – something I had never thought of since I began teaching.

My passion for contextualising science in my classroom and the positive vibes I got from Professor Ken inspired me to pursue my studies. For instance, Professor Ken would always address us (BEd Honours students) as *"future scholars"* and often make remarks such as *"We will discuss that at master's level, or when you will be writing your master's proposals".* All these motivated me to enrol for my master's degree in 2021.

I experienced a humble beginning to this journey. I had to write a research proposal as a guiding tool for my master's thesis, and I should admit that I struggled throughout. My writing pace was slowed down as I was a full-time secondary school teacher, a student, a wife and an expectant mother. I struggled to strike a balance between my schoolwork and family responsibilities, but I managed to submit my proposal in 2022. The process of approving my proposal and obtaining ethical clearance from the Education Faculty Research Ethics Committee (EF-REC) was smooth; in June 2022, permission was officially granted to collect data and thumbs up to this committee.

Due to the Covid-19 pandemic in 2020/2021, my financial status during the year of 2022 also discouraged me because I owed the university a huge amount of money. I lost momentum and I had to pause for almost nine months (June–March), doing absolutely nothing while I was supposed to be collecting data and writing up the first part of the thesis. Nonetheless, giving up on my studies did not cross my mind and I still had so much hope to begin my research. More so, I was fortunate to have a supportive and inspiring supervisor, Professor Ken who constantly motivated me not to give up. A week would not pass by without receiving an email

from him asking for my research progress and I should confess, sometimes I did not reply. One day I received a call from one of my fellow master's students (a friend and a sister) who took her precious time to motivate me and give me some tips and advice on how to continue with my research.

The advice and motivation I constantly received from my supervisor and fellow master's scholars proved fruitful. The ubuntu spirit instilled in us by Professor Ken was profound and I still believe in one of his favourite quotes: *"If you want to walk fast, walk alone, if you want to walk far, walk together".* We continuously supported each other and shared valuable resources to enhance our professional growth.

As a result, I was re-energised and collected my data; I aimed to complete my research study by the end of the year (2023). While collecting my data, I struggled to find recent literature relevant to my study. To make matters worse, I could not access useful platforms such as Google Scholar or RU-connect. However, I reached out to one of the university's Information Technology specialists, Dr Clement Simuja during one of our contact sessions at the National Institute for Educational Development (NIED) for assistance and the issue was resolved. This, and other personal challenges greatly affected the pace of writing my thesis.

Despite encountering multiple challenges, this research study provided insights and broadened my perspective. I have learned how to integrate IK into my classroom to mediate the learning of abstract concepts. The study taught me the importance of prior everyday knowledge and acknowledging what my learners already know during my teaching. The findings of this study made me realise that language is an important tool in teaching and learning as I observed how it enhanced active participation among participants (Mavuru & Ramnarain, 2019; Msimanga & Lelliot, 2014).

This study has given me the opportunity to work with my learners as co-researchers and the IKCs. The IKCs' presentations made me realise that there is science in our homes and communities. I also realised that the science I teach in my classroom is the same as the science at home. The ubuntu spirit shown by the IKCs during the demonstrations that allowed them to showcase their cultural heritage and wisdom was profound. The IKCs willingly opened their doors to us to share their knowledge using their easily accessible resources. Most importantly, they were caring and loving and felt proud that their culture was valued at school. What a

rewarding journey indeed: "*Uha pandula ngo vake"* (If you don't appreciate good deeds, one day you will end up stealing).

6.7 Conclusion

This study sought to mobilise the Indigenous practices of making *oshikundu* and preserving *ombidi* to support Grade 10 Biology learners in talking and making sense of diffusion and osmosis. This was done by tapping into the cultural heritage of the IKCs regarded as the MKOs (Vygotsky, 1978) in this study. Through the IKCs' practical demonstrations, the learners embraced the use of easily accessible resources in doing hands-on practical activities (Asheela et al., 2021). Consequently, learners were able to link home science to science taught at school. The findings from this study also revealed that the integration of IK into teaching science has the potential to enhance meaningful learning.

The study showed that the learners valued the presence of the IKCs and regarded them as MKOs because they were more knowledgeable about IK (Vygotsky, 1978). Also, the cultural stereotype of not questioning elders was challenged. As a result, the learners were able to link the IKCs' explanations during the presentations to the explanations they learned at school. This finding validates Taylor and Cameron's (2016) notion that IK has the potential to complement Western knowledge, and that there should be a dialogue between these two knowledge systems (Seehawer & Breidlid, 2021).

It also emerged in this study that home language plays a vital role as it increases learners' participation and social interactions (Sedlacek & Sedova, 2017). Therefore, there is a greater need for teachers to consider their learners' sociocultural backgrounds when mediating learning of science (Mavuru & Ramnarain, 2020) to make science more accessible and meaningful to their learners.

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APPENDICES

Appendix A: Ethical clearance letter

Rhodes University, Education Faculty
Research Ethics Committee
PO Box 94, Makhanda, 6140, South Africa
Tel: +27 (0) 46 603 8393
Fax: +27 (0) 46 603 8028
email: e.rosenberg@ru.ac.za

https://www.ru.ac.za/researchgateway/ethics/

25 July 2022

Prof Kenneth Ngcoza

Education Department

K.Ngcoza@ru.ac.za

Dear Prof Kenneth Ngcoza and Ms Helena Shilomboleni

Re: Mobilising the indigenous technologies of making oshikundu and preserving ombidi to support Grade 10 Biology learners to make sense of the concepts of diffusion and osmosis

APPLICATION NUMBER: 2022-5559-6815

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

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

Should any substantive change(s) be made during the research process, that may have ethical implications, you should notify the Education Faculty REC Chair via email. This includes changes in investigators. The REC Chair will advise as to whether a new application is necessary.

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

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

Sincerely,

Prof Eureta Rosenberg

Chair: Education Faculty Research Ethics Committee

Appendix B: Proposed timeframe for this study

Table 1: Proposed timeframe for this study

Date	**Activity**
January – October 2021	Writing of research proposal
November 2021	Finalising research proposal, data-gathering tools, and ethics application and consent letters
January - April 2022	Submission of the final research proposal to the EHDC. Designing of data-gathering tools
April – May 2022	Piloting data-gathering tools – writing up Literature Review and Methodology chapters
June – July 2022	Data gathering and analysis
August - September 2022	Data analysis and discussion of findings
October 2022	Writing up and preparing for submission of the first draft
November–December 2023	Corrections, editing, proofreading and submission of the second draft
June 2024	Submission of final full thesis for examination

Appendix C: Tools, methods and purpose of data-gathering

Table 1: Shows the tools, methods and purpose of gathering information

Stage	**Method to be used to gather data**	**Purpose**	**Research question**
Stage 1	Focus group interview	To find out the learners' attitudes towards learning diffusion and osmosis	1
Stage 2	Group Activity	To determine learners' individual prior- knowledge	2
Stage 3	Participatory observation	To find out the influence of integrating IK in teaching, Mediation of learning using model lessons on diffusion and osmosis that integrate IK	3 & 4
Stage 4	Learners' journal reflections	To find out the influence of model lessons that integrate IK in the teaching of science	4

Appendix D: Focus group interview schedule

Focus group interview schedule

1. Why were you chosen to represent your group for this focus group interview?
2. Why did you choose to do Biology in Grade 10?
3. Could you please tell me how do you learn science concepts in Biology?
4. What do you understand by local knowledge?
5. What relevance does knowledge from home or community have at school?
6. What traditional practices at your home or community do you know of? How are these related to the Biology taught at school?
7. In what ways are biological concepts of diffusion and osmosis relevant to your everyday life?
8. Could you please tell me how best should the topics diffusion and osmosis can be taught and learned?
9. Is there anything else that you would like to share with me?

Appendix E: Group activity questions

Group activity questions

1. What are some traditional practices that you know from your homes or community related to the concept diffusion?
2. What are some traditional practices that you know from your homes or community related to the concept osmosis?
3. Briefly differentiate between diffusion and osmosis.
4. How is diffusion related to osmosis or not?

Appendix F: Journal reflection questions

Journal reflections questions

1. What are your current views on local knowledge?
2. How did you understand local knowledge before the community members' presentations?
3. What did you learn about local knowledge after the community members' presentations?
4. What did you enjoy (or not) during the community members' presentations?
5. What do you think is the relevance of local knowledge in Biology?
6. Any other comments/suggestions

Appendix G: Learners' journal reflections

Journal reflections questions

1. What are your current views on local knowledge?

   local knowledge is better than memorising and studying books, because in local knowledge everything is visible and easy to catch or master.

2. How did you understand local knowledge before the community members' presentations?

   I never understood it, because I didn't get eye to eye with it, and local knowledge will teach us more, better than just learning in books.

3. What did you learn about local knowledge after the community members' presentations?

   I learned that local knowledge is the best in revealing processes, because learners will not forget about them.

4. What did you enjoy (or not) during the community members' presentations?

   I enjoyed it, because I learned alot and I will not forget.

5. What do you think is the relevance of local knowledge in Biology?

   - It is important, because everything in it is taught in biology.

6. Any other comments/suggestions

   - local knowledge will be my way to science!

Journal reflections questions

oto Litengahelini

1. What are your current views on local knowledge?- yokeumbo

My view on local knowledge I just want to say that it educate us on how to know the idea and to learn more about the local knowledge on how to learn the old thing.

2. How did you understand local knowledge before the community members' presentations?

For my understand I think it only walk from home but it doe's not come do do at school. I also understand that local knowledge it only thing which oraaly pass and the year.

3. What did you learn about local knowledge after the community members' presentations?

I learn more about how to come up thing, how old (idoom) thing were doing by the old people. how to prepare a traditional food like ombidi and oshikundu

4. What did you enjoy (or not) during the community members' presentations?

During the community member's presentations I am enjoy about the diffuse and osmosis how to prepare oshikundu and ombidi and the idoom/old thing that we were do.

oshili shafimana ngaashi pi okulongifa

5. What do you think is the relevance of local knowledge in Biology?

I think it very importance to relevance of local knowledge because is learn as the old say about thing and teaching how thing come up, how a kind to do a certain idoom that you are teaching

6. Any other comments/suggestions

About the comment I will comment about Local knowledge to continue through our everyday life. I will also suggestion about the idoom of the oshikundu and ombidi to continue with old thing

Journal reflections questions

1. What are your current views on local knowledge?

Mine are fantastic, because I think local knowledge make us understand topics better.

2. How did you understand local knowledge before the community members' presentations?

I understand it better and even if but now I know it more better and even if you wake me up in the morning at 1:00Am, I will be able to answer you.

3. What did you learn about local knowledge after the community members' presentations?

I learn alot for example diffusion, osmosis and change in matter.

4. What did you enjoy (or not) during the community members' presentations?

I enjoyed alot because I discovered alot and we ate our food up.

5. What do you think is the relevance of local knowledge in Biology?

So we can get to know what our teachers taught us more better and know how to differentiate.

6. Any other comments/suggestions

local knowledge in Biology is needed so we can get to know things (Topics) better by comparing with the local society

Journal reflections questions

1. What are your current views on local knowledge?

-I think local knowledge is good because we ob
~~class~~ presentation. In that presentation we learned
how to come up with Oshikundu and Evanda.

2. How did you understand local knowledge before the community members' presentations?

Before the community member's presentation, I was
don't know how to come up with Oshikundu and
Evanda and which method ~~xx~~I will use to come
up with those things.

3. What did you learn about local knowledge after the community members' presentations?

- I learned method to be used so that I/we can
come up with Oshikundu and Evanda. Process that
take place in these things.

4. What did you enjoy (or not) during the community members' presentations?

-I enjoy the methods that were being used.
-I am saying I enjoy method that I was do
not know.

5. What do you think is the relevance of local knowledge in Biology?

Presentation is relevance of local knowledge in
Biology because is what we do at all home and
what you can observe.

6. Any other comments/suggestions examples of

-We need to use local knowledge in Biology text
books because local knowledge is easy to observe
and easy to do.

Journal reflections questions

1. What are your current views on local knowledge?

Local knowledge is better than memorising and studying books, because in local knowledge everything is visible and easy to catch or master.

2. How did you understand local knowledge before the community members' presentations?

I never understood it, because I didn't get eye to eye with it, and local knowledge will teach us more, better than just learning in books.

3. What did you learn about local knowledge after the community members' presentations?

I learned that local knowledge is the best in revealing processes, because learners will not forget about them.

4. What did you enjoy (or not) during the community members' presentations?

I enjoyed it, because I learned a lot and I will not forget.

5. What do you think is the relevance of local knowledge in Biology?

- It is important, because everything in it is taught in biology.

6. Any other comments/suggestions

- local knowledge will be my way to science!

Appendix H: Sharing circle focus group questions and responses

Sharing circle focus group interview (SCFGI) questions and the responses from each participant

Research Question: What are Grade 10 Biology learners' attitudes and motivation towards learning diffusion and osmosis before the intervention?

Question 1: Why were you chosen to represent your group for this SCFGI? (Icebreaker)	
Participant	*Responses*
L1F	I was chosen because I'm the most talkative person in our group and I like Biology.
L2F	Because I'm confident and I'm the only one who speaks loud in our group.
L3M	The same as L2F…and I speak louder.
L4F	My group mates have chosen me because of the trust they have, and simply because I am a public speaker.
L5M	I was randomly picked through the draw and I accepted.
L6M	How did L6M respond to this question?
Question 2: Why did you choose to do Biology in grade 10?	
L1F	I want to be a doctor, and for me to become a doctor I have to study Biology.
L2F	I chose Biology because I want to become a surgeon, and the career requires Biology which is the study of human body.
L3M	I want to be a Biologist in future.

L4F	I grew the curiosity to learn science when I was in grade 8, and also because my preferred career is related to Biology. *Follow-up question: what is your preferred career?* To become a cardiologist.
L5M	I performed well in Life Science in the previous grade and developed the interest in Biology.
L6M	Biology is compulsory in the class I was placed, I did not opt for it.
Question 3: Could you please tell me how do you learn science concepts in Biology?	
L1F	I learn concepts from the textbooks.
L2F	I learn with understanding from the teachers' presentations in class.
L3M	By listening to the teachers' explanations and also through class activities given by the teachers.
L4F	I try to relate the concepts to my everyday life.
L5M	I listen to the teacher's explanations in class and do further research in textbooks for better understanding.
L6M	By understanding, practicing and observing.
Question 4: what do you understand by local knowledge?	
L1F	Is about knowing local things that has to do with Biology.
L2F	In my opinion, I think is the local practices that we do in everyday life.

L3M	Local knowledge refers to the things we do at home like cooking, milking, cultivating, preparing traditional brews and collecting firewood.
L4F	Local knowledge refers to the knowledge I have from my home background.
L5M	Hhmmm…I think local knowledge is all about the wisdom we get from our parents and grandparents.
L6M	Is the information I know from my cultural background such as milking cows, ploughing and weaving storage baskets.
Question 5: What relevance does knowledge from home or community have at school?	
L1F	Local knowledge is useful in school because it helps us to apply things we know from home.
L2F	It all depends if knowledge is important and allowed in school. Some knowledge are not relevant like how to make traditional whisky *(ombike)* which is alcoholic and destroys families.
L3M	Something that is done at home and it is taught at school will help you relate and understand it better because you know about it already from home.
L4F	Most of the things we do or see at home are the ones we do at school and this helps me understand science concepts better.
L5M	If the knowledge from home is similar to the knowledge learned in class, yes it can be relevant.
L6M	Everyday life is about science, so this helps us to understand science better and makes it relevant.

Question 6: What traditional practices at your home or community do you know of? How are these related to the Biology taught at school?	
L1F	Preserving a variety of food such as fruits, wild spinach (ombidi), meat (eedingu) for later use. This practices are pure biological concepts in food preservation topic.
L2F	Preparing traditional brews such oshikundu and omalodu. For example, when water is added to the mixture to dilute it and obtain more brew is in relation to diffusion.
L3M	Preparing traditional whisky. I always watch my grandmother when preparing this traditional whisky and observes water(whisky) in a condenser drops in the flask as a result of condensation. This is pure science.
L4F	"Can I say it in my vernacular, Ms?" "Yes please"…Well, *oha tu xwike omadimba ngeenge hatu vele eshikisha ndee hatu fenya omwifi oo taudi pokakangwa, ile tutule omadima move mapyu ndee hatutu li nyukumine.* [We burn the leaves of a bitterboss plant (Pechuel-loeschea) to inhale in the smoke when we suffer from flu, and also put its leaves in hot water to for steaming].
L5M	Drilling a borehole is a traditional practice which is also taught is school science. Water will move from far underground where highly concentrated to the low concentration area which is an example of osmosis.
L6M	Rrrr…hmmm, I have no idea Ms.
Question 7: In what ways are biological concepts of diffusion and osmosis relevant to your everyday life?	
L1F	We apply these concepts we have learnt at school in our home settings.
L2F	They are relevant because diffusion and osmosis takes place at home. For instance, putting salt in the soup or adding sugar to a cup of coffee. The particles dissolve through the process of diffusion.

L3M	Concepts learnt at school help us to understand and do things better at home. For instance, when preparing oshikundu, flour will dissolve in water through diffusion. I have learnt that I can speed up the process by using boiled water and stir the mixture.
L4F	We have learnt that diffusion helps human beings to breathe through gaseous exchange on the lungs. Same for osmosis which help plants absorb water and mineral salts through their roots.
L5M	The knowledge we gain at school helps us to educate our parents more. For example, I always tell my grandmother not to dry her ombidi (wild spinach) on a metal surface or corrugated iron as this will speed up the process of osmosis which might destroy all the nutrients. Consequently, the spinach will become tasteless and turns white.
L6M	The concept diffusion we learn at school is the same concept that helps us to smell good (delicious) food in the kitchen, from a distance.
Question 8: Could you please tell me how best the topics diffusion and osmosis can be taught and learned?	
L1F	These concepts can be taught better by explaining in our vernaculars or relating to local knowledge.
L2F	Must be taught using examples of local practices for better understanding.
L3M	Science concepts should be taught using modern technologies such computers.
L4F	By doing experiments and by relating these concepts to everyday life.
L5M	Hhmmm, with more practical examples and real-life experiences.
L6M	We will learn better if teachers can assist to translate some or most concepts in Oshiwambo.

Question 9: Is there anything else that you would like to share with me?	
L1F	I am very much delighted to be part of this wonderful engagement. Thank you.
L2F	I have a suggestion…For the book writers to include practical examples of local knowledge in our Biology textbooks, instead of just Western examples.
L3M	I want to urge all science teachers to always relate their presentations to local practices.
L4F	No, thank you for your time Ms.
L5M	This was a good interaction indeed and I learnt a lot. Best wishes for your studies.
L6M	Nothing, Thank you.

Appendix I: Observation schedule

Observation schedule (adapted from Nikodemus, 2017)

Q.3. What learning opportunities are created for Grade 10 Biology learners during the practical demonstrations of the Indigenous technologies of making *oshikundu* and the preservation of *ombidi* by expert community members?

Name of the school……. Observation Date …… Grade:…..

Subject: ……... Number of Learners: …….

Lesson Topic: ……. Observer: …….

Social interactions	**Remarks**
The participation of learners during the lesson	
The interaction of learners in class with one another	
The interaction of learners in class with the teacher	
The interaction of learners with the community members	
How learners take other learners' views	
How learners are motivated in the lesson	
How learners treat one another	
Learners' courage to respond to their peers' thoughts and discussion	
Other things:	

Language	**Remarks**

The use of English and how it impacts participation	
How home language is used in class	
How learners' everyday experiences and ways of talking and knowing are expressed during the lesson	
Other things:	
Learner engagement	**Remarks**
The involvement of learners in active learning	
How learners are sharing information	
Learners' participation opportunity in questions and activities	
Learners' openness and interest in the lesson	
Others things:	
Attitudes	**Remarks**
Learners' view on IK	
Learners' interest in IK	
Leaners' enjoyment of the lesson as a whole	
Learners' feelings about the use of IK in the lesson	
Learners' attitudes before and after the lesson where IK is integrated	
Other things:	

Appendix J1: Letter to the Regional Director of Education, Arts and Culture, Ohangwena Region

RHODES UNIVERSITY
Where leaders learn

The Regional Director

Ministry of education, Arts and culture

Ohangwena region

Dear Mr Hamatwi

Re: Request for permission to conduct educational research with Grade 10 learners at Ongha Senior Secondary School

I am Helena N I Shilomboleni (Student number: 19S9556), a part-time student doing a master's in science education at Rhodes University, South Africa and also a Maths and Science teacher at Ongha Secondary School. I hereby humbly request your permission to conduct a research study with learners at Ongha Secondary School in your region. My research is an intervention in the integration of Indigenous technologies of making *oshikundu* and preserving *ombidi* to support Grade 10 Biology learners in making sense of diffusion and osmosis.

The study is motivated by the fact that these two concepts are misunderstood and mostly poorly performed by learners which is evident in the Biology examiners' reports of the past six years. My assumption is that this might be due in part to the fact that learners do not acquire conceptual understanding and also, the science curriculum is not explicit on how local Indigenous technology should be integrated in science teaching in order to assist learners understand concepts better. It is hoped that this study might help learners gain some insights on how Indigenous technology can be used to contextualise and make science relevant.

Activities done during the study will be audio and video recorded for validation. I will seek written consents from parents or guardians of the learners and the learners themselves as per

the university's ethics. I will also ensure that the data collected will be kept safely in the school's strong room for a certain period of five years. Additionally, I will work with a Grade 10 - 11 Biology teacher who will help me in observing the learners as well two community members who will be demonstrating the two local technologies to the learners. I plan to conduct the study between March and April 2022.

Looking forward to hearing from you soon.

FILL IN

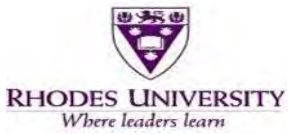
I hereby grant permission to the researcher to conduct the educational research.

Name……Signature……Date ……

Yours Sincerely

HNI Silomboleni +264 81290 2820/ helena860325@gmail.com or my supervisor +27788852143/ k.ngcoza@ru.ac.za or (nhotamu49@yahoo.com)

Appendix J2: Letter to the Inspector of Education, Ongha Circuit



The Inspector of Education

Ongha Circuit

Ohangwena region

Dear Mr Amoomo

Re: Request for permission to conduct educational research with Grade 10 learners at Ongha Senior Secondary School

I am Helena N I Shilomboleni (Student number: 19S9556), a part-time student doing master's in science education at Rhodes University, South Africa and also a Maths and Science teacher at Ongha Secondary School. I hereby humbly request your permission to conduct a research study with learners at Ongha Secondary School in your circuit. My research is an intervention on the integration of Indigenous technologies of making *oshikundu* and preserving *ombidi* to support Grade 10 Biology learners to make sense of the concepts diffusion and osmosis.

The study is motivated by the fact that these two concepts are misunderstood and mostly poorly performed by learners which is evident in the Biology examiners reports of the past six years. My assumption is that this might be due in part to the fact that learners do not acquire conceptual understanding and also, the science curriculum is not explicit on how local Indigenous technology should be integrated in science teaching in order to assist learners understand concepts better. It is hoped that this study might help learners gain some insights on how Indigenous technology can be used to contextualise and make science relevant.

Activities done during the study will be audio and video recorded for validation. I will seek written consents from parents or guardians of the learners and the learners themselves as per the university's ethics. I will also ensure that the data collected will be kept safely in the school's strong room for a certain period of five years. Additionally, I will work with a Grade 10 - 11 Biology teacher who will help me in observing the learners as well two community members who will be demonstrating the two local technologies to the learners. I plan to conduct the study between March and April 2022.

Looking forward to hearing from you soon.

FILL IN

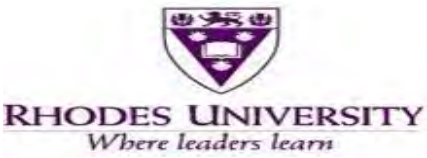
I hereby grant permission to the researcher to conduct the educational research.

Name……Signature……Date……

Yours Sincerely

HNI Silomboleni +264 81290 2820/ helena860325@gmail.com or my supervisor +27788852143/ k.ngcoza@ru.ac.za or (nhotamu49@yahoo.com)

Appendix J3: Letter to the biology teacher



Enquiries: Ms HNI Shilomboleni Cell number: +264 81290 2820

Dear …….. (Teacher's Name)

Re: Request for your participation in a research on the integration of local knowledge to mobilise learning of the concepts diffusion and osmosis

I am Helena N I Shilomboleni (Student number: 19S9556), a part-time student doing master's in science education at Rhodes University, South Africa and also a Maths and Science teacher at Ongha Secondary School. I hereby request for your participation in my research project as critical friend for a duration of about three (3) weeks.

The study will mobilise integration of local/Indigenous technologies of making oshikundu and ombidi preservation to support Grade 10 Biology learners to make sense of the concepts diffusion and osmosis. The learners will be co-researchers and will be required to (i) collect data from community members through observation, (ii) do a group activity and present it in class, (iii) interact with the two community members during the presentations and (iv) write reflections. You will interact with two expert community members who will be doing practical demonstrations of the afore-mentioned Indigenous technologies, and also assist me in videotaping these activities while I present one lesson which we (you and me) will co plan. I plan to conduct the study between March – April 2022.

Kindly be informed that your participation in this study is voluntary. It is therefore your right to withdraw at any time. The identity and views of the participants will not be revealed, I will maintain anonymity, and data that will be collected will not be used against the aims and

objectives of this study. Should you agree to participate in the study, you are reminded that all information and data collected during the study will be kept confidential and will be kept in the school'strong room for at least a period of five years. The data collected will be used for reporting in my thesis and publications. For any clarity, I can be reached on 0812902820 or email (helena860325@gmail.com) or contact my supervisor (Prof. Kenneth M. Ngcoza at Rhodes University) k.ngcoza@ru.ac.za.

If you agree or do not agree to participate in this research, please complete the consent form below and indicate your choice by making a tick (√) in an appropriate box below.

.

I …… (Full name of the teacher), hereby confirm that I understand the content of this document and the nature of the research. I therefore,

☐ Agree to participate in the study, ☐ Do not wish to participate in the study

I am aware that information about the study must be kept confidential and high level of professionalism is expected from myself.

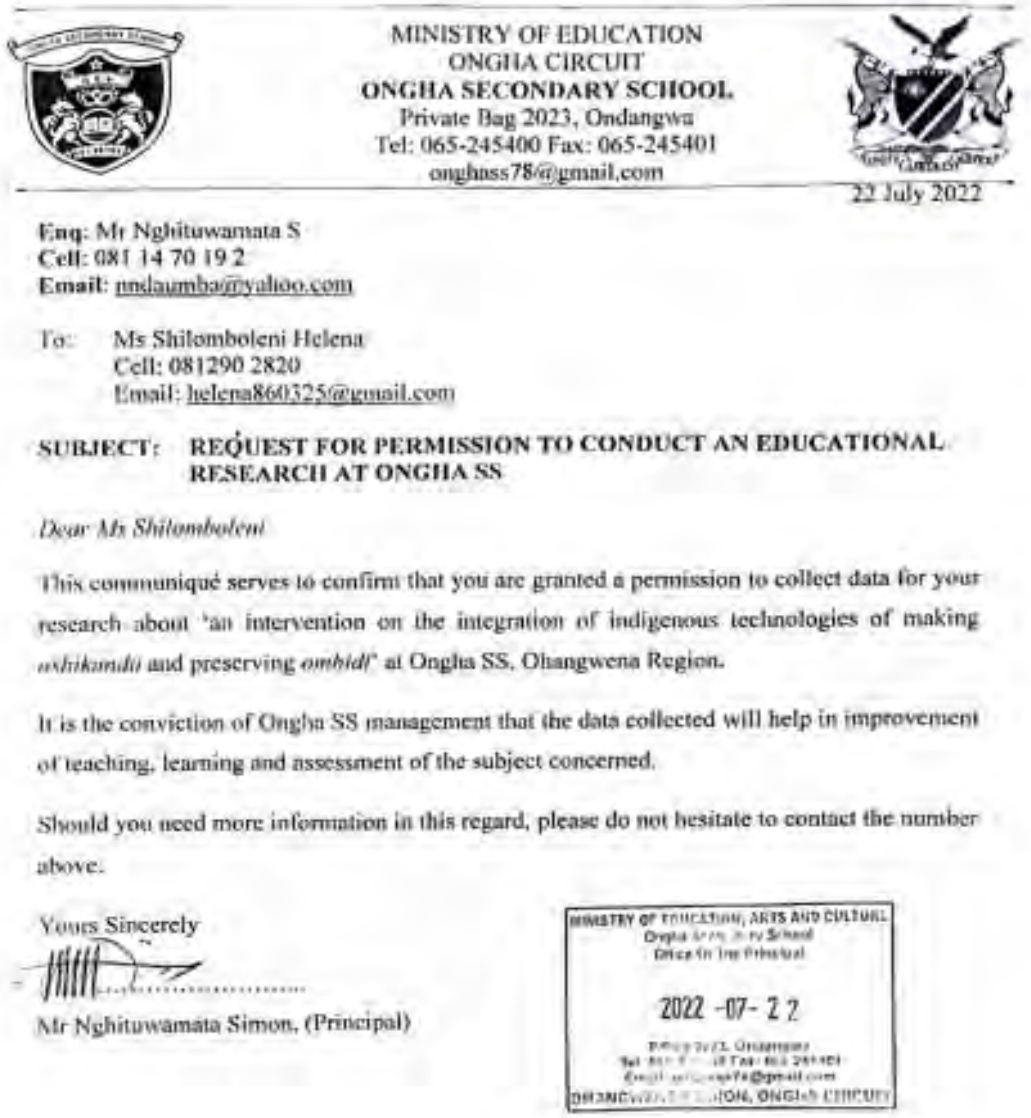
Signature: ---------- Date: ----------

_____

Yours Sincerely

HNI Shilomboleni

Appendix K: Permission letter to Ministry of Education, Ongha Circuit



MINISTRY OF EDUCATION
ONGHA CIRCUIT
ONGHA SECONDARY SCHOOL
Private Bag 2023, Ondangwa
Tel: 065-245400 Fax: 065-245401
onghass78@gmail.com

22 July 2022

Enq: Mr Nghituwamata S
Cell: 081 14 70 19 2
Email: nnslaumba@yahoo.com

To: Ms Shilomboleni Helena
Cell: 081290 2820
Email: helena860325@gmail.com

SUBJECT: REQUEST FOR PERMISSION TO CONDUCT AN EDUCATIONAL RESEARCH AT ONGHA SS

Dear Ms Shilomboleni

This communiqué serves to confirm that you are granted a permission to collect data for your research about 'an intervention on the integration of indigenous technologies of making *oshikundi* and preserving *ombidi*' at Ongha SS, Ohangwena Region.

It is the conviction of Ongha SS management that the data collected will help in improvement of teaching, learning and assessment of the subject concerned.

Should you need more information in this regard, please do not hesitate to contact the number above.

Yours Sincerely

Mr Nghituwamata Simon, (Principal)

MINISTRY OF EDUCATION, ARTS AND CULTURE
Ongha Secondary School
Office of the Principal
2022 -07- 22
ONGHA CIRCUIT